吉林大学仪器科学与电气工程学院

College of Instrumentation & Electrical Engineering, Jilin University

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Academic Practice “Six in One” Training Project

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航空电磁探测数据去除发射波形影响的研究*

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摘要：在时间域航空电磁探测中，由于不同发射电流波形的设置，电磁数据不具有统一形式，并存在数据量大，数据处理速度慢等问题。以非正交 e 指数为基函数，并将其与接收机高空飞行时记录的电流发射波形进行预卷积，形成新的 e 指数基函数，该基函数包含发射波形的影响，通过奇异值分解算法和解卷积算法，将电磁数据分解为该基函数的线性组合，达到去除发射波形影响的目的。将电磁数据从时间域转换至 tau 域，最终形成与飞行测量系统无关的电磁数据标准形式，提供一套可应用于航空电磁数据转换为 tau 域的算法。

关键词：奇异值分解算法 tau 域 解卷积

中图分类号：P631 **文献标识码**：A

Research on Removing the Influence of Airborne Electromagnetic Data Lanch Waveforms

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Abstract: According to the time-domain airborne electromagnetic survey, electro-magnetic data does not have a unified form when emission current waveforms are different . There are some problems still exist, including a large amount of data, slow speed data processing and so on. Non-orthogonal e exponential function, and the emission current of the receiver records must be pre-convolution to form a new basis function, and the basis function contains the system response of the emission current. The electromagnetic data is decomposed as a linear combination of the basis functions using singular value decomposition and de-convolution algorithms to remove the impact of the emission waveforms . According to a conversion of the time-domain airborne electromagnetic data into tau-domain , a kind of electromagnetic data standard form is formed, which has nothing to do with the flight measurement system. Eventually a set of algorithms applied to converting the airborne electromagnetic data into tau-domain are provided.

Key words: singular value decomposition algorithm tau-domain de-convolution

0 引言

航空电磁法是航空物探常用一种测量方法[1]，具有速度快，成本低，通行性好，可大面积覆盖，可用于海域探测等优势。主要用来快速普查金属矿体，大面积地质填图，水文地质，工程地质勘查和环境监测等领域[1]。

目前我国 AEM 发射波形主要采用方波或梯形波，观测时间为无发射电流期间（发射电流 $I(t)=0$），即所谓 off-time 观测[2]。通过接收线圈测量二次场空间分布形态，就可发现地下异常地质体的存在，并确定异常体的电性结构和空间分布形态。本研究通过反卷积算法[3]，将电磁数据分解为该基函数的线性组合，达到去除系统响应、发射电流波形和采样时间窗影响的目的[4]。将电磁数据从时间域转换至 tau 域，形成与飞行测量系统无关的电磁数据标准形式是电导率深度成像解释技术通用性实现的重

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项目类型：创新项目

要基础，有利于快速反演。

1 奇异值分解

奇异值分解 (singular value decomposition, SVD) 是一种正交矩阵分解法[5,6]；SVD是最可靠的分解法，

$$[U,S,V]=SVD(A) \tag{1}$$

其中U和V代表二个相互正交矩阵，而**S**代表一个对角矩阵

$$A=[U][S][V^{T}] \tag{2}$$

使用SVD分解法的用途是解最小二乘法和数据压缩。

2 任意发射电流产生的电磁响应计算

根据航空电磁系统探测原理，接收线圈感应电动势与发射电流得关系：

$$dB/dt = i(t)*h(t) \tag{3}$$

可用如图 1 所示的框图表示，

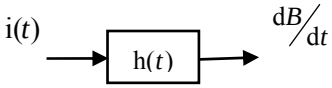

图 1 航空电磁系统输入输出示意图

Fig.1 The schematic diagram of the aem system input and output

其中 i(*t*)表示发射电流，d*B*/d*t* 代表接收线圈感应电动势， h(*t*) 为该系统对于冲激响应在接收线圈处产生的归一化感应电动势，载入测试时间数据对数坐标下得到图像如图 2。

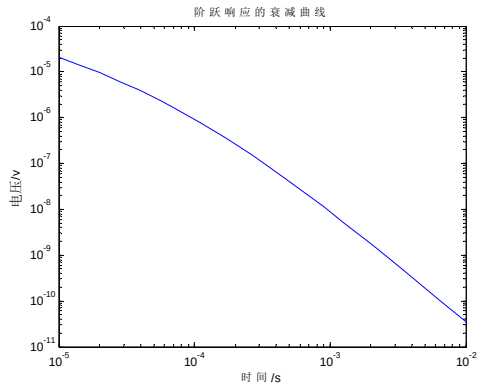

图 2 阶跃响应的衰减曲线

Fig.2 The decay curve of the step response

将航空电磁系统看作一个线性时不变线性系统，已知发射电流为阶跃波形 u(*t*) 时，在接收线圈处产生的归一化感应电动势 g(*t*)，已知冲激信号和阶跃信号有如下关系：

$$\delta(t) = u'(t)$$

则输入冲激信号时产生的归一化感应电动势为 g′(*t*)，因此任意波形 i(*t*) 在接收线圈处产生的归一化感应电动势[7]可写成

$$dB/dt = i(t)*g'(t) \tag{4}$$

根据卷积交换律性质有

$$dB/dt = i'(t)*g(t) \tag{5}$$

实验中载入任意三种波形可分别得到其响应曲线，图 3 为梯形波及其导数，发射波形导数与阶跃响应卷积则可得到其响应曲线如图 4，截取 off-time 段响应曲线如图 5。

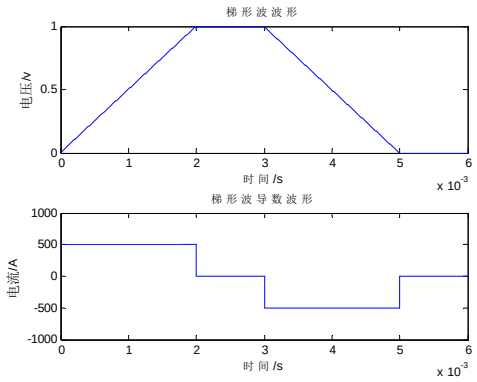

图 3 梯形波波形及其导数

Fig.3 Trapezoidal wave and its derivative

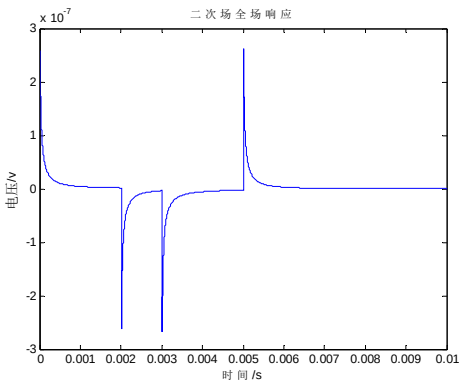

图 4 梯形波二次场全场响应

Fig.4 The second full response of the trapezoidal wave

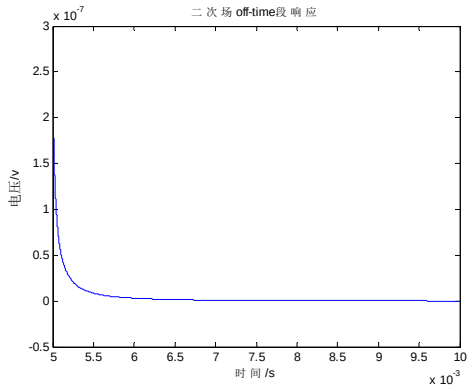

图 5 梯形波二次场 off-time 段响应

Fig.5 The off-time period of trapezoidal wave secondary response

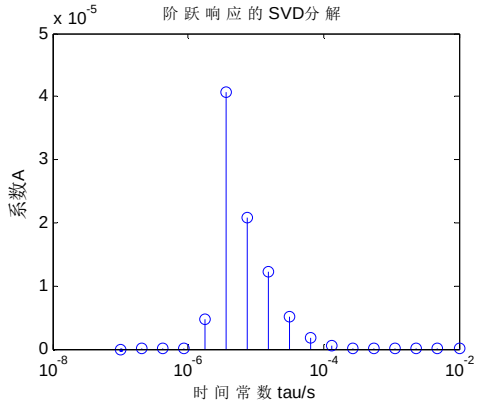

图 6 阶跃响应的 SVD 分解系数

Fig.6 The SVD decomposition coefficient of the step response

3 电磁数据的 tau 域参数的确定

阶跃响应的衰减曲线如图 2。对原基底进行 SVD 分解计算，阶跃电流响应：

$$A(t)=\sum_i A_i \exp(-\frac{t}{\tau_i}) \tag{6}$$

$$\begin{bmatrix} D_1 \\ . \\ . \\ . \\ D_n \end{bmatrix} = \begin{bmatrix} AofT(t_1,\tau_1) & . & . & AofT(t_1,\tau_m) \\ . & & & . \\ . & & & . \\ AofT(t_n,\tau_1) & . & . & AofT(t_n,\tau_m) \end{bmatrix} \begin{bmatrix} A_1 \\ . \\ . \\ A_m \end{bmatrix} \tag{7}$$

其中 **[D]** 为时间数据矩阵，**[AofT]** 为待分解基函数矩阵，**[A]** 为系数矩阵，由于

$$[AofT]=[U][S][V^T] \tag{8}$$

对其中的 **S** 矩阵进行去除奇异值，其中依据时间域的范围设定 10e-6 为门限值，凡是大于此值的特征值均予以保留，而小于此值的特征值赋成 0。把处理过的矩阵 **S** 代入中，求得系数

$$A = V*S*U^T*D^T \tag{9}$$

系数 **A** 如图 6。

把系数 **A** 代入原式后重构阶跃响应曲线，将重构前后的阶跃响应衰减曲线进行拟合，取适当的 tau 值，选择每十倍频程均匀取 4 点的方案，即从 0.001ms 至 10ms，每一个数量级间隔 3 点，拟合效果及误差分析如图 7。

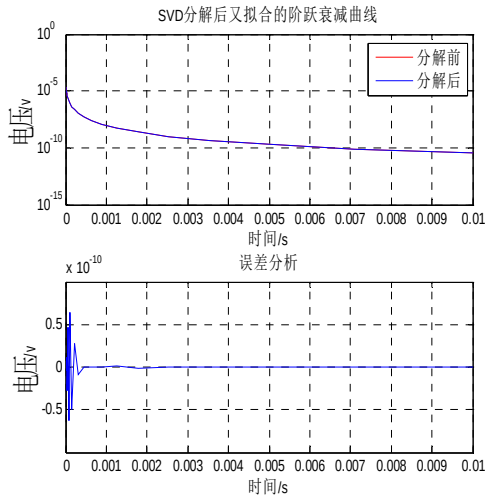

图 7 阶跃响应在重构前后的拟合及误差分析

Fig.7 The fitting and error analysis of step response before and after the reconstruction

从中我们还可以看出其平均误差在 10e-9 的数量级上，符合误差允许范围。

4 新基函数确定及电磁数据反卷积技术研究

在时间域航空电磁数据的 tau 域基函数分解是指，将某一发射电流的 off-time 二次感应电动势分解为一系列 e 指数的形式，将接收线圈记录的发射阶跃电流的响应表示为：

$$A(t)=\sum_i A_i \exp(-t/\tau_i) \quad (10)$$

则任意电流的响应：

$$B(t)=i'(t)*A(t)=i'(t)*\sum_i A_i \exp(-t/\tau_i)$$

$$=\sum_i A_i (i'(t)*\exp(-t/\tau_i)) \quad (11)$$

其中 $\sum_i (i'(t)*\exp(-t/\tau_i))$ 为新基底。对新基底进行 SVD 分解，将 B（t）写成矩阵形式，记为 C，求得系数

$$A2 = V*S*U^T*C^T \quad (12)$$

系数 **A2** 如图 8 所示。

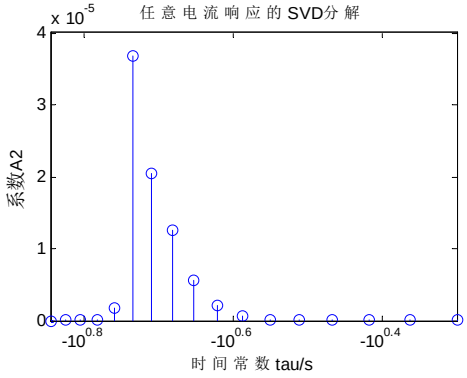

图 8 梯形波新系数 A2

Fig.8 The new coefficient A2 of the trapezoidal wave

将 **A2** 与原基函数进行组合得到去除波形响应的曲线，然后将其与原阶跃响应进行拟合，并分析误差。任意波形以梯形波为例，去除梯形波波形响应曲线与原阶跃响应拟合如图 9，对其进行误差分析如图 10。

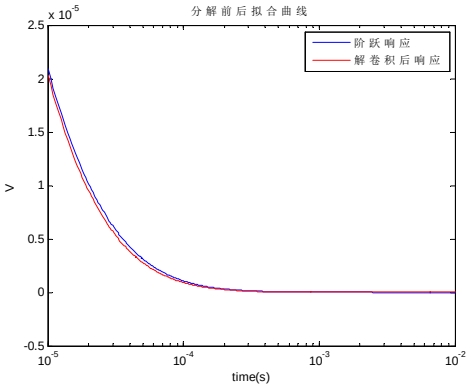

图 9 去除梯形波波形响应与原阶跃响应拟合

Fig.9 The fitting of the original step response and the removing trapezoidal wave response curves

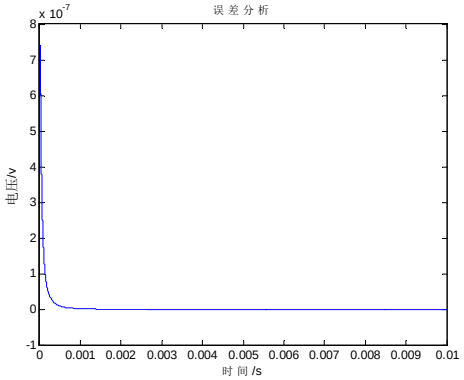

图 10 误差分析

Fig.10 The error analysis

从中我们还可以看出其平均误差在 10e-7 的数量级上，符合误差允许范围。

5 结论

综上所述，利用 SVD 分解法对时域航空电磁响应数据进行处理,在理论分析的基础上进行了计算机数值模拟,并重构了感应电动势理论响应曲线。结果表明,经奇异值分解降秩后的矩阵保证了计算的精度和稳定性,达到了去除发射波形影响的效果，这对研究复杂的时域航空电磁法理论和快速处理解释时域航电数据问题有实际的指导意义。

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基于MSP430防爆机器人的设计*

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摘要： 在一些恐怖袭击活动中，警务人员常常处于爆炸、有毒气体的危险之中，因此研制出一种可移动防爆机器人来代替人进行一系列搬运，拆卸危险物品很重要。本文主要针对于复杂情况下危险物品复杂多样的特点，设计了一种可无线传输视频四自由度防爆机器人。该机器人平台具有体积小，活动灵活，可拆卸物品，可切换工具的特点。采用MSP430作为控制系统对防爆机器人控制，本系统具有可靠性，稳定性及功耗低等优点，本文介绍了该控制系统的软硬件设计以及实现的具体方法。

关键词： 防爆机器人;无线通讯;无线视频传输;MSP430;机械手臂

中图分类号：TP242　　文献标识码：A

The Design Based on MSP430 Explosion-proof robot

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Abstract: In terrorist activities, the staff are often in danger of being explosive, poisonous gas, thus developed a portable explosion-proof robots are replacing people a series of handling, it is very important to remove the dangerous goods.This article mainly for dangerous goods under complex conditions the characteristics of the complex and varied, we design a wireless video transmission of four degrees of freedom robot explosion-proof.The robot platform has small volume, flexible activities, removable objects, the characteristics of the swappable tools.Uses MSP430 as the up and down a machine to realize the wireless video transmission and control of the robot.

Key words: Explosion-proof robot　Wireless communications　Wireless video transmission　MSP430　Mechanical arm

0 前言

20世纪以来世界各地恐怖活动越演越烈，成为社会世界安全问题的最大隐患，其中爆炸、投毒等危害的范围最为广泛和严重。为了降低处理该类危险物品的伤害程度，必须采取先进的辅助设备处理疑似爆炸物品和生化危险品，防爆反恐机器人则成为各国的首选。本文涉及到的机器人是应用于防爆系统中的，要求能够在远程人为控制的情况下，实现对疑似爆炸物的拆卸工作，并能通过机械手臂运输爆炸物。

1　防爆机器人系统设计

恐怖活动通常发生在人员比较集中或环境比较复杂的情况下，要求机器人能够灵活运动。防爆机器人要求能够在远程人为控制的情况下，实现对疑似爆炸物的拆卸，并能通过机械手臂运输爆炸物。防爆机器人采用两个MSP430作为上、下位机，该单片机可以满足多样自动化的控制需要。由于具有紧凑的设计，良好的扩展性和强大的功能指令，使得整个控制系统的操作简单易行，同时系统的可靠性和控制的准确性也得到保证。系统结构如图1所示。

*指导教师：蔡靖

项目类型：创新项目

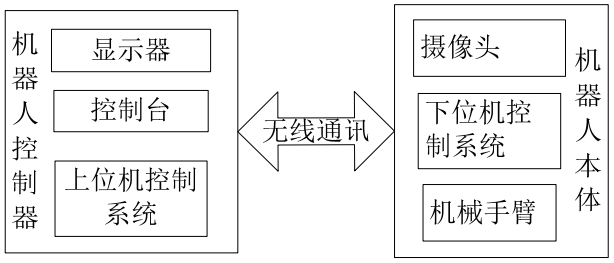

图1 系统结构框图

Figure 1 System structure diagram

防爆机器人的控制系统主要由上、下位机两部分组成。上位机部分由视频接收及显示模块、机器人动作控制模块组成；下位机包括全方位运动小车平台、中央控制模块、拟人化机械手臂、视频采集与传输模块、控制指令传输模块、伺服系统、电源供应及自检模块。各模块连接如图2所示。上位机用于整个系统的启停控制，控制台上为一系列的控制按钮，控制台将机器人将要进行的动作上传到上位机，然后进过上下位机的通信，将数据传输给下位机。同时上位机接收来自下位机的位置、角度及周围环境的温度等信息并在显示器上显示出来。防爆机器人机体上的摄像头将机器人工作现场的画面通过传输模块在显示器上实时反映机器人的工作状态，由后方工作人员通对视频分析，用键盘控制防爆机器人前后左右移动到达危险物所在地，然后控制机械手臂的转动，抓取危险物品或者对危险物进行拆卸，最终达到解除危险的目的。

1.1 机械手臂控制

防爆机器人的机械手臂采用4自由度三维旋转的机械手臂，可完成上下、左右方向的运动来进行夹持动作。对机械手臂的控制实际上是对舵机的控制。机械手臂由4个舵机驱动，分别为机械臂肩关节电机、机械臂肘关节电机、机械臂腕关节电机和手指开合电机。标准舵机由一个宽度可调的周期性方波脉冲信号即PWM波控制，本系统采用MG995型舵机，舵机的控制信号为周期是20ms的脉宽调（PWM）信号， PWM波一个周期分为PWM宽和延时等（WT）两个阶段。舵机电路支持的PWM信号为0.5-2.5mS，相对应舵盘的位置为0-180°，分为n=250小份，呈线性变化，PWM的控制精度为

$$PCP=2mS\div250=8uS \quad (1)$$

舵机的控制精度

$$ECP=180°\div250=0.72° \quad (2)$$

所以舵机转角函数

$$\varphi=0.72\times n \quad (3)$$

PWM 上升沿时间函数

$$t = 0.5+n\times PCP \quad (4)$$

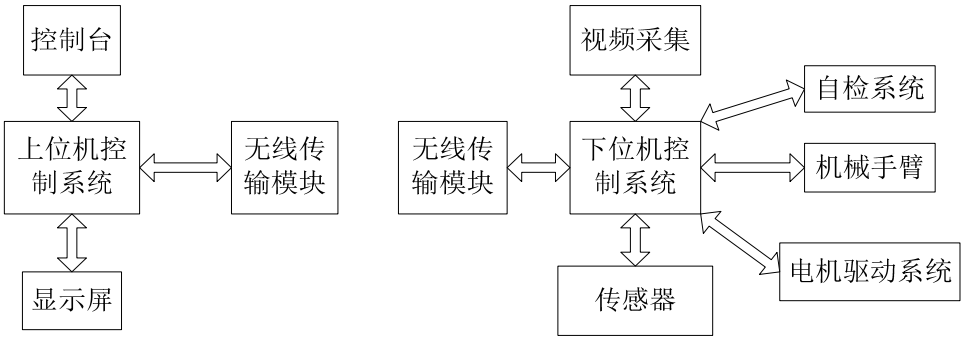

图2 防爆机器人各模块结构图

Figure 2 Explosion-proof robot module structure

只要控制n值就可使舵机达到旋转目标值。也就是说，给它提供一定的脉宽，它的输出轴就会保持在一个相对应的角度上，无论外界转矩怎样改变，直到给它提供一个另外宽度的脉冲信号，它才会改变输出角度到新的对应的位置上。舵机内部有一个基准电路，有一个比较器，将外加信号与基准信号相比较，判断出方向和大小，从而产生电机的转动信号。由此可见，舵机是一种位置伺服的驱动器，转动范围不能超过180°，适用于需要角度不断变化并可以保持的驱动当中，如机器人的关节、飞机的舵面等。图3表示出一个典型的20ms 周期性脉冲的正脉冲宽度与微型伺服马达的输出臂特定位置的关系。

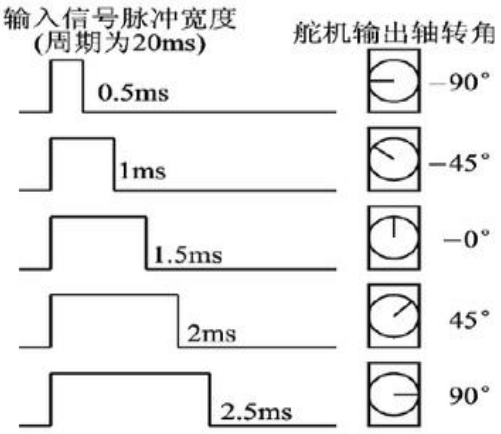

图3 脉宽与舵机偏角的关系

Figure 3 Pulse width and Angle of the relationship between the steering gear

本系统所需的PWM信号是由单片机定时器B的时钟模块产生，该时钟模块有4种技术功能选择及8种输出方式选择，采用增技术模式和翻转/复位的输出方式，图4为此种组合模式下的示意图。由图可知，利用TB0的TBCCR0值作为技术周期，TB1~TB5的TBCCR1~TBCCR5值作为计数值，计数器达到TBCCRx（x取1~5）值时，输出信号进行翻转，达到TBCCR0值时输出信号进行复位，从而可以方便的设置所需占空比的PWM信号。

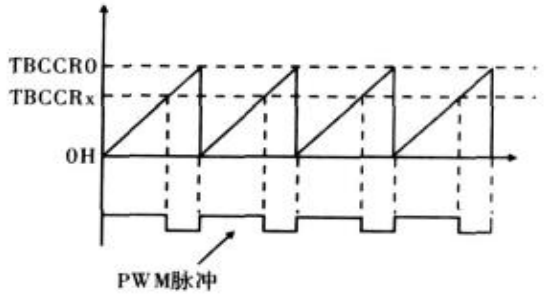

图4 增技术模式下的PWM输出示意图

Figure 4 Increase technology mode of PWM output waveform diagram

1.2 主从控制系统

基于机器人灵活，便捷的特点，主从控制系统采用MSP430F149单片机控制，TI公司的MSP430系列为超低功耗微控制器，在无线控制的防爆机器人应用中，这种优化的体系结构结合五种低功耗模式可以达到延长电池寿命的目的。MSP430系列单片机属于工业级芯片，能够在-40~85℃的宽温度范围内工作，并且带有PWM发生器等控制输出，适合用于机器人的控制中。MSP430系列单片机存储器采用的是同一结构，物理上完全分离的存储区被安排在同一地址空间，这种组织方式和CPU采用精简指令相互协调，对外围模块的访问不需要单独的指令，在接收和发送指令和数据时提高内外设数据吞吐能力，实现高速传输。该防爆机器人中以MSP430F149微处理器为核心，采用主从双处理器分工控制。机器人上位机通过无线视频通信接收工作现场的视频信息，在主控制器进行信息处理，工作人员根据机器人与危险物的位置信息通过控制台发出下一个动作信息，并通过无线信向下位机的从控制器传送控制命令，从MSP430F149的PWM通道和I/O口输出PWM波驱动机械手臂上的舵机运动及脉冲和方向来驱动车体上的直流电机运转。该防爆机器人的执行机构由4个舵机和2个直流伺服电机驱动，分别为机械臂肩关节电机、机械臂肘关节电机、机械臂腕关节电机、手指开合电机、车体左轮电机和车体右轮电机。本系统中舵机所需的PWM信号时由单片机定时器B的时钟模块产生，通过编程输出锁需占空比的PWM信号。

1.3 无线通讯模块

该防爆机器人采用单片射频收发器nRF905模块进行无线信息的发射和接收，该模块是挪威Nordic VL公司推出的单片射频收发器，工作电压为1.9~3.6V，工作于433/868/915MHz三个ISM频道，频道之间的转换时间小于650ns。nRF905由频率合成器、接收解调器、功率放大器、晶体振荡器和调制器组成，不需要外加声表滤波器，ShockBurst工作模式，自动处理字头和CRC（循环冗余码校验），使用SPI接口与微控制器通信，曼彻斯特编码/解码由片内硬件完成，无需用户对数据进行曼彻斯特编码，因此使用非常方便。此外其功耗低，以-10dBm的输出功率发射时电流只有11mA，适于在便携设备中应用。nRF905典型应用电路如图5所示。

上位机通过该模块接收下位机收集到的位置、角度及周围环境温度等信息在显示屏上显示；同时下位机通过该模块接收来自上位机发出的动作指令，进行下一步的行动。防爆机器人通过该模块来接收上位控制器发送的命令，快速地接收命令，执

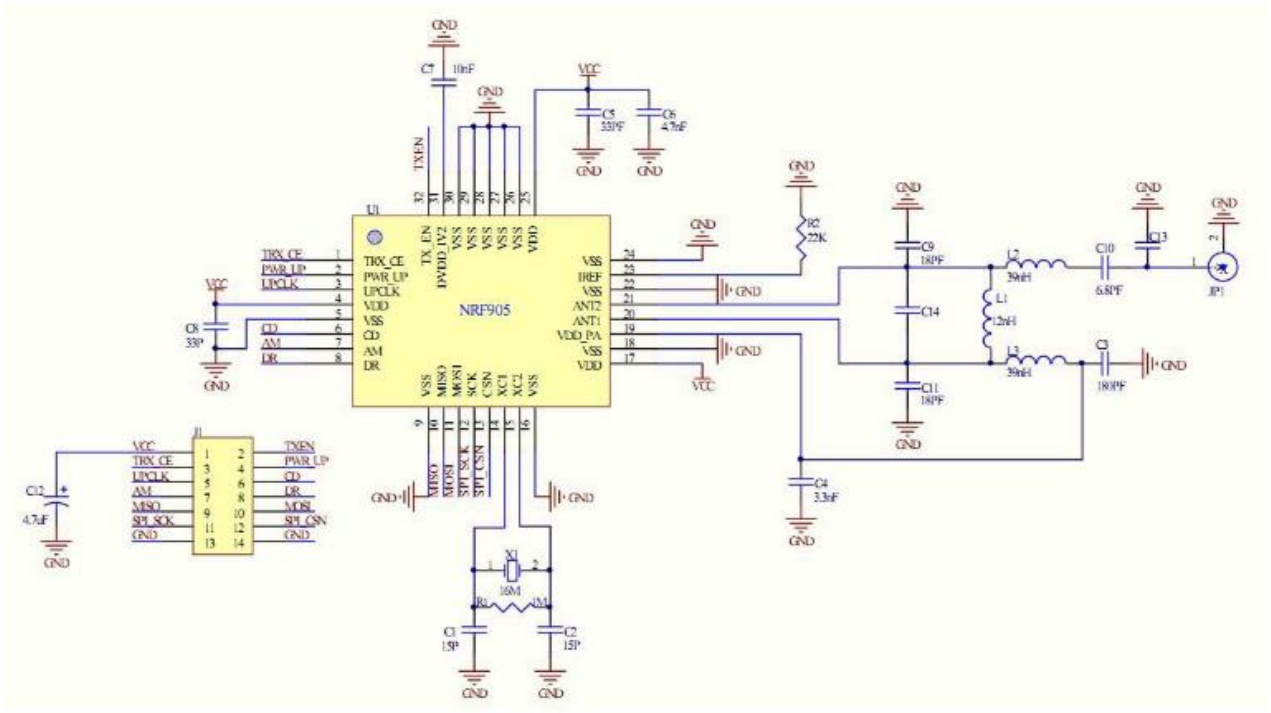

图5 nRF905应用电路

Figure 5 Nrf905 application circuit diagram

行移动和机械手臂等的相应动作，到达目的地抓取危险物品进行移动或者拆卸。

2 供电模块

考虑两驱动电机，摆臂驱动电机及摄像头驱动电机在额定功率下工作的情况，并且不需要同时达到最大，考虑负荷50%的功率要求，摄像头前端照明灯和驱动控制模块工作在满负荷状态，系统的总功率为：

$$P = 0.5P_d + P_w + Pc + Pl \qquad (5)$$

其中：P_d ——主驱动电机、摆臂电机、摄像头驱动电机功率之和

P_w ——前端照明灯功率

P_c ——系统驱动控制模块功率

P_l ——系统电源转换盒驱动器功率造成的功率损失

根据电机和驱动模块的选型知

$$P_d = 0.5*(65.7*3+0.22) = 98.5W \text{ , } P_w = 15W \text{ ,}$$

$$P_c = 10W \text{ , } P_l = 10W \text{ .} \qquad (6)$$

系统的最大功耗为P=133.5W。因此要保证连续工作两个小时，电池的容量要达到267W，因此需选12V/22Ah以上容量的蓄电池。由于机器人机械臂有一定重量，为保证机器人中心在车体中心附近，蓄电池安放在机器人车体后部。为此选择电压为12V，容量为12Ah的两块铅蓄电池并联使用，可满足机器人连续运行时的电流需求。

3 防爆机器人控制系统软件设计

机器人系统的控制过程为：用户将机器人下一个动作指令通过控制台输入到主控制系统中，主MSP430对这些指令进行处理，转换为数据，通过无线传输输入到下位机的从控制系统；从MSP430接收到数据后，将这些信号转换为控制信号，控制机器人车体上的直流电机和机械手臂上的舵机来完成相应的动作。系统的控制流程如 6、7 所示。

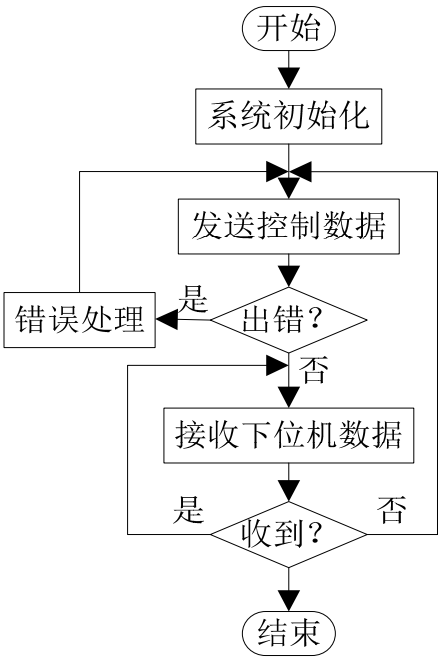

图6 上位机系统流程图

Figure 6 PC system flow chart

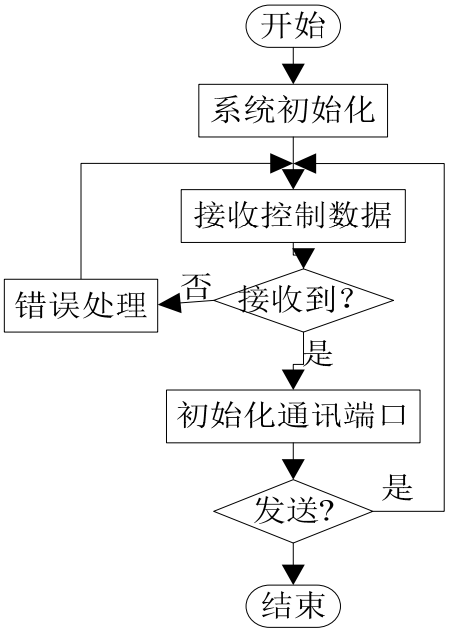

图7 下位机系统流程图

Figure 7 Under a flow chart of the machine system

4 测试结果

4.1 PWM 波形稳定性测试

由MSP430单片机输出的PWM波，占空比变化范围为：2.63%-11.82%，可控制舵机的角度转动范围为：10°-170°；步进为：0.57%，相应的舵机转动角度为10°。波形稳定，杂波很少，符合系统预设要求。波形如图8、9所示。

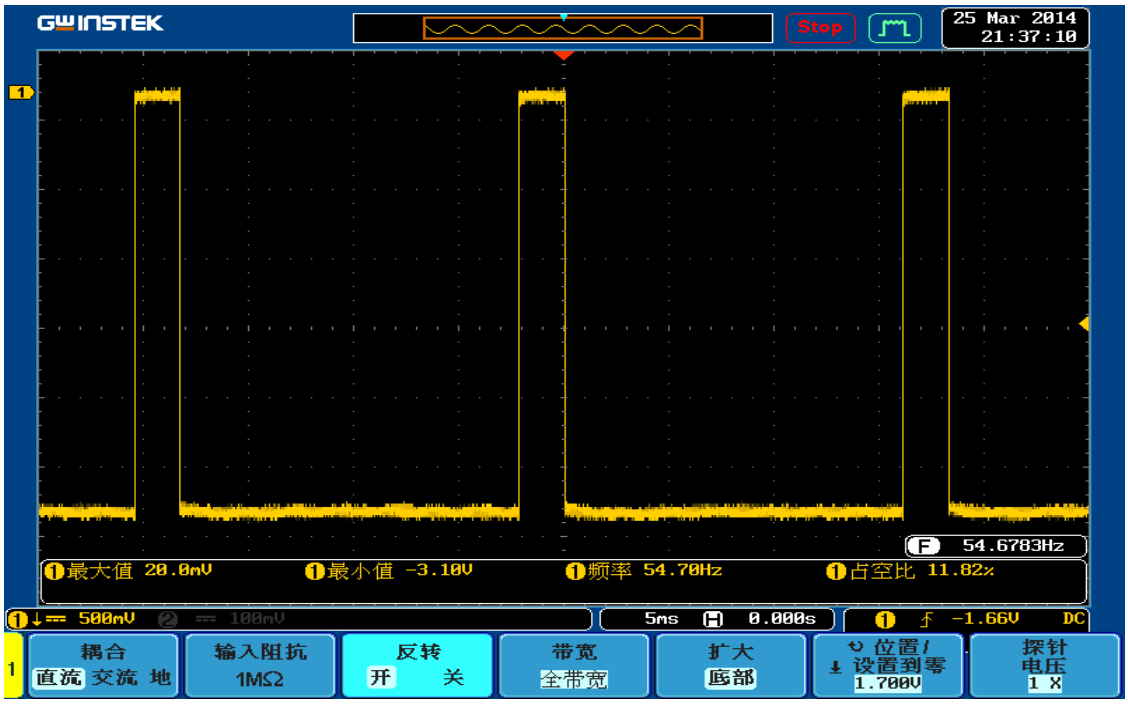

图8 输出最大占空比波形图

Figure 8 Compared the output biggest waveform figure

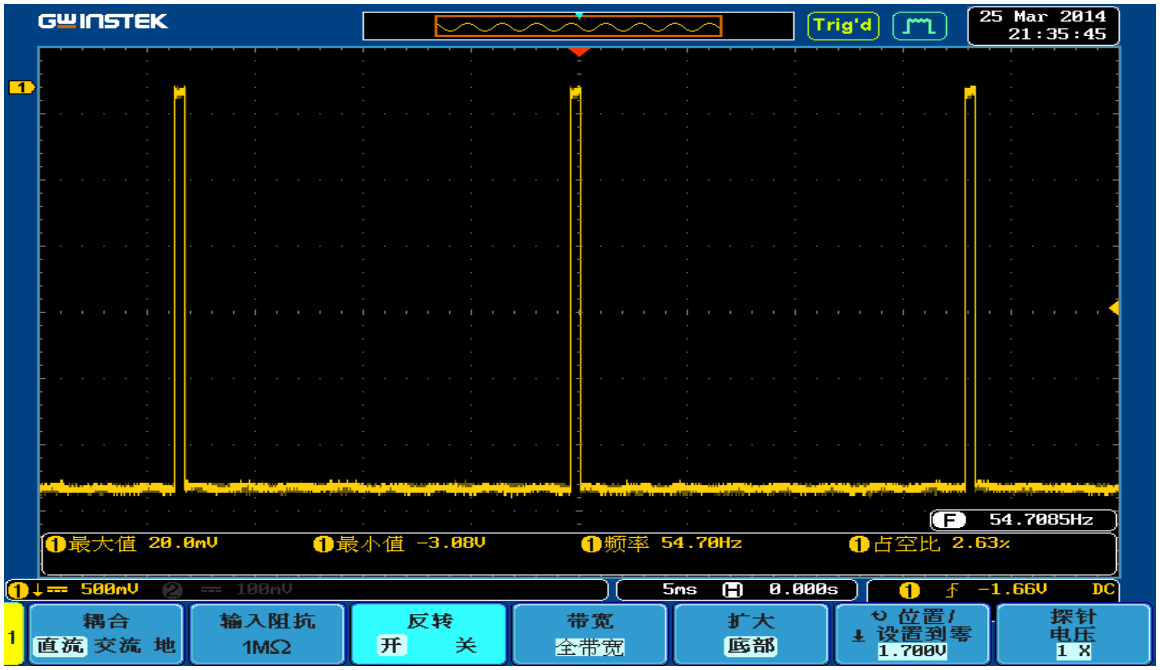

图9 输出最小占空比波形图

Figure 9 The output duty cycle minimum waveform figure

4.2 波形跟踪精度测试

利用自制的舵机测试软件对某一通道进行正弦跟踪拟合测试，经实际测算，误差能有效控制在0.11%之内，跟踪性能良好。

5 结束语

本系统采用两个MSP430微控制器分别作为上下位机进行移动机器人的控制，可使整个系统的耗能降低，性能稳定，易于操作，维护方便，性价比高。

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智能家居机器人原型的设计与研究*

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摘要：本文设计并实现了一个多功能、可控制的智能家居机器人。散布在机器人各节点的微型传感器获取外部信号，通过直连线路或网络将信息进行传递，由中央控制芯片接收并进行对比、判断，再给出下一步的动作指令。设计并实现的智能家居机器人实物原型基本实现了智能化识别、定位、跟踪、监控和管理等功能，可以采用自动控制、手动控制、定时巡逻等模式进行工作，甚至可以用手机实时监测，能够自主行驶、提取障碍物、清扫垃圾、跟踪看护、语音控制等，对室内的光照强度、温度、湿度、烟气煤气、火警、偷盗、水情等情况进行动态监测，在某项超出阀值时，能够自动报警。

关键词：智能 机器人 传感器 家居

中图分类号：TP242　　**文献标识码**：A

The research and design of prototype of intelligent household robots

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Abstract：To research and design an intelligent household robot that can be controlled, By controlling the chip microcontroller provide such as intelligent home control, use of communications equipment for the operation is interrupted, and by spreading tiny sensors in each node to determine abnormalities. The smart home system connected to the Internet, information exchange and communication; make the smart home system with independent storage and retrieval of information, in order to realize intelligent identification, positioning, tracking, monitoring and management, in order to be able to observe in real time outside home situation at home. The basic physical model has been designed to achieve, including automatic control, manual control, regular patrols, as well as real-time monitoring of mobile phones, to achieve light intensity, temperature, humidity, flue gas, fire, theft, and other dynamic hydrological monitoring, can advance to handle, and the police to inform the owner or relevant units, and can automatically forward extraction obstacles, scavenging, tracking nursing, speech perform other functions.

Key words：Intelligent　Robot　Sensor

0　前言

0.1　研究背景及意义

随着计算机技术、现代通信技术和自动控制技术的不断进步，智能化家居系统也随之进入了千家万户，家居智能化的开发和建设是未来国家、经济发展的必然趋势。随着科技的提高，经济的发展，人们的物质生活水平的提高，对家居环境的要求也越来越高，家居服务正面向更便捷、更高效、更节能、更安全、更环保的方向发展，作为家居智能化的重要组成部分-智能家居机器人发展前景可观。由智能家居机器人代替人来完成清洁卫生、提取障碍物、看护老人小孩等各种家务劳动，为住户控制好空气的湿度、温度和光照强度等，让住户安心居住。此外，配以防盗监测和煤气火情水情安全检查为主要内容的家居智能安防系统，会让住户安心在外工作。一个能有效完成家庭服务和家居安防的智能家居机器人，是一项极具应用前景的高新技术行业项目，也是智能机器人目前研究的一个热点。

*指导教师：王永志

项目类型：创新项目

0.2 国内外研究现状分析及评价

自 20 世纪 80 年代末我国引入智能家居的概念以来，国内的智能家居逐步兴起，由沿海到内地，智能家居行业得到飞速的发展。虽然还未能像美国、日本那样对住宅智能化系统的技术制定标准，但已经借助智能家居的概念和技术开始推行智能化住宅小区的建设了，智能家居系统正逐步走入普通百姓家庭。由于发展时间较短，我国智能家居的发展存在很多障碍和问题：（1）智能家居工程技术人员缺乏、管理水平低；（2）行业规范与标准制定滞后；（3）智能家居产品的层次和技术含量低，智能化不明显，精品很少。1999 年，建设部勘察设计司、建设部住宅产业化办公室联合组织实施全国住宅小区智能化技术示范工程，目标是提高住宅使用功能、推进住宅质量换代、促进住宅产业化，同时摸索出一套适合各地的住宅小区智能化技术体系。该示范工程的启动，标志着我国智能化住宅小区的建设进入了新的发展阶段。有人形容 2005 年-2007 年是智能家居在中国的普及年，处于一个准智能家居阶段。国内产品已经成熟，普通居民有能力接受智能家居。我国在《2000 年小康型城乡住宅科技产业工程项目实施方案》中，将建设智能化小康示范小区列入国家重点发展方向。因此必然促进智能化从智能大厦向住宅小区智能化，乃至家庭智能化的方向发展。建设部要求“到 2010 年，大中城市的 60%住宅要实现智能化。

在国外，在 1984 年美国出现智能家居系统之后，一些经济发达的国家都先后提出相应的方案，并开展研究与应用，目前在美国、新加坡和德国等都有广泛的应用。2003 年，新加坡有近 30 个住宅小区的近 5000 户家庭配置了家庭智能化系统，而在美国有近 4 万户家庭。目前智能家居在国外正在迅速普及。在智能家居产品方面，成熟的智能家居系统、具备各网络接入功能的信息家电越来越多；行业规范方面，它正逐步成形，例如家庭总线系统 HBS(Home Bus System)，由日立、三菱、松下、东芝等公司联合提出，由日本电子机械工业协会与电波技术协会共同制定。国外设计户型主要是单体别墅，智能家居的使用相对独立，不能满足中国人口众多和住房集中的管理和需求。现阶段，国内外技术领域的差异很小，仅 2-3 年。

0.3 研究构思和主要完成任务

研究、设计一个可以控制的家居智能机器人，包括自动控制，手动控制，定时巡逻，以及手机实时监测，能够实现光照强度、温度、湿度、烟气煤气、火警、偷盗、水情等动态监测，可提前自行处理，并报警通知主人或相关单位，并且可以自动前行、提取障碍物、清扫垃圾、跟踪看护，语音执行等功能。通过控制芯片如单片机等为智能家居提供控制，使用通讯设备为操作中断，并通过散布在各节点的微型传感器，判断异常情况。把智能家居系统与互联网连接起来，进行信息交换和通讯，使智能家居系统具有自主存储信息与提取，以实现智能化识别、定位、跟踪、监控和管理，以便能够实时在外观察家里的家居情况。

1 设计方案

1.1 硬件总体设计方案

图 1 给出了硬件的总体组成框图。由该图可知，采用某个核心控制器控制子控制器及部分高级功能，子控制器控制传感器、无线通信模块等，模块间需要融合，尽量独立出来可以分离的模块。

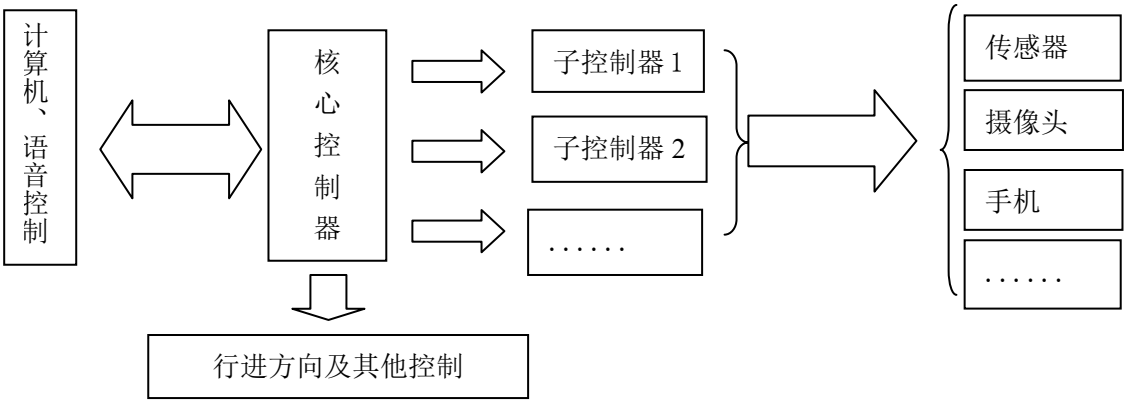

图 1 硬件总体控制方案框图

Fig.1 Hardware block diagram of the overall control scheme

1.2　模块设计方案

事先设定目的地，由机器人的自动寻路、不断调整最终到达目的地区；在行进、停止时，均可以通过无线与计算机控制中心、相关室内设备进行通信。

（1）使用芯片控制智能机器的行进、转向等，同时还要考虑小车要与控制端的转向、前进和后退同步。

（2）通过温度传感器监测室内温度、烟雾监测室内烟雾密度，可以将测得的温度、烟雾情况发送到控制中心。

（3）智能机器人能够控制空调(或者加热与降温装置)电源的打开、关闭。

（4）通过光传感器感知室内外的阳光情况，通知窗帘的控制装置，由其电动机打开(如室内光暗)或关闭(室外光强)窗帘。要注意应该是在白天，晚上则不能打开窗帘，故应有对时间判断。

（5）利用火焰传感器及超声波传感器等，捕捉到火焰方位、距离等参数，控制小车调整方向，前进到距离火焰一定距离时开启风扇将火焰吹灭或用液压水枪装置或水泵将火焰浇灭。

（6）采用红外或者热传感器感知人的存在(有位移或体温)，设定好监测标准后，当有人非法从窗户、门进入时，能够监测、判断并发出警报提醒主人。

（7）结合超声波传感器、热释电跟踪（或者其他可以识别应跟踪人的方法）等实现智能机器人跟随人手调整方向、行进等功能。

（8）可通过语音控制智能机器人前进、左转、右转、后退、停止等行进方向。

（9)在车前方安装摄像头能实时的把录像结果存储在电脑里，当遇到意外情况报警时，应能够通知到户主手机，户主也可用手机调取存在电脑里的画面或直接由摄像头现场再拍照传给户主或通过视频(类似 QQ 或微信里面的实时视频通信功能)传输。实现思路如下：

(1)使用 51 单片机采集循迹传感器信息，循迹传感器是通过循迹黑线进行路线自动识别，检测到黑线的传感器会输出高电平，未检测到黑线的传感器输出低电平，因而通过实时扫描传感器的输出信号即可控制小车的路线实时行走在黑线上。

(2)使用 51 单片机采集温湿度传感器 DHT11 的数据输出，DHT11 串口一共向外发送 5 位 16 进制数据：温度高 8 位、温度低 8 位（默认为 00)、湿度高 8 位、湿度低 8 位（默认为 00)、校验 8 位，同时还采集烟雾传感器信息，即危险状态输出低电平，安全状态输出高电平。单片机通过串口接收温度数据，并口接收烟雾数据后判断处理，然后显示在 LCD1602 上。

(3)51 单片机(2)中采集的温度数据通过 NRF905 发送给接收机，接收机也通过 NRF905 接收温度数据；通过处理后，判断是否在程序设定的温度范围（23-26 摄氏度）内，若是则不进行加热或降温（现用灯亮代表降温开始，蜂鸣器响代表加热开始)；如果在设定范围外，则不加热或降温。

(4)51 单片机串行采集 DS1302 时间数据，在早 8 点到晚 6 点期间采集光敏传感器的光照信号，判断室内光照强度：光强会输出低电平，光弱输出高电平；NRF905 发送电平到另一接收机，该接收机通过步进电机正反转模拟窗帘的打开或者关闭。

(5)51 单片机实时扫描六路火焰传感器的输出，一旦检测到火焰，即火焰传感器任一路输出由高电平变成低电平后，控制器会控制小车正对火焰，此时超声波检测前方障碍物（即蜡烛）的距离，显示在 LCD1602 上，同时启动风扇进行灭火（此处的风扇灭火也是模拟，由于电压及风扇的特殊性，风速太小，不足以吹灭蜡烛)，同时通过串口和 GSM 模块通信，通过华为 AT 指令向预设手机发送短信，内容为：“SOS：your house is in danger!!”。

(6)车前方有红外热释电传感器，能够感知人或其他动物发出的红外线，单片机通过采集热释电的输出，即检测到人时，传感器输出高电平，然后单片机控制蜂鸣器鸣叫，进行警报。

(7)跟踪功能是结合三个超声波传感器，分别判断正前方、偏左、偏右三个方向，单片机分别检测三个超声波传感器的距离数据，然后决定前进、左转、右转。

(8)语音功能是通过 LD3220 进行语音识别，然后串行传输给单片机，单片机处理后，通过 SYN6288 进行语音合成并控制小车动作。语音包括“好的，马上行动”、“好的，立刻执行”、“左转”、“右转”、“好的，马上停下来”等，同时控制小车前进、左转、右转、后退、停止等，同时还可与小车进行简单对话，有：问“你叫什么”、“你多大了”、“你的生日”、“累了么”、“再见”、“我爱你”等，答“小强”、“两个月”、“一月十八号”、“有点累”、“拜拜”、“我也爱你”等。

(9)小车前方安装有无线摄像头，通过接收器和采集卡连接计算机，在安装在计算机上的上位机中实时显示小车前方画面，同时可进行录制、存储。在计算机和手机上另安装一款软件 Splashtop remote,通过此软件可使用手机远距离操作计算机，

进而可以查看实时画面或存储的视频。

功能模块间相互配合阐述如下：

其中(1)(5)(6)(7)实现方案为用 51 单片机 1，通过开关选择功能 1，采集 3 路循迹传感器信息，6 路火焰传感器信息，以及热释电传感器信息，驱动电机驱动芯片 L298N，控制小车的前进后退左转右转，从而进行循迹或者火焰检测，发现火焰或者非法人员可进行警报和短信通知，检测到火焰后还可以控制灭火装置灭火。同时该单片机的功能 2，即跟踪功能，通过顺序采集 3 路超声波传感器信息，进行距离检测，然后驱动小车转向或前进。

(2)(3)(4)实现方案为用 51 单片机 2，通过采集温湿度传感器 DHT11，烟雾传感器 YL_15，光敏传感器，时钟芯片 DS1302 等的数据，其中温湿度传感器和烟雾传感器数据显示在 LCD1602 上，同时驱动 NRF905 通过不同地址发送温度数据以及开窗关窗信号。其中温度控制需要一个单片机接收 NRF905 发送的地址 1 的温度数据，然后确定加热或降温，从而保持室温在确定范围内；窗帘控制需要一个单片机接收 NRF905 发送的地址 2 的光照数据，用来决定是否开窗或关窗，但需要注意的是开窗帘只能开 1 次，关 1 次，开 1 次，关 1 次。

(8)实现方案为通过语音芯片 LD3220 进行语音识别，再通过单片机驱动小车。

(9)实现方案为通过摄像头采集数据，通过采集卡以及电脑上位机进行实时图像显示，通过手机远程控制软件 Splashtop remote 控制电脑。

相对应的电路原理图依次如下：

(1)主要芯片为 STC89C52 和小车电机驱动模块 L298N。

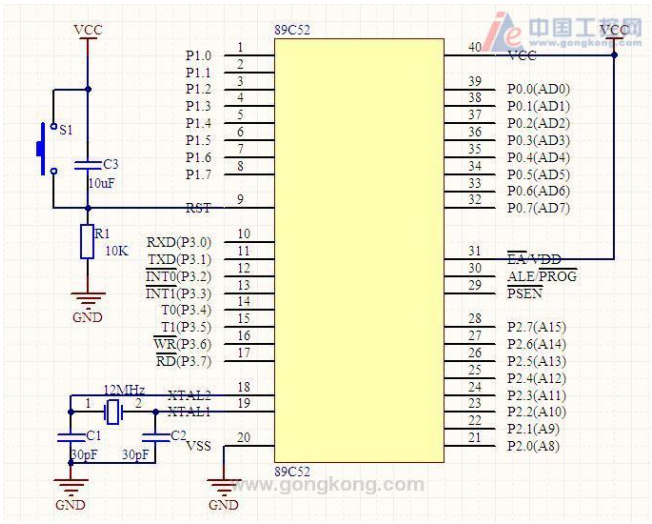

图 2　STC89C52 最小系统原理图

Fig.2　STC89C52 minimum system schematic diagram

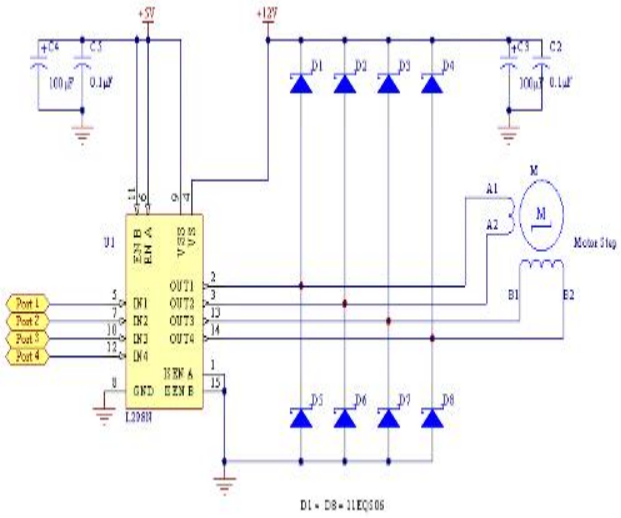

图 3　L298N 原理图

Fig.3　L298N schematic diagram

(2)应用 DHT11 温湿度传感器和 MQ 烟雾传感器，可用于家庭和工厂的气体泄漏监测装置，适宜于液化气、丁烷、丙烷、甲烷、酒精、氢气、烟雾等的探测。

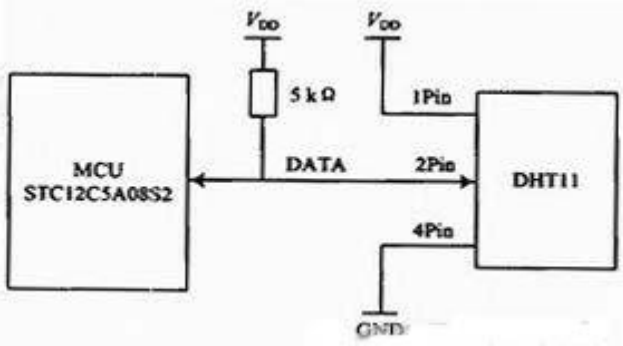

图 4　DHT11 温湿度传感器与 MCU 连接图

Fig.4　DHT11 temperature and humidity sensor and MCU connection diagram

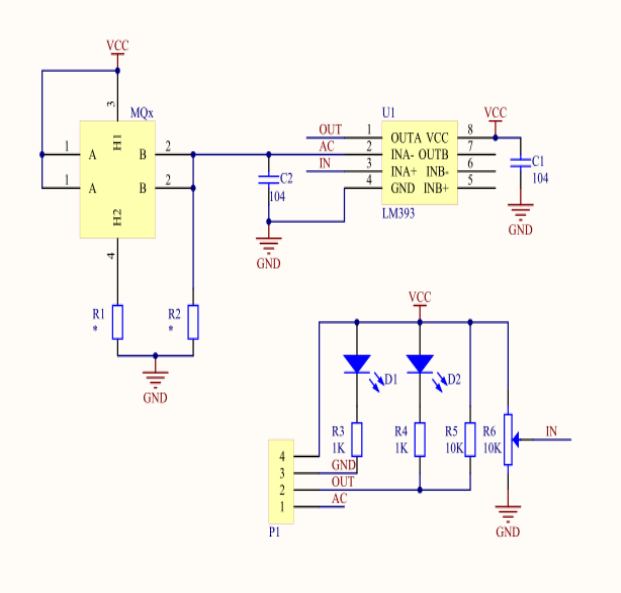

图 5　MQ 烟雾传感器原理图

Fig.5　MQ smoke sensor principle diagram

(3)　应用 NRF905 无线模块

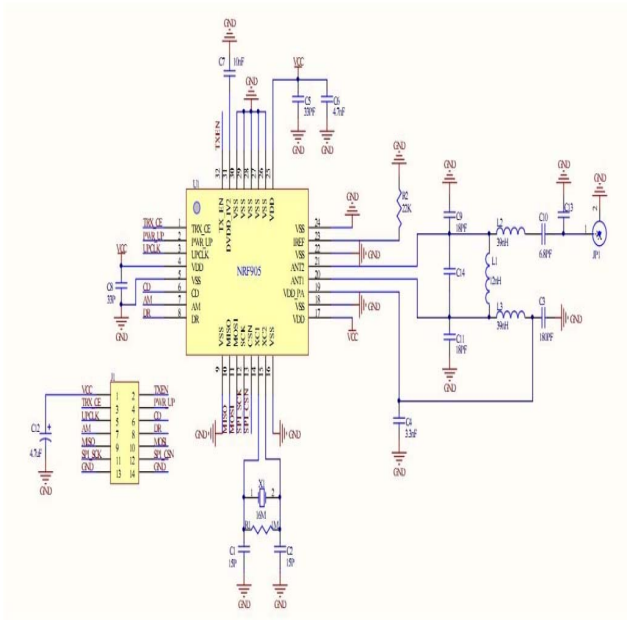

图 6　NRF905 无线模块原理图

Fig.6　The principle diagram of the NRF905 wireless module

(4)　应用光敏传感器

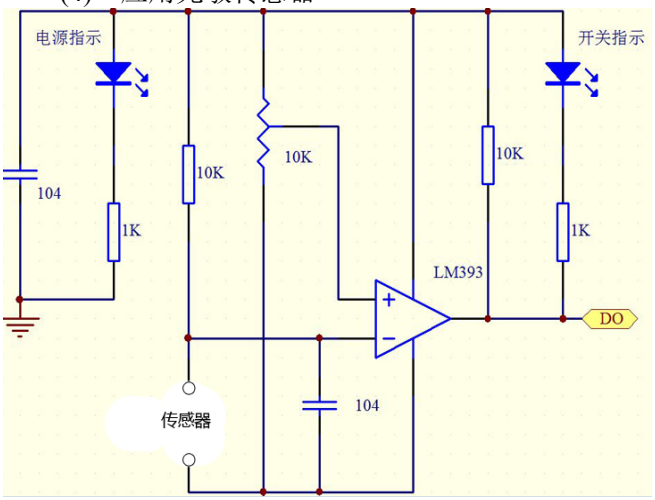

图 7　光敏传感器原理图

Fig.7　Photosensitive sensor principle diagram

(5)　应用六路火焰传感器

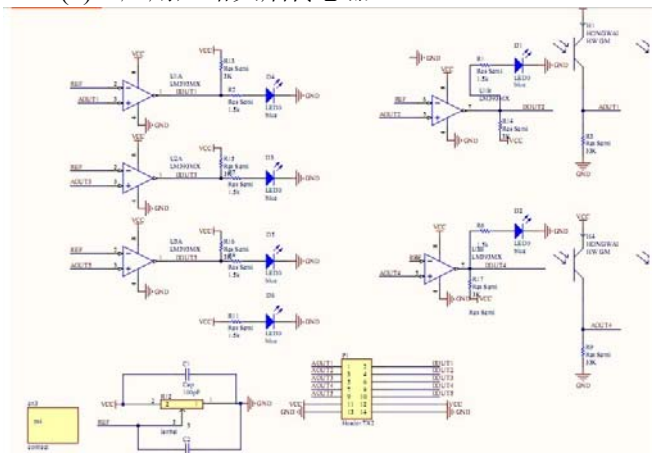

图 8　六路火焰传感器原理图

Fig.8　The principle diagram of the six-way flame sensor

(6)　应用红外热释电传感器

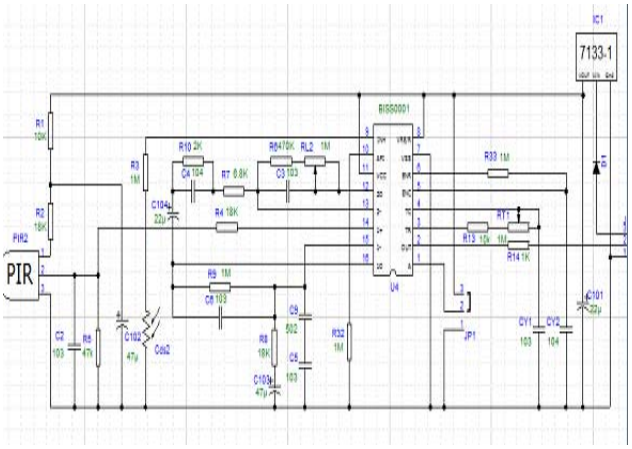

图 9　红外热释电传感器原理图

Fig.9　The principle diagram of the pyroelectric infrared sensor

(7)　应用超声波传感器

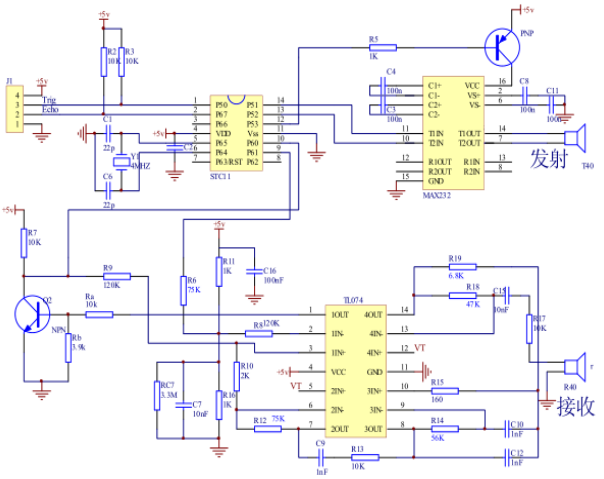

图 10　超声波传感器原理图

Fig.10　The principle diagram of the ultrasonic sensors

(8)　应用 SYN6288 语音合成模块和 LD3320 语音识别模块

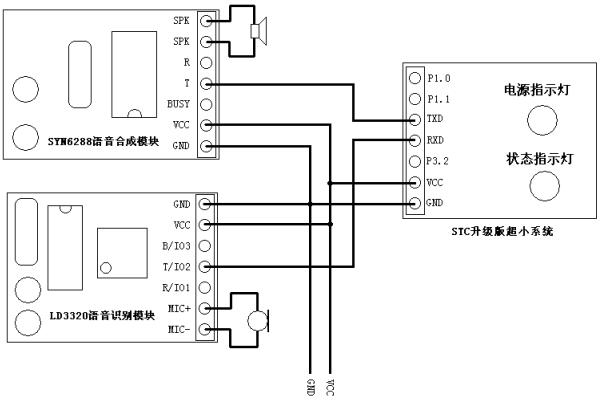

图 11　声控模块连接图

Fig.11　Voice control module connection diagram

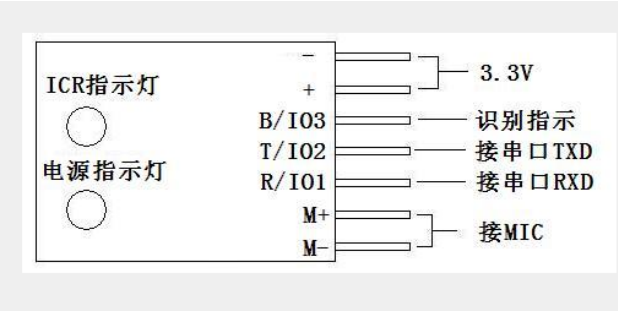

图 12　语音合成芯片管脚图

Fig.12　Speech synthesis chip pins

2　调试结果

通过对实物模型的多轮调试，完成了规定的九项功能：

(1)用黑色胶布贴出任意一种形状的路线，机器人均可以按照路线方向自行调整行进方向，能够实现智能巡线前进。

(2)机器人可以监测温度、湿度、烟雾及光照情况，并将温度数据、光照情况等通过无线模块分别发送到子控制中心一和二。

(3)子控制中心一接收到温度数据进行实时显示，并进行判断，若不在设定值范围内，则会进行加热或者降温；若在正常设定范围内，则不进行升降温。

(4)对于光照的判断受控于时间设置。默认情况下，窗帘的控制时间设为早上八点到晚上六点之间，根据接收到的光照数据，子控制中心二可以准确进行判断开窗或者关窗；在晚上六点到早上八点之间，子控制中心二不起作用，窗帘会一直处于关闭状态。

(5)当正在燃烧的蜡烛靠近机器人时，其携带的火焰传感器感应到火焰，会反馈给中央处理器，发出灭火指令—即打开风扇进行“强”风力灭火，并实时显示蜡烛离车的距离，同时还会向主人手机发送短信（如 SOS：your house is in danger!!）。

(6)当有人靠近达到预设距离时，机器人会自动发出警报，此功能可用于家中无人时监测室内是否有人非法入侵。

(7)将状态调整至跟踪功能时，机器人可根据前方行人的行进方向，自动调整其行进方向，实现跟踪功能。

(8)对着机器人说“往前走”、“左转”、“右转”、“后退”、“停止”等口令时，其会做出相应的动作。

(9)将智能机器人上的无线摄像头、连接在计算机上的无线采集器的频率调整一致时，计算机端可实时接收到机器上携带摄像头反馈回来的清晰的画面信息，为使用者提供远程录制实时视频、拍摄画面等功能。

图 13、图 14、图 15 分别给出了家居智能机器人实物模型的左侧、正面、右侧的角度图。

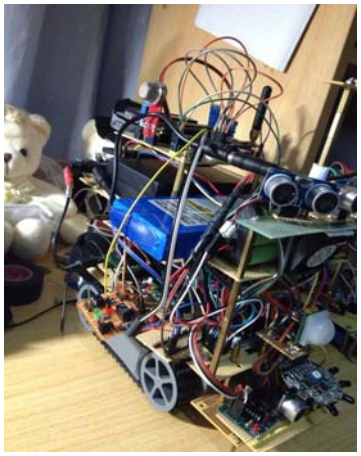

图 13　模型左侧面图

Fig.13　Left side view of the model

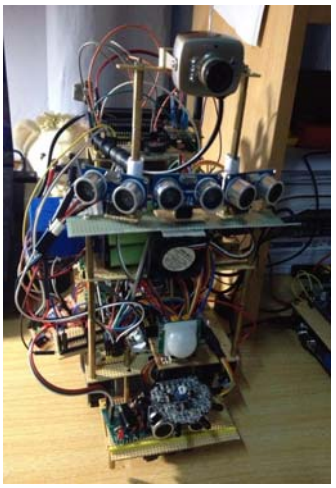

图 14　模型正面图

Fig.14　Front view of the model

图 15　模型右侧图

Fig.15　Right side view of the model

3　结论

本项目以智能家居为主题，利用智能机器人来模拟实现智能家居系统的功能，尝试在智能家居的广泛应用的探索道路上贡献自己的力量，来满足人们的需求。通过设计与测试，已经完成预期功能。

从立项到结题一路走来，受益颇多。从最初对智能家居系统的初步了解，通过广泛查阅资料，向老师和同学咨询请教，到对智能家居机器人的越来越熟悉，直到在老师的指导下最终完成实物模型。这一年来，我们学到的知识远远超出了我们的期望值，既提高了科研的基本技能，同时也提高了分析问题和解决问题的能力，以及文献检索能力、英文阅读能力、团队协作和沟通能力。衷心感谢一年来指导老师、同学们对于我们的指导和帮助。

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基于超声波定位的舞台自动追光灯*

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摘要：本系统构想是将超声波定位系统利用到舞台灯光追踪上。由于舞台灯光发热量大，人工控制灯光跟踪舞台演员不可能一个人长时间工作，而且灯光耀眼，给操作者带来很大难度。所以急需一种可以自动控制跟踪演员的设备。本超声波定位系统不只局限于舞台追踪。还可以扩大范围，应用到其他工程现场，如：用于矿坑里的工人定位。可以避免工人的误操作走入不安全的区域。也可在发生矿难时，及时赶到旷工遇难现场拯救旷工生命。本系统通过 stm32 对整个系统进行控制，实现定位并且追踪。

关键词：超声波定位　舞台追踪　stm32

Automatic track lights based on ultrasonic positioning stage

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Abstract： The idea is to use ultrasonic location system to track on the stage lights. The stage lighting heat large, artificial lighting control to tracking stage actor impossible for a person to work for a long time, and the dazzling light, give the operator to bring very great difficulty. So we need a tracking device can automatically control the actor. The ultrasonic positioning system is not limited to the stage tracking. Can also expand the scope, application to other engineering field, such as: for workers locate caves. Can the misoperation of workers into the unsafe area to avoid. Also in the mine, to save a life time miss wreckage

Key words： ultrasonic positioning　stage tracking　stm32

0　前言

超声波测距技术已进展到成熟时期，基于超声波定位的舞台追光灯是在超声波测距技术上的延伸，即超声波定位技术，目前在我国也正处于初始阶段。

1　试验方法和实验方案

1.1　试验方法

超声波定位的舞台自动追光灯系统由主系统和携带机系统两部分构成，主系统有单片机、无线发射模块、超声波接收电路、电机以及灯光部分组成，如下图所示。

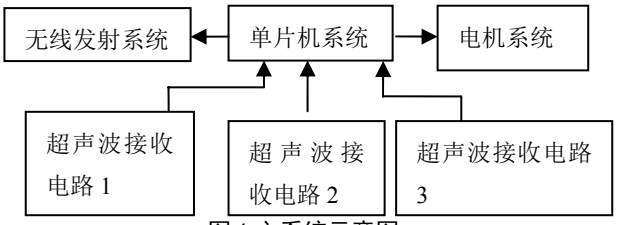

图 1 主系统示意图

Fig.1 Main system diagram

携带机系统由单片机、无线接收电路、超声波发射电路及电池构成。携带机系统框图如下图所示。

*指导教师：王君

项目类型：创新项目

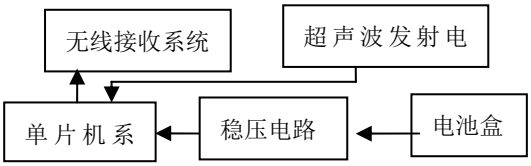

图 2 携带机系统示意图

Fig.2 Machine system diagram carry

首先用主系统的超声波模块测量追光灯与地面之间的距离，并在现场放置至少 2 个超声波测量点，被跟踪的物体携带无线接收模块，超声波发射模块。首先，有主系统单片机发射无线电信号，同时主系统单片机开始计时。当被跟踪的物体接收到无线电信号后，和自己 ID 进行比较，确认 ID 后，携带机系统中的单片机控制超声波发射模块发射超声波。当测量点接收到超声波后主系统单片机停止计时，并将时间数据记录，从而测定测量点与被跟踪物体的距离，再根据追光灯与地面之间的距离确定被跟踪物体的位置，调整追光灯的角度实现跟踪。

2　数学模型

由于包络检测法和回波检测法存在其固有缺点，而且实施起来存在一定的困难，所以我们选用到达时间测量法来实现测距。为了消除接收信号中回波的影响，利用声速相对光速慢的特点，设计出了一种新的到达时间测量法：将超声波的接收传感器与射频发射模块置于 A 端，而将超声波的发射传感器与射频的接收传感器置于 B 端，先从 A 端发射射频信号，告之 B 端发射超声波，由于电磁波的传播速度比声速大得多，所以可以忽略射频的传播时间，从 A 端发射射频开始计时，到 A 端收到超声波信号为止，记录这段时间，则可以用式 S = V *t 来计算 A 端与 B 端的距离（其中 V 为声速，因为本系统测试时温度基本恒定在 25℃，所以声速可取恒定值 346.575m/s）：

利用这种方法，可以分别得到移动节点到三个固定节点的距离 l1、l2、l3，由于本系统的各个节点呈空间分布，所以根据勾股定理，可以求出三个固定节点在地面二维坐标系中的投影点到移动节点的距离 l11、l22、l33。设三个固定节点在地面二维坐标系中的投影坐标分别为（x1，y1），（x2，y2），（x3，y3），移动节点的坐标为（x0，y0），则根据下式的加权质心算法可以求得移动节点的坐标：

$$\begin{cases} x0=(x1/l11+x2/l22+x3/l33)/(1/l11+1/l22+1/l33) \\ y0=(y1/l11+y2/l22+y3/l33)/(1/l11+1/l22+1/l33) \end{cases}$$

3　系统测试结果

3.1 实验数据

表 1 系统整体测试记录表（一）

单位：cm

实测坐标 \ 理论坐标	（50.0，50.0）	（50.0，60.0）	（50.0，70.0）	（60.0，40.0）	（60.0，50.0）
实验一	（55.0，59.0）	（50.0，69.0）	（55.0，71.0）	（60.0，32.0）	（61.0，58.0）
实验二	（56.0，57.0）	（51.0，68.0）	（53.0，70.0）	（58.0，40.0）	（63.0，60.0）
实验三	（52.0，54.0）	（52.0，69.0）	（55.0，76.0）	（57.0，37.0）	（62.0，58.0）
实验四	（57.0，56.0）	（51.0，68.0）	（56.0，74.0）	（60.0，34.0）	（63.0，59.0）
实验五	（54.0，53.0）	（52.0，68.0）	（53.0，75.0）	（60.0，35.0）	（62.0，59.0）
平均坐标	（54.8，55.8）	（51.2，68.4）	（54.4，73.2）	（59，35.6）	（62.7，58.8）

表5.4 系统整体测试记录表（二）

单位：cm

理论坐标 / 实测坐标	（60.0，60.0）	（70.0，40.0）	（70.0，50.0）	（70.0，60.0）	（70.0，65.0）
实验一	（63.0，68.0）	（73.0，31.0）	（76.0，50.0）	（71.0，64.0）	（74.0，61.0）
实验二	（62.0，66.0）	（78.0，35.0）	（70.0，49.0）	（78.0，69.0）	（74.0，61.0）
实验三	（59.0，67.0）	（79.0，37.0）	（79.0，49.0）	（74.0，69.0）	（79.0，61.0）
实验四	（64.0，69.0）	（77.0，34.0）	（77.0，49.0）	（75.0，69.0）	（74.0，60.0）
实验五	（63.0，67.0）	（76.0，35.0）	（75.0，50.0）	（78.0，70.0）	（77.0，61.0）
平均坐标	（62.2，67.4）	（76.6，34.4）	（76.8，49.4）	（75.2，68.2）	（75.6，60.8）

3.2 测试结论

3.2.1.定位范围

经过测试表明，本系统基本可以实现对于在地面上120.0cm*120.0cm的二维直角坐标系中移动节点的定位。

3.2.2.系统的平均定位误差

X轴的平均定位误差：

（4.8+1.2+4.4+9+2.7+2.2+6.6+6.8+5.2+5.6）/10=4.1（cm）

Y轴的平均定位误差：

（5.8+8.4+3.2+4.4+8.8+7.4+5.6+0.6+8.2+4.2）/10=5.2（cm）

3.2.3 系统的平均定位精度

X轴平均定位精度：

（120.0-4.1）/*100%=96.6%

Y轴平均定位精度：

（120.0-5.2）/120.0*100%=95.7%

4 结论

本系统以stm32单片机作为主控芯片，结合无线收发模块以及超声波发射接收传感器等，设计并实现了基于超声波定位的舞台追光灯系统。

经过测试，在所选实验条件下，超声波传感器的发射距离超过600cm，基本可以实现在舞500.0cm*500.0cm的直角坐标系中的定位，其中X轴的平均定位精度为96.6%,Y轴的平均定位精度为95.7%。

由于本系统中的无线收发模块精度达不到，仍需对其改进，达到在极短时间内的定位，此项工作有待提高。

此系统地成功将解决舞台人工打灯追踪的劳力，方便，准确，也适合各种需要自动追踪灯光的工作。

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基于压电陶瓷片的无线充电式遥控开关*

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摘要：传统的电气开关(尤其是照明开关)的安装布线耗时费力，而且成本高；控制方式也过于单一，使用遥控器又需要经常更换电池。为克服这些缺点，研制了一种基于压电陶瓷片的无线充电式遥控开关。其特点是利用压电陶瓷片为电路提供触发电压，通过单片机编码电路识别脉冲来向发射模块提供数据，利用无线射频技术与接收器通信，由接收器给用电设备发出控制信号，控制其工作。整套系统可以很方便地实现无线智能遥控，而且环保免电池维护，可靠性高，具有很高的实用价值。

关键词：压电陶瓷片；无线充电；无线射频

中图分类号：TP17 **文献标识码：**A

A Wireless Rechargeable Remote Control Switch Based on the Piezoelectric Ceramic Piece

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Abstract: The installation and wiring of traditiona lelectrical switches, especially the lighting switches, are time-consuming,laborious and high costs. Also the control is too single and it often needs to replace batteries for the rem ote control.To overcome these shortcomings,based on the piezoelectric ceramic piece,a wireless rechargeable remote control switch is designed.The characteristics of this control sw itch are that the piezoelectric ceramic chip provides trigger voltage for circuit.Through the coding circuit of single chip microcomputer,identifing the pulse,providing data to the Launch module.Using the radio frequency technology, it communicates w ith the receiver, which then gives control signals to the e lectricity equipment to control it work.The entire system can easily achieve inte-lligent wirless remote control. It is environmental protection w ithout batteries maintenance and of high reliability and high practiclvalue.

Key words: Piezoelectric ceramic piece;Wireless charging;Radio frequency

0 前言

随着人们生活水平的提高，智能化控制始终是人们追求的目标。传统的电气开关(尤其是照明开关)缺点逐渐体现，即需要布线距离长，设计自由度低；即使使用遥控器也需要使用电池供电，不绿色环保；每个开关只能控制一个用电设备，不智能。本文介绍的无线遥控开关以压电陶瓷结构和基于STC15系列单片机的无线射频通讯技术为核心，可起到远距离无线遥控开关的作用，并带有无线充电功能，绿色环保，经济效益高。

1 压电陶瓷的应用和前景

压电陶瓷在现代功能陶瓷中占有非常重要的地

*指导教师：于生宝

项目类型：创新项目

位，具有广泛的用途。自19世纪80年代居里兄弟首先在石英晶体上发现压电效应后，压电材料和压电器件的研究和生产发展极为迅速，2000年全球压电陶瓷产品销售额约达30亿美元以上，近几年压电陶瓷在全球每年销售量按15％左右的速度增长。压电陶瓷是含高智能的新型功能电子材料，随着材料及工艺的不断研究和改良，压电陶瓷的技术应用愈来愈广，并且压电发电具有结构简单、不发热、无电磁干扰、无污染和易于实现小型化和集成化等优点，并因此能满足低耗能产品的电能需求而成为目前研究的热点之一。

日、美、欧等发达国家对于压电发电自助供电系统进行了多年研究，取得了良好进展，尤其是日本在应用方面走在世界前列。

2006年至2009年期间，东日本旅客铁道株式会社在东京火车站进行过三次“发电地板”试验，目标是实现乘客通过自动检票口时产生可使100瓦的灯泡发光0.1秒的电力。2010年上海世博会上，日本馆展示了压电发电地板，参观者轻轻几步就可将电灯点亮，这让很多人惊喜不已。另据报道，日本的NEC等公司联合开发了新型发光道路标识，在公路下埋有压电发电装置，使其驱动LED发光指示牌，基本达到可自供电的实用水平。

目前，国内大部分研究人员还停留在对压电储能的研究上，并且压电储能技术已经基本成熟，并已经在小型电子产品上成功实践过。但并没有把这种压电储能技术应用到生活当中去。为了充分利用生活当中的各种洁净能源，并把压电储能推向社会生活，所以我们以基于压电陶瓷的无线控制开关为切入口展开研究。

2　系统组成

无线充电式遥控开关主要由五部分组成。其中压电陶瓷触发电路产生触发信号，为单片机识别并编码；无线充电装置为单片机（编码）及发射器供电，整套模块都选用低功耗器件；单片机编码及发射电路构成一个整体，单片机编码电路输出固定编码值发射电路，由发射电路将编码在 433Mhz 高频载波进行发射；接收电路将射频信号有效地接收，然后送入单片机解码电路，解码电路将接收的信息解码后，转换成对外围辅助电路的控制信号；外围电路将解码输出的控制信号放大后控制继电器，以此来控制用电设备，实现开关作用。系统组成框图如图 1 所示。

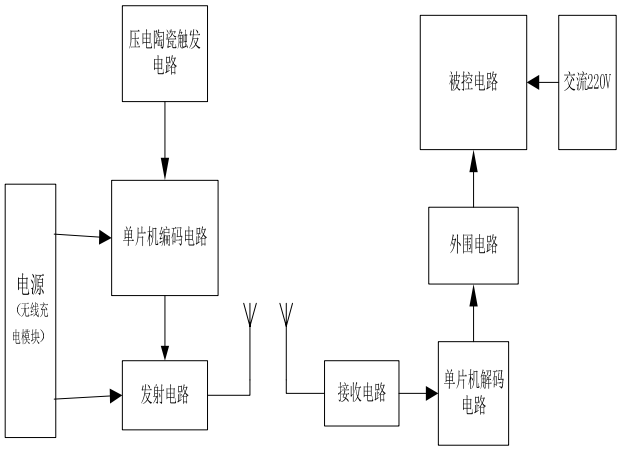

图 1　整体方框图

3　系统功能

3.1　压电陶瓷触发电路

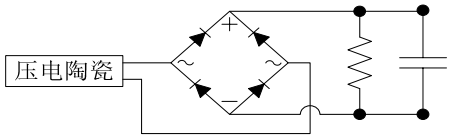

图 2 压电陶瓷触发电路

新一代传感技术的发展较大程度上依赖于改进微电子器件的无线供能技术，即直接从环境中提取能量。压电转换是利用环境振动诱导压电结构变形，进而引起材料内部的正负电荷中心分离，从而产生极化电压，极化电压将驱动电极板上自由电荷定向流动而输出电能。

将压电陶瓷和调节，储能电路有效连接在一起，如图2所示。压电陶瓷触发电路由压电陶瓷片，整流桥和储能电路构成。压电陶瓷片上下表面都附有电极板，电极板和直接和整流桥相接。波动压电陶瓷片，使压电结构因力电转换而产生交流电流。交流电流流过整流桥后产生直流电，并在储能电路中产生较稳定的直流触发电压，保证该触发电压可让单片机识别并编码发送。

3.2　无线充电装置

无线供电技术（无线充电）可以让接收端隔着空气、纸张或者塑料外壳等就能实现电能的传输，确实大大方便了应用，这项技术是最近才取得突破性的发展并且逐步实用化的。

无线供电采用“磁耦合共振”这种新技术所消耗的电能只有传统电磁感应供电技术的百万分之一，当发射端通电时，它并不会向外发射电磁波，而只是在周围形成一个非辐射的磁场。这个磁场用来和接收端联络，激发接收端的共振，从而以很小

的消耗为代价来传输能量。在这项技术中，磁场的强度将不过和地球磁场强度相似，人们不用担心这种技术会对自己的身体和其他设备产生不良影响。

无线供电模块内部集成了振荡电路、整形电路、检测电路、频率干扰抑制电路、电流自动控制、无线功率发射电路等部分组成。

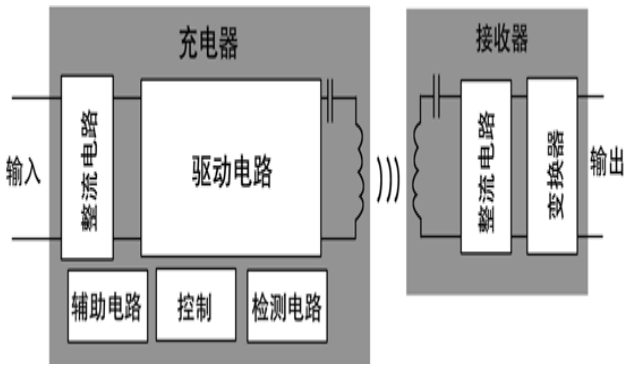

图3 无线供电模块

无线充电模块是专为便携式电子小产品的无线供电、充电而开发设计的，具有体积小、使用简便、转换效率高，无需再用电池供电，更加经济环保。

3.3 单片机编码和发送电路

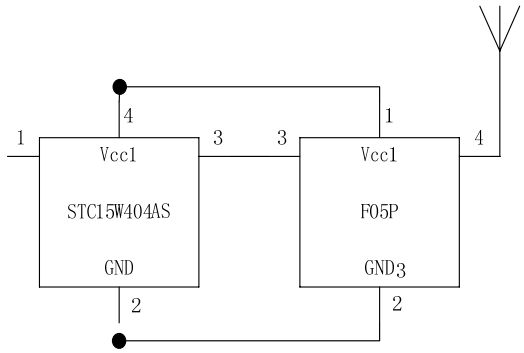

图 4 单片机编码和发送电路

为了提高遥控使用时间，因此对整体低功耗性能有高要求；考虑到单片机能检测触发信号，所以最好单片机可自带 AD 转换，于是选用这款 STC 系列 15w404AS 单片机。STC15W404AS 单片机是增强型 51CPU，速度比普通 51 快 8-12 倍；FLASH 型大容量 SRAM；8 通道 10 位高速 ADC；两组高速异步通信端口。

发射电路采用集成的发射模块，选用河南安阳市新世纪电子研究所有限公司生产的F05P型低功耗发射模块，如图5所示。F05P 采用SMT 工艺，树脂封装，小体积，声表稳频，内部具有一级调制电路及限流电阻，适合短距离无线遥控报警及单片机无线数据传输。F05P具有较宽的工作电压范围及低功耗特性,ASK 方式调制。

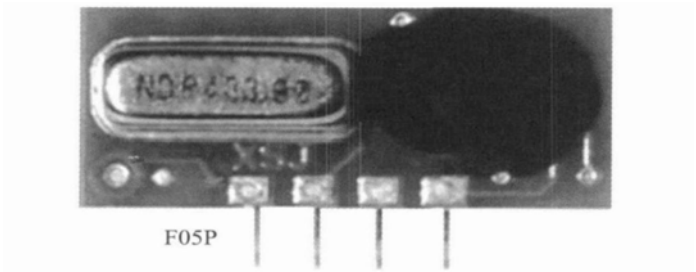

图 5 发射模块 F05P

3.4 接收电路

接收电路如图6所示。

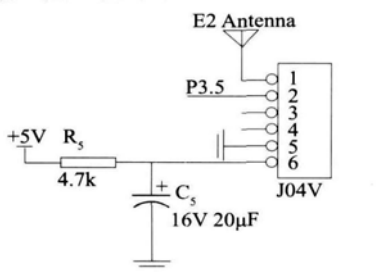

图 6 接收电路

接收电路采用集成的接收模块，选用河南安阳市新世纪电子研究所有限公司生产的J04V 型接收模块,如图7所示。J04V 是小体积、低功耗、低电压超再生接收模块，输出无噪声干扰，接收灵敏度高。

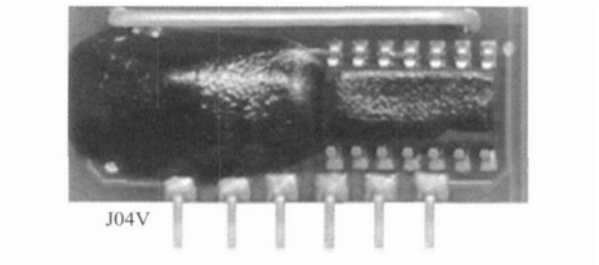

图 7 接收模块 J04V

3.5 单片机解码和外围控制电路

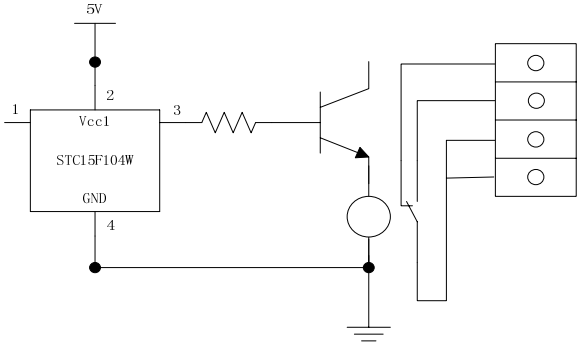

图 8 单片机解码和控制电路

为了保持整套系统的对称性和可靠性，接收部分的单片机选用与发射部分同类型的STC15 单片机。这款STC15F104E单片机是8脚的的，其功能和其他STC15单片机差不多，但功耗更低。每次接收到来自接收器J04V的编码，单片机就会向外围电路发出控制信号；外围电路主要是继电器。单片机的控制信号经三极管放大后驱动继电器。继电器线圈吸合，则将受控设备接入220 V交流回路；线圈释放，则受控设备接入的220 V 回路断开，以此来控制用电设备，实现开关的作用。

3.6 系统电路图

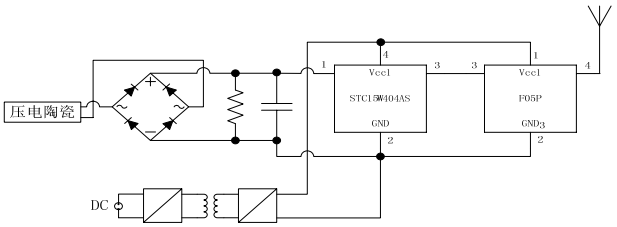

图 9 系统电路图

4 作品完成报告

每当挤压压电陶瓷片，带有AD的15型单片机能识别触发信号想发送端发送数据，接收端亦能收到数据，解码单片机可以较好解码并向控制电路发送控制信号，使继电器闭合，灯泡能正常发光。总体来说，作品能较好实现目的。

5 结论

本文设计的基于压电陶瓷片的可充电式无线遥控开关可满足人们的生活和工作需要。压电转换方式的力电转换性能好、能耗低、易微型化，因此具有非常广阔的应用前景。可无限充电的设计具有绿色环保的概念，并且大大提高了遥控器的使用寿命。室内装修免埋管、免布线、不凿壁，提高施工效率并且有效降低施工成本，提高设计自由度。而且控制端的设备电压最高为 5V，又会大大增强人在控制开关时的安全性。

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第二部分　英文论文集

Part II　English Proceedings

Research on Removing the Influence of Airborne Electromagnetic Data Launch Waveforms

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***Abstract*—According to the time-domain airborne electromagnetic survey, electro-magnetic data does not have a unified form when emission current waveforms are different .There are some problems still exist, including a large amount of data, slow speed data processing and so on.Non-orthogonal e exponential function,and the emission current of the receiver records must be pre-convolution to form a new basis function, and the basis function contains the system response of the emission current. The electromagnetic data is decomposed as a linear combination of the basis functions using singular value decomposition and de-convolution algorithms to remove the impact of the emission waveforms. According to a conversion of the time-domain airborne electromagnetic data into tau-domain, a kind of electromagnetic data standard form is formed, which has nothing to do with the flight measurement system. Eventually a set of algorithms applied to converting The airborne electromagnetic data into tau-domain are provided.**

Ⅰ. INTRODUCTION

AIRBORNE Electromagnetic Method[1] is one of the common method used in airborne geophysical prospecting. AEM has advantages over the speed, low cost and good passage, covering large area, being used for sea detection and it is mainly used to rapid metal ore body census, large area geological mapping, hydrogeology, engineering geology exploration and environmental monitoring, etc[1]. At present, native main AEM emission waveforms using square or trapezoidal wave, and the observation time is no emission current (emission current *I(t)=0*),the so-called off-time observation[2]. By analyzing receiving coil measuring secondary field spatial distribution form, It can be found that the existence of the underground abnormal geological body, and the electrical structure, spatial distribution of the abnormal body can be determined. For airborne electromagnetic detection in time domain, data doesn't have unified form because of the different emission current and different sampling time settings window. And there are some problems still exist, such as large amount of data, low speed of data processing. By de-convolution algorithm[3], electromagnetic data are decomposed into the liner combination of the basis function, to remove the influence of system response, emission current waveform, and sampling time window in this study[4].

Ⅱ. SINGULAR VALUE DECOMPOSITION

Singular value decomposition is an orthogonal matrix decomposition method; the decomposition method of SVD is the most reliable.

$$[U, S, V] = SVD(A) \tag{1}$$

The U and V represents two mutually orthogonal matrix, and S is a diagonal matrix

$$A = [U][S][V^T] \tag{2}$$

The purpose using the SVD decomposition method is to solve the least squares method and data compression.

Ⅲ. CALCULATING THE ELECTROMAGNETIC RESPONSE OF THE EMISSION CURRENT

According to the principle of airborne electromagnetic system detection, the relationship of the receiving coil induction electromotive force and the emission current is:

$$dB/dt = i(t) * h(t) \tag{3}$$

It can be shown in figure 1block diagram,

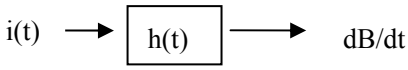

Fig.1 The schematic diagram of the aem system input and output

i(t) is emission current, and dB/dt on behalf of the receiving coil induction electromotive force, h(t) is the normalized induced electromotive force which is produced in receiver coil for the system impulse response. Loading the test time data under logarithmic coordinates, the images as shown in figure 2.

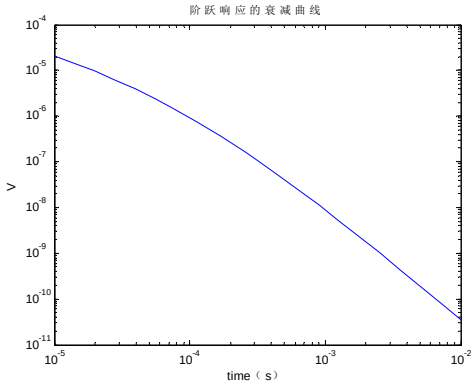

Fig.2 The decay curve of the step response

Aem system can be thought as a linear time invariant linear system. When the emission current is step wave form, known at the receiver coil normalized induced electromotive force, and the known impulse signal and step signal has the following relationship:

$$\delta(t) = u'(t) \tag{4}$$

The normalization of induction electromotive force g′(t) is generated when input impulse, so the normalized induced electromotive force[7] at the receiver coil of random waveform i′(t) can be written as :

$$dB/dt = i(t) * g'(t) \tag{5}$$

According to the nature of convolution commutative law,

$$dB/dt = i'(t) * g(t) \tag{6}$$

When loading any three of the waveform in experiment, the response curve is available respectively. Figure 3 shows Trapezoid spread and its derivative, and the convolution of launch waveform derivative and step response shows in figure 4, clipping off-time period of response curve as shown in figure 5.

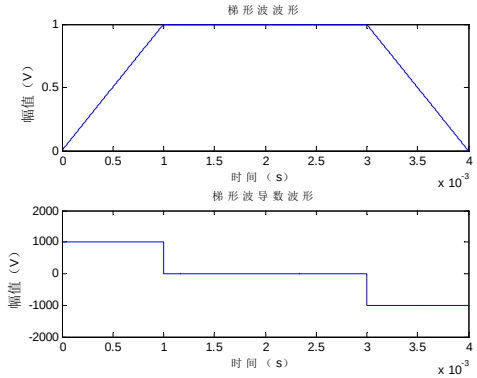

Fig.3 Trapezoidal wave and its derivative

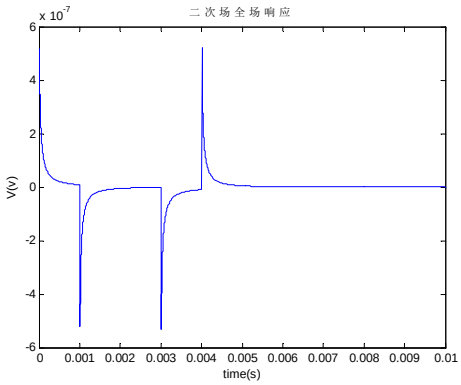

Fig.4 The second full response of the trapezoidal wave

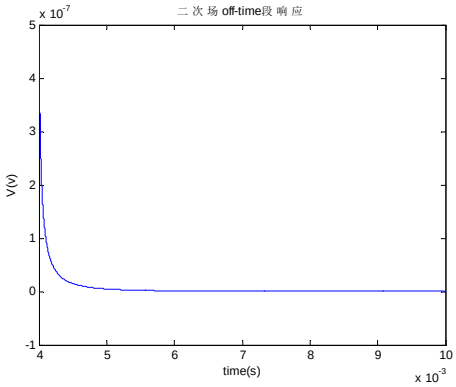

Fig.5 The off-time period of trapezoidal wave secondary response

Ⅳ The Determination of Electromagnetic Data

Tau Domain Parameters

The decay curve of step response is shown in figure 2. On the original decomposition of basement, step current response:

$$A(t) = \sum_i A_i \exp(-t/\tau_i) \tag{7}$$

$$\begin{bmatrix} D_1 \\ . \\ . \\ . \\ D_n \end{bmatrix} = \begin{bmatrix} AofT(t_1,\tau_1) & . & . & AofT(t_1,\tau_m) \\ . & & & . \\ . & & & . \\ . & & & . \\ AofT(t_n,\tau_1) & . & . & AofT(t_n,\tau_m) \end{bmatrix} \begin{bmatrix} A_1 \\ . \\ . \\ A_m \end{bmatrix} \quad (8)$$

[D] is the time data matrix , and [AofT] is the matrix of de-composition baisis function, and [A] is the coefficient matrix, as:

$$[AofT]=[U][S][V^T] \quad (9)$$

To remove the singular value in **S** matrix, and setting the range of 10e-6 as the threshold value which based in time domain. All the eigenvalues of the greater than this value are retained, and the eigenvalues of the less than this value are setting to 0. The coefficients are obtained with the processed matrix **S** substituted into the formula.

$$A = V*S*U^T*A(t)^T \quad (10)$$

Coefficient A is shown in figure 6.

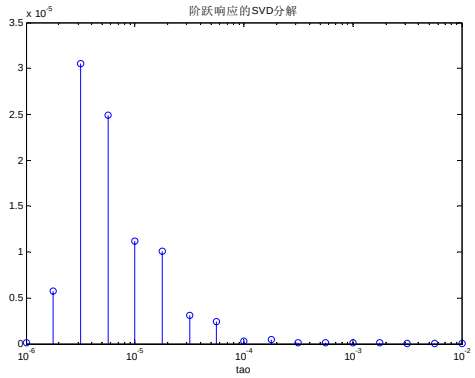

Fig.6 The SVD decomposition coefficient of the step response

The coefficient A was substituted into the original formula refactoring step response curve, and the step attenuation curves were fitting before and after reconstruction. Taking appropriate tau values, choosing every ten octave even pick up 4 points, that is, from 0.001ms to 10ms, each order of magnitude at 3 points intervals. The fitting effect and the error analysis are shown in figure 7.

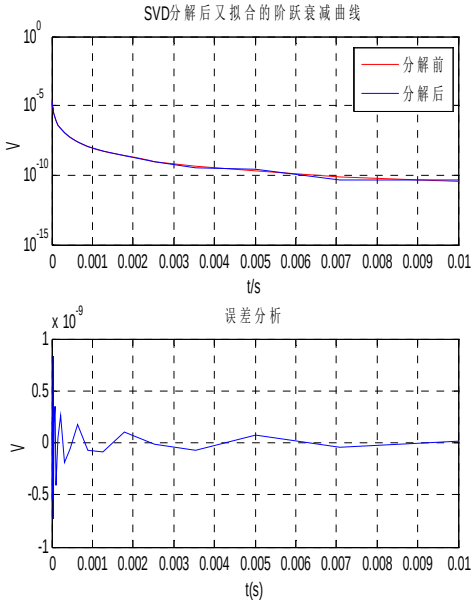

Fig.7 The fitting and error analysis of step response before and after the reconstruction

We can also find that the average error is on 10e-9 order of magnitude, which is in the range of allowable error.

Ⅴ. The New Basis Function Determination and the Research of Electromagnetic Data De-convolution

The tau domain basis function decomposition of airborne electromagnetic data in time domain is that one of the emission current of off-time quadratic induction electromotive force is decomposed into a series of e index, and the launch step current response in receiving coil is expressed as:

$$A(t) = \sum_i A_i \exp(-t/\tau_i) \quad (11)$$

The random current response:

$$B(t) = i'(t) * A(t) = i'(t) * \sum_i A_i \exp(-t/\tau_i)$$

$$= \sum_i A_i (i'(t) * \exp(-t/\tau_i)) \quad (12)$$

$\sum_i (i'(t)*\exp(-t/\tau_i))$ is the new basement.

Coefficient are obtained on the SVD decomposition of new base:

$$A_2 = V * S * U^T * B(t)^T \qquad (13)$$

Coefficient A2 is shown in figure 8.

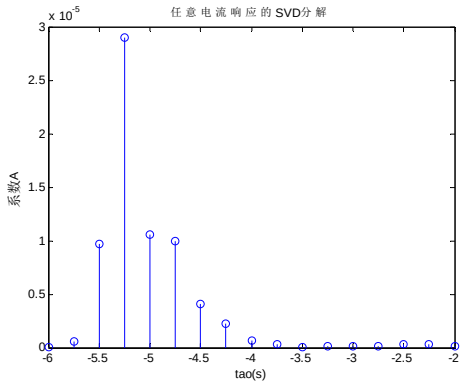

Fig.8 The new coefficient A2 of the trapezoidal wave

A2 and the original basis function are combined to get the waveform response curve, and then fitting with the original step response, and analysing the error. Take trapezoidal wave as an example, the fitting about removal trapezoid wave form response curves and the original step reponse in shown in figure 9, the error analysis is shown in figure 10.

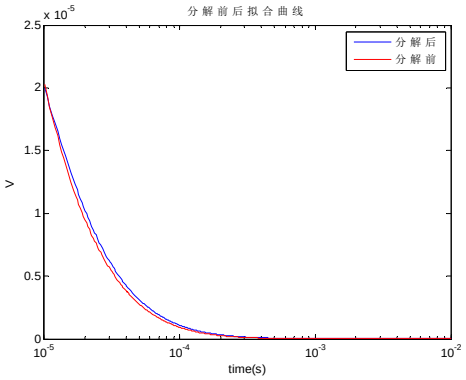

Fig.9 The fitting of the original step response and the removing trapezoidal wave response curves

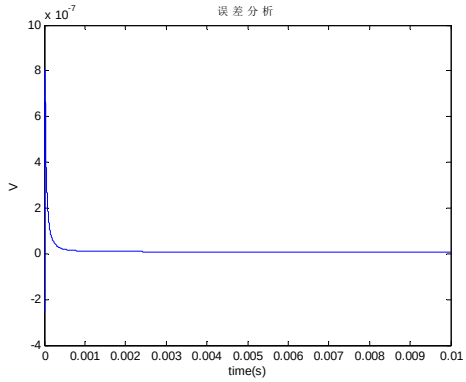

Fig.10 The error analysis

We can also find that the average error is on 10e-7 order of magnitude, which is in the range of allowable error.

Ⅵ. CONCLUSION

To sum up, the time-domain airborne electromagnetic response is processed using the method of SVD decomposition, and the computer numerical simulation is carried out on the basis of theoretical analysis, and reconstructing the induction electromotive force response curve. Results show that the significance to the study of complex time-domain electromagnetic method and rapidly processing and interpretation theory of airborne electromagnetic data.singular matrix after the singular value decomposition ensures the precision and stability of the calculation, and achieves the effect to remove the influence of transmitted waveform. Which has practical guiding.

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Research on non-invasive blood glucose measurement based on Photoplethysmograph

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***Abstract*—The clinical method of blood glucose(BGL) measurement at present is extracting blood from the patients,which is based on the principle of biochemical reaction.This invasive method is painful,susceptible and discontinuous.To deal with these problems, we focus on a non-invasive way on the strength of the photoplethysmography detection theory by irradiating the finger with two beams of near infrared lights of 805nm and 940nm.The wave of 805nm is sensitive to glucose,while the 940nm one acts as the reference. By processing the information of the blood glucose extracted from the transmitted lights,the blood glucose value can be calculated.Experiments have convinced that the continuous non-invasive blood glucose measurement can be achieved.**

I. INTRODUCTION

DIABETES is one of the four main diseases endangering human health.According to the World Health Organization(WHO), the number of diabetics in the whole world will grow to 300 million. Not only the diabetic brings a great suffering to the patients and their family, but also the increasing diabetic population has brought a heavy burden to our state and society. Therefore, accurately measure blood glucose to prevent diabetes is of positive significance[1] . The clinical method of blood glucose detection needs pricking blood from fingers or vein, obtains the BGL through the electrochemical process, Colorimetry or Colorimetric method. This invasive method is not only a wast of time but also discontinuous, the used paper causes environmental pollution, frequent testing increases the risk of infection. In view of the above problems we proposed a non-invasive blood glucose measurement based on photoplethysmograph, has adequate performance for safe, non-invasive estimation of blood glucose.

II. Principle of Photoplethysmography Blood Glucose Measurement

Photoplethysmography is a non-invasive measurement method using photoelectric means to detect the changes of blood volume in vivo. When irradiating the finger by a near-infrared light of fixed wavelength, we derive the transmission light after the absorption by skin, artery, vein, muscle tissue and bone. The measurement schematic diagram is shown in figure 1.

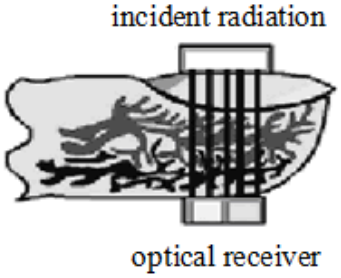

Fig.1 Near-infrared light transmission fingers schematic diagram

The light absorption of the skin, muscle, tissue and in the blood is held constant, the volume of blood in the skin is of a pulsatile change in the heart function, when the heart contracts the biggest peripheral blood volume, the light absorption amount is maximum, therefore the light intensity detected is minimum; on the contrary, when during diastole, the detected light intensity is maximum, thus the intensity of light received by the light receiver to increase the pulsation changes. Turn the light intensity signal into electrical signal, then get photoplethysmography. It follows that the volume pulse wave contains glucose to near infrared absorbing information. And blood glucose in near infrared absorption intensity is related to blood glucose concentration.

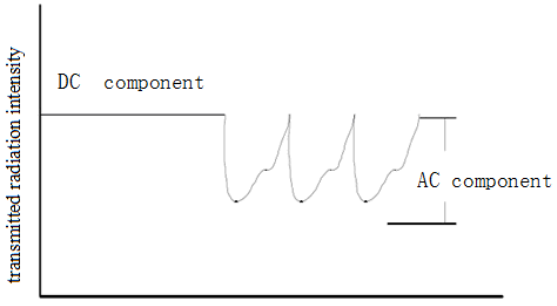

Fig2. Photoelectric receiving tube schematic reception

Figure 2 is photoplethysmography signal received by the photoelectric receiving tube, which consists of two components:

1.The DC component, which is composed of venous blood and muscle tissue, bone absorption;

2.The fluctuation of AC component, which is synchronous with the pulse rate, mainly reflect the absorption of glucose in arterial blood.

According to the law of Lambert-Beer, When diastolic, assuming λ as the wavelength, I_0 as the light intensity of a vertical irradiation finger monochromatic light, the transmitted light intensity is :

$$I = I_0 / (e^{\varepsilon_0 c_0 l_0} e^{\varepsilon_1 c_1 l} e^{\varepsilon_2 c_2 l}) \quad (1)$$

In the formula, ε_0, c_0, l_0 represent the total absorption coefficient of non ripple component and the venous blood in the organization, the concentration of light absorbing material and optical path length respectively; ε_1, c_1, l stand for the absorption coefficient of glucose, blood glucose and arterial blood path separately; ε_2, c_2 represent the concentration of the reference substance and the optical absorption coefficient of the reference materials respectively.

Glucose exhibits two absorption bands in the near infrared region: 700~1330nm, 1540~1820nm, it is of importance that there is board and strong absorption band between 1450nm and 1920nm[8]. In order to avoid this band, and considering that water should have same light absorption coefficient at the two beams of lights, it appears theoretically possible to use 805nm and 905nm in the near infrared region. The wave of 805nm is sensitive to glucose, while the 940nm one acts as the reference. It means that $\varepsilon_2^{\lambda_1} = \varepsilon_2^{\lambda_2}$ (λ_1 represents for 805nm, λ_2 represents for 940nm).

When using the 805nm light to irradiate the finger, based on the formula (1), it conclude that:

$$\ln I_0^{\lambda_1} / I_{DC}^{\lambda_1} = \varepsilon_0^{\lambda_1} c_0 l_0 + \varepsilon_1^{\lambda_1} c_1 l + \varepsilon_2^{\lambda_1} c_2 l \quad (2)$$

Arterial blood optical path length increases from l to $l + \Delta l$ with systolic, the corresponding transmission light intensity turns I_{DC} into $I_{DC} - I_{AC}$.

$$\ln I_0^{\lambda_1} / (I_{DC}^{\lambda_1} - I_{AC}^{\lambda_1}) = \varepsilon_0^{\lambda_1} c_0 l_0 + \varepsilon_1^{\lambda_1} c_1 (l + \Delta l) + \varepsilon_2^{\lambda_1} c_2 (l + \Delta l) \quad (3)$$

In the formula (3), I_{DC} is the strength of the transmitted light at diastolic period; Δl is arterial blood optical path variation with systolic; I_{AC} is the transmission light intensity variation during the period that heart turns systolic to diastolic.

Using the formula (3) to substract the formula (2), we can derive the formula (4):

$$\ln(I_{DC}^{\lambda_1} - I_{AC}^{\lambda_1}) / I_{DC}^{\lambda_1} = \varepsilon_1^{\lambda_1} c_1 \Delta l + \varepsilon_2^{\lambda_1} c_2 \Delta l \quad (4)$$

The ratio of communication components and DC component is for less than 1. Taking that into consideration, wen conclude that:

$$\ln[I_{DC} - I_{AC}] / I_{DC} \approx I_{AC} / I_{DC}$$

Thereby, the expression (4) could change to (5) as the following:

$$I_{AC}^{\lambda_1} / I_{DC}^{\lambda_1} = \varepsilon_1^{\lambda_1} c_1 \Delta l + \varepsilon_2^{\lambda_1} c_2 \Delta l \quad (5)$$

When using the 940nm light to irradiate the finger, it is the same way we conclude that:

$$I_{AC}^{\lambda_2} / I_{DC}^{\lambda_2} = \varepsilon_1^{\lambda_2} c_1 \Delta l + \varepsilon_2^{\lambda_2} c_2 \Delta l \quad (6)$$

Using the equation (5) to substract the formula (6), we can derive the following equation:

$$\frac{I_{AC}^{\lambda_1}}{I_{DC}^{\lambda_1}} - \frac{I_{AC}^{\lambda_2}}{I_{DC}^{\lambda_2}} = (\varepsilon_1^{\lambda_1} - \varepsilon_1^{\lambda_2}) \bullet c_1 \bullet \Delta l \quad (7)$$

According to the above formula, the glucose could be derived:

$$c_1 = \frac{1}{(\varepsilon_1^{\lambda_1} - \varepsilon_1^{\lambda_2}) \Delta l} \bullet \left(\frac{I_{AC}^{\lambda_1}}{I_{DC}^{\lambda_1}} - \frac{I_{AC}^{\lambda_2}}{I_{DC}^{\lambda_2}} \right) \quad (8)$$

III. Establishment of measurement model

Least squares method is a kind of mathematical optimization techniques, by minimizing the sum of the squares of the error data to find the best match function. Assume the parameter R as the followed:

$$R=I_{AC}^{\lambda_1}/I_{DC}^{\lambda_1}-I_{AC}^{\lambda_2}/I_{DC}^{\lambda_2} \quad (9)$$

Then, the expression (8) could be changed into:

$$c_1=\frac{1}{(\varepsilon_1^{\lambda_1}-\varepsilon_1^{\lambda_2})\ \Delta l}\bullet R \quad (10)$$

The collected pulse wave form is shown in figure 3, combining the data of the pulse wave and the equation (9) , R could be concluded.

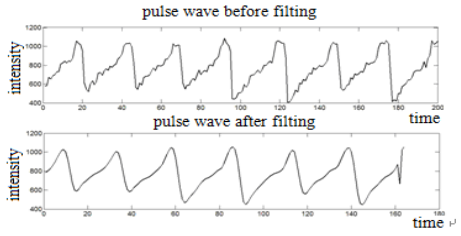

Fig.3 Pulse Wave

Basing on the test to a 22-year-old healthy male Mr.Sun, a series of pulse wave data was obtained, the corresponding R were calculated and denoted by R_i. At the same time, glucose levels(C) of the subjects were measured by glucose meter of Yue II (The error is less than 0.5mmol/L) and singed with C_i.Use MATLAB to get fitting curve of A and B. The fitting curve of C_i and R_i was derived from MATLAB, and shown in the forth figure.

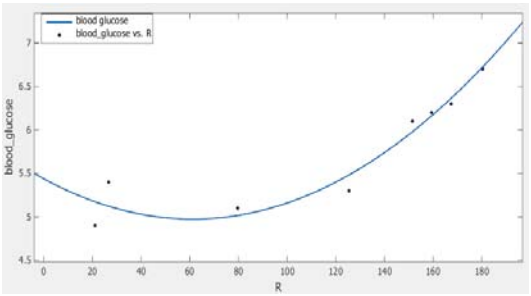

Fig.4 Fitted curve of C&R

From the figure above, we can get the relationship of C&R:

$$C=p_1\cdot R^2+P_2\cdot R+P_3 \quad (11)$$

Fitting coefficients: p1=0.0001198 P2=-0.01438 P3=5.418

On the basis of formula (10) and (11), the final calculation formula of blood sugar was obtained.

IV.Testing Results and Analyses of System

A. The testing process

In order to validate the photoplethysmography pulse wave blood glucose measurement theory, we took tests on both single-player and multiplayer with the photo electric pulse blood glucose measurement system respectively, considering the glucose level from glucose meter of Yue II as the standard reference.

Tests on single-player: The subjects was still Mr.Sun. In the period from fasting until 3 hours after a meal, every 30 minutes the blood glucose of the subjects was measured by the system, so we got a series of glucose values and meanwhile compared them with standard values. The test was made in the laboratory, the indoor temperature was 18℃~21℃, relative humidity was 40%. Moreover, whether it was before the test or still in the process of testing, the testee had no strenuous exercise and kept in peaceful mind. Table 1 has showed 9 sets of data from the tests, basing on which a line chart was obtained and showed in figure 5.

Table1.Analysis of the results(Single)

Nu-mber	theoretical blood glucose level mmol/L	actual blood glucose level mmol/L	error mmol/L
1	3.05	5.4	2.35
2	3.04	3.6	0.56
3	3.20	3.0	0.20
4	3.46	4.9	1.44
5	3.52	3.3	0.22
6	3.67	2.7	0.97
7	2.66	5.1	2.44
8	2.93	6.8	3.87
9	3.56	4.7	1.14

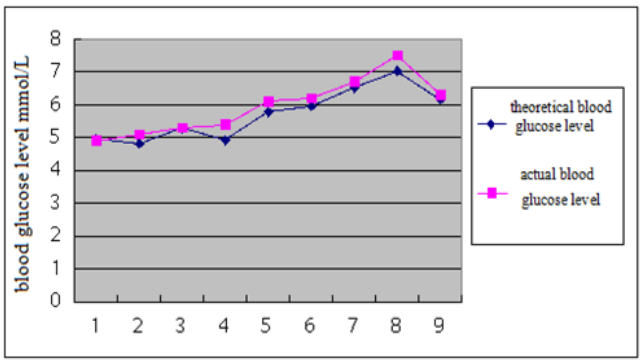

Fig.5 Noninvasive blood glucose values compared with the standard (single)

Tests on multiplayer: There were 9 healthy male testees range from 21 to 23 years old. The test conditions and methods were same with the tests on single-player. Table 2 has showed 9 sets of data from the tests, basing on which a line chart was obtained and showed in figure 6.

Table2.Analysis of the results(multiple)

Nu-mber	theoretical blood glucose level mmol/L	actual blood glucose level mmol/L	error mmol/L
1	4.96	4.9	0.06
2	4.82	5.1	0.28
3	5.29	5.3	0.01
4	4.91	5.4	0.49
5	5.78	6.1	0.32
6	5.96	6.2	0.24
7	6.51	6.7	0.19
8	7.03	7.5	0.47
9	6.17	6.3	0.13

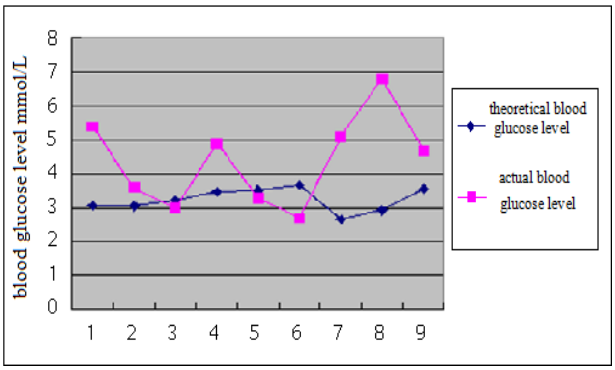

Fig6.Noninvasive blood glucose values compared with the standard (multiple)

B. Analysis

For the single detection, the calculated value error range is 0.06~0.49 mmol/L, most of the results error is less than 0.4 mmol/L. Moreover, the correlation coefficient calculated is 0.977, in line with national standards.

For the multiplayer detection, the calculated value error range is 0.2~3.87mmol/L, most of them were scattered. From Figure 6 can be seen that both of them have no clearly significant relationship.

From the above analysis: A single model should be established before this system can be used, and the system only applicable for glucose measurement on the specific person, does not have a reference value for others.

V. Conclusion

In this study, according to the theory of photoplethysmography puls wave, and using the law of Lambert-Beer to design a set of noninvasive blood glucose measurement system. Before using the system, it needs to use the single model and a certain R value to establish a certain model then to fit, and it is only applicable for glucose measurement to the modeler.

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Research on visualization of magnetic field model in the region of Changchun

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***Abstract*—IGRF,the global geomagnetic reference model,is a mathematical model which is described the geomagnetic field and its annual variation rate.Based on the IGRF model, using Geomag7.0 as a tool and Google Earth(a Virtual Earth 3D software) as carrier,had a research on visualization models of the geomagnetic field in Changchun.Using Geomag7.0 to generate a series of geomagnetic elements c.Creating KML files of Changchun based on these data.Then open these files can check the visualization results of regional geomagnetic field components in Google Earth,visually.**

0 INTRODUCTION

EARTH'S magnetic field is one of the indispensable geophysical fields for human to survive.It is accompanied by the formation and evolution of earth,with complex spatial structure and time evolution,and it is a protective screen for earth as well.The earth's magnetic field can prevent the earth's surface form space radiation,which is important for human to live.And the earth's magnetic field is constantly changing,that is why studying it is such a important thing.

Geomagnetic field model and it's calculation is one of the important research contents of magnetism.It also provide a reference system for the traditional positioning and orientation,using widely in the earth science,geophysical exploration and other fields,influencing profoundly on national defense,military and economy,and also presenting a higher accuracy requirement on time and space distribution of the geomagnetic field.With the rapid progress of computer technology.Combining with IGRF model with information technology is the inevitable trend of future development.

I. TEST METHOD AND EXPLORATION

A. Introduction of the model

The international geomagnetic reference field is a model of a series of main magnetic field of earth and its mathematical model of variable rate (secular change).In the positive region of terrestrial space,the earth's main magnetic field,which is originating in the interior of earth,can be expressed as a scalar magnetic potential's(v) negative gradient.Here V can be expanded into a spherical harmonics as follows:

$$V(\gamma,\theta,\lambda,t)=R\sum_{n=1}^{n_{max}}\left(\frac{R}{r}\right)^{n+1}\sum_{m=0}^{n}\left[g_n^m(t)\cos m\lambda+h_n^m(t)\sin m\lambda\right]p_n^m\theta$$

r,θ,λ represent the spatial position of calculate point.r is the radial distance to the reference core,λ is east longitude degrees calculated from Greenwich.θ is the inner earth colatitude (90° minus the latitude). $g_n^m(t)$, $h_n^m(t)$ are the spherical harmonic coefficients.Use the enough uniform distribution point value around the earth to solve the system of equations.N and m are the order and degree in spheric harmonic function. $p_n^m(\cos\theta)$ is a schmidt quasi normalized associated Legendre functions in n-order m-degree.

Geomag7.0 is a software written by Stefan Maus,according to the spherical harmonic coefficients published by IAGA in 2010.Use the order 'cd' in DOS to get in the geomag7.0 directory,and initialize the longitude, latitude, altitude and relevant calculation parameters.

B.Visualization application research

Visualization is a new development direction and

an important research field of computer graphics.Generally we think,visualization is a king of theory, method or technology using the principle and method of graphics to convert the data to graphics or image on a screen,and proceed interactive processing at the same time.It relates to computer graphics, image processing,computer vision,computer aided design and other fields,providing synthesis technique for,research data representation,data processing, decision analysis and a series of studies,and presenting in a more intuitive way.

Making a visualization application research, especially in Changchun area,we need a 3D earth model as a carrier.It's so hard to make such a new model,because it need a better hardware condition,spending a lot of time and energy.Most importantly,it will not riper than the software which is published by a business company.Therefore,We compared a couples of the current representative free 3D geographic information browser and chose Google Earth at last,which is a free software published by Google.Use the powerful virtual globe software Google Earth,in order to get the visual image of the Earth's magnetic field visually.Use the geomagnetic data which exist in Geomag7.0 database to create KML files and put them in Google Earth in different magnetic components. This can let the geomagnetic data and geomagnetic charts show on earth,of course in the corresponding area.As long as we let the geomagnetic data and geomagnetic charts show on earth,we can easily watch the geomagnetic information visually.And the KML file can create colorful image identification as well.Upload the KML file into the internet,then we can easily enjoy the geomagnetic field model of network visualization.

II. RESULTS AND DISCUSSION

Base on the IGRF geomagnetic reference model as is mentioned above, the geomagnetic field 3D contour maps in Changchun area created by Geomag7.0 and Google Earth are as follows(figure 2.1 to figure 2.3):

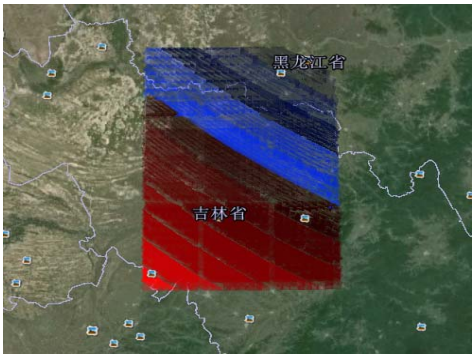

Figure 2.1 Magnetic declination D in Changchun area

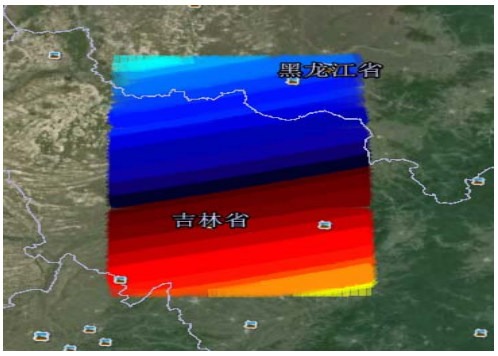

Figure 2.2 Magnetic inclination I in Changchun area

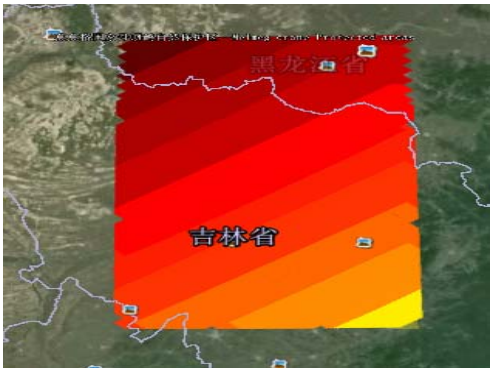

Figure 2.3 Magnetic field intensity F in Changchun area

Earth's magnetic field contour plans in Changchun area are as follows(figure 2.4 to 2.6):

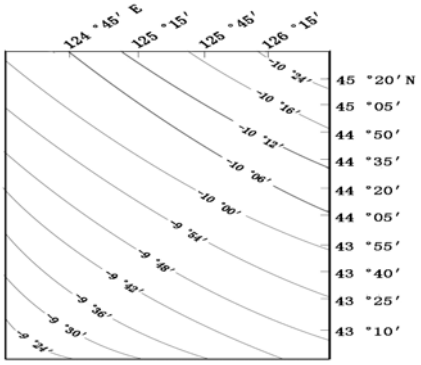

Figure 2.4 Magnetic declination D in Changchun area

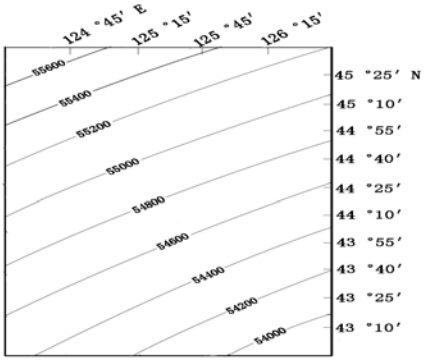

Figure 2.5 Magnetic inclination I in Changchun area

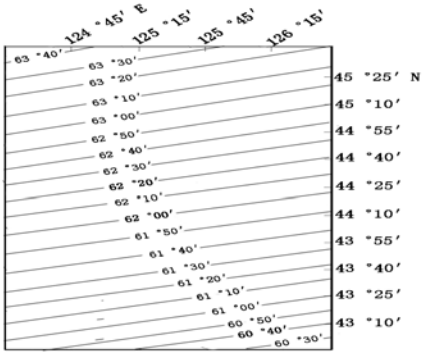

Figure 2.3 Magnetic field intensity F in Changchun area

The information above show the simulated results of magnetic declination D, magnetic inclination I and magnetic field intensity F in Changchun area.According to the longitude and latitude which lie the Changchun area,draw the Earth's magnetic field contour plans with 15’ as interval in latitude(124 ° 45’-126 ° 15’) and 30’ as interval in longitude(43 ° 10’-45 ° 20’).The results are shown above.

III. CONCLUSION

To sum up in conclusion,combine the IGRF model,Geomag7.0 and Google Earth successfully get preliminary results in visualization application.It can get clear contour map and visually know the distribution of magnetic field in Changchun area.If the KML files are uploaded into the internet,then people who are interesting about the magnetic contour map can easily download the resource.That is the benefit of the Internet.

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Smart Security Patrol Car Based on Multi-sensor Detection

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***Abstract*—Traditional artificial security patrol system restricted by human factors, the patrol route, time, frequency, and the density is not reasonable. We design a car which has multi-sensor such as flame sensor, ultrasonic sensor, light sensor and so on. It uses freescale main controller and auxiliary controller which coordinate with each other to complete tracking and obstacle avoidance, low battery detection, temperature acquisition, smoke alarm, video transmission, intelligent control of motor speed and accurate positioning and so on. Patrol car uses PC for remote control and uses the real-time transmission image to test the security target. From the experiment test we know the car's maximum error is 3%, so its intelligent patrol effect can meet the development requirements of the current, meanwhile the small form, full functions and strong practicability all shows that it has a broad market application prospect.**

***Key words*—security; patrol car; sensor system; remote monitoring and control; real-time communication**

INTRODUCTION

With the enlargement of city scale, security work play an increasingly important role in the modern society. For a long time, security work has always been the traditional human patrol system, and the patrol route, time, frequency and density are not reasonable enough. So it is difficult to avoid the waste of human and effort, due to the sense of responsibility of patrol peoples are not strong, it also causes the phenomena of demotivation and dereliction of duty so that enterprises and units often spend lots of manpower and material resources and financial resources on security, but it's still difficult to have the ideal security effect[1].

The smart security patrol car is integrating a variety of sensors and able to monitoring various environmental parameters of patrol locations in real-time. And it can carry out automatic alarm in emergency situations such as when fire or strangers intrusion events occur. The car through the camera to complete the function of tracking and obstacle avoidance and use the light intensity sensor to collect the light intensity to provide car lighting. It uses the wireless transceiver module to transmit videos and through the PC display to implement the remote control. The smart security patrol car can also realize intelligent charging. The function of autonomous patrol and remote monitoring make it has the advantages of flexible convenience and strong stability, and enable it to reach comprehensive monitoring patrol in the case of less people unattended, so it can save the manpower and improve the efficiency of the patrol [2].

The research and development of the smart security patrol car overcome the disadvantages of traditional patrol system, it's a kind of advanced equipment which has the function of autonomous patrol, gathering information, intelligent charging and accurate positioning. The patrol car uses the advanced control system and algorithm, so it can not just to perform excellent patrol, the study of intelligent control system is also coming into a deeper layer, it also plays an important role in studies the auto industry [3].

I THE SYSTEM DESIGN

The smart security patrol car use freescale K60 chips as the main controller and together with MSP430 Single chip microcomputer to coordinate control the stable operation of the whole system. The main controller mainly control the car moving, speed regulation, wireless transmission and other functions, auxiliary controller mainly carry out the smoke alarm, temperature detection, light intensity, power management, voice prompt and such kinds of sensing

functions.

When the car is on patrol, it through the camera to detect the road ahead, it drives fast on an empty road patrol, but once it in the dangerous accident location it will slow down to patrol carefully. Its various sensors can sense the environmental changes, once it detected smoke and fire, it will send alarm signal. The car through the ultrasound real-time dynamic monitoring, it will make a voice warning and alarm to the terminal when strangers invaded. Once the car battery is lower than the set value, it will stop the patrol and return to the starting point for charging automatically. In addition, in order to overcome the traditional GPS positioning precision, we design the effective localization algorithm for real-time positioning on the car, so that once an emergency have happened, we can get the site in time to improve the efficiency of patrol.

II THE HARDWARE DESIGN OF THE CAR

The patrol car has perfect sensor system[4], motion control algorithm, the ability of real-time communication and reliable actuators[5]. The system's overall diagram and specific function is shown in figure 1:

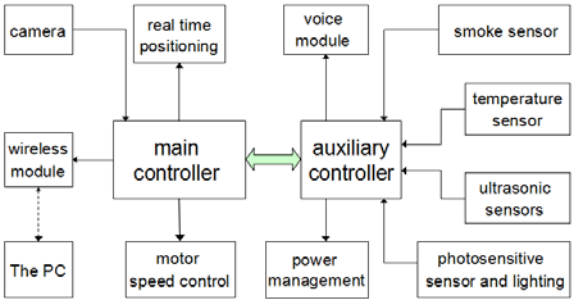


Fig.1 The system's overall diagram

First of all, the car equipped with smoke, light intensity, temperature, ultrasonic and other sensors, so it can collect the environmental informations in real-time.

①It uses thermistor and A/D transform to detect the temperature. Thermal resistance has the advantages of sensitive and reliable[6]. The A/D converter has many advantages, such as inhibition of series mode interference ability, high resolution, good linearity, low cost, which solves the question of the DS18B20 such as precision is not high and the temperature range is low.

②The smoke sensor using the principle that when the early fire occurs the fuel oxidated sharply and released the aerosol particles and smoke. They would enter into the detection chamber to adsorbent and neutralize positive and negative ions, so that the ionization current decreases sharply, and ion current balance changes.This will produce a voltage increment in the middle electrode which was proportional to the measured concentration of smoke to warn fire by analyzing changes in voltage increment [8].

③The images which gathered by the camera is influenced by light intensity, we use the light intensity sensor BH1750 to collect intensity and provide different levels of lighting for the car.The chip has I2C bus interface and with the advantage of wide range of input light,low power, built-in A/D converter, no external components etc[9].

④It detect intrusion by the ultrasonic sensor. Ultrasonic ranging is a kind of effectively non-contact measurement method,the principle is that ultrasonic sensor can occur certain frequency ultrasonic and spread with the aid of medium air, it will reflected back when reach the measuring targets or obstacles, so we can draw the distance by calculating round-trip time[10] . We can monitor around by Connect it with the rotate 360 degrees rudder, and the ultrasonic module will continuously scan in each direction, compare the former cycle position information by ultrasonic scanning with the later cycle position information in order to detect the dynamic objects. According to the steering angle to determine the target position information, then the CPU control camera to monitor the goal and send voice prompt, which successfully solve the short identification distance and low sensitivity of the pyroelectricity[11].

Secondly, The smart security patrol car through the camera for tracking to complete normal driving, and realize remote monitoring through wireless communication[12].Using cameras to path identification, its working principle is the picture of the camera was used to extract the car in front of the road in order to get the traffic information in front of the car [12].As shown in figure 2, and then take the collected images in "binary" by the software[14].(camera acquisition of gray image

threshold is greater than the preset value to buy 1, opposite to buy 0) As shown in figure 3, the PID algorithm based on binary image of steering gear and motor control[15] .Eventually make the car can along a predetermined path [16]. Using cameras to improve the speed of railway information acquisition and solved the infrared tracking stability shortcomings of tube at high speeds.

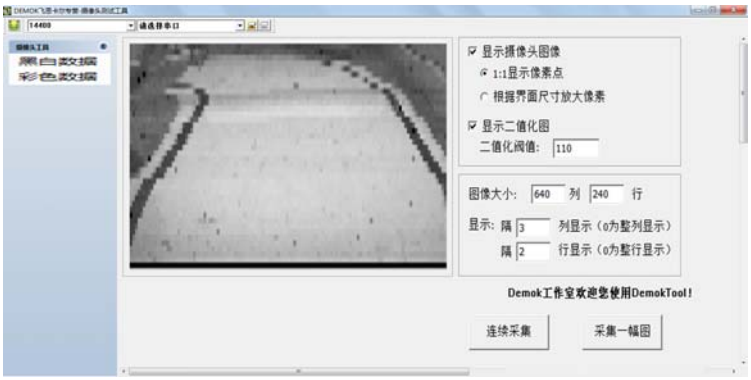


Fig.2 Traffic information graph

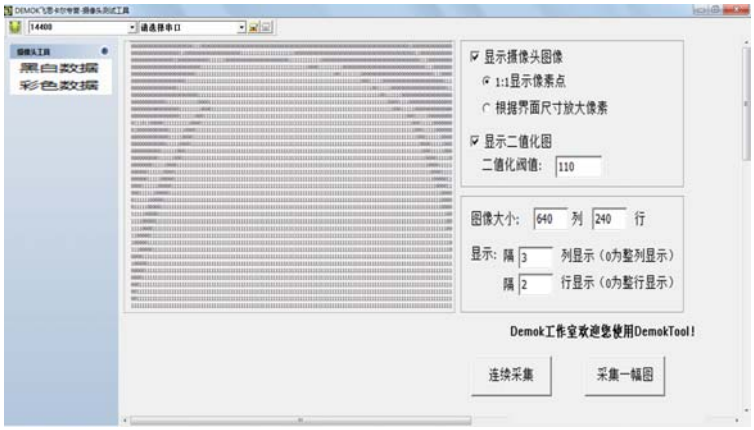


Fig.3 The two value image

Cameras capture images through the wireless module and sent them to the windows platform of PC to realize the remote control of the patrol car [17], and the PC interface is shown in figure 4. On the basis of independent patrol, we can in the course to set the speed of the car, such as we can set the car driving as fast to save time to improve the efficiency of patrol at an empty safe road patrol in corridor, and once it patrol in the site patrol the car will slow speed in full detail to quality security patrol.

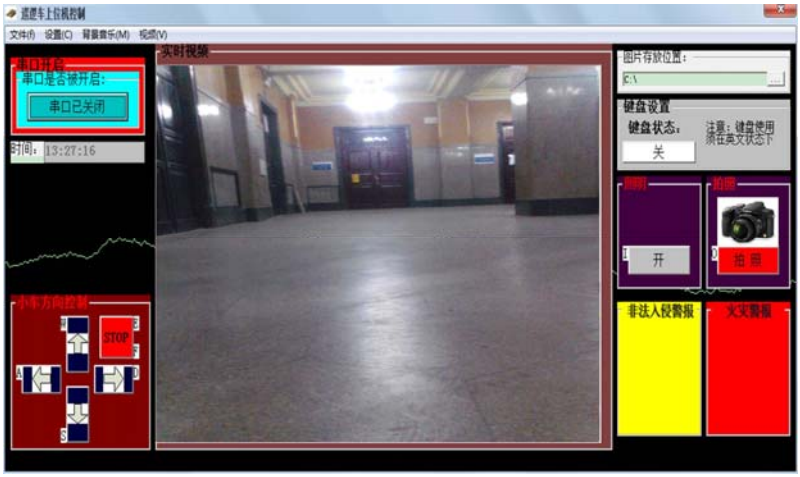


Fig.4 PC software interface

Secondly, when the car is on patrol there will be automatic alarm once emergency happened, this is where the real time we know the location of the car in order to take timely measures to guarantee the

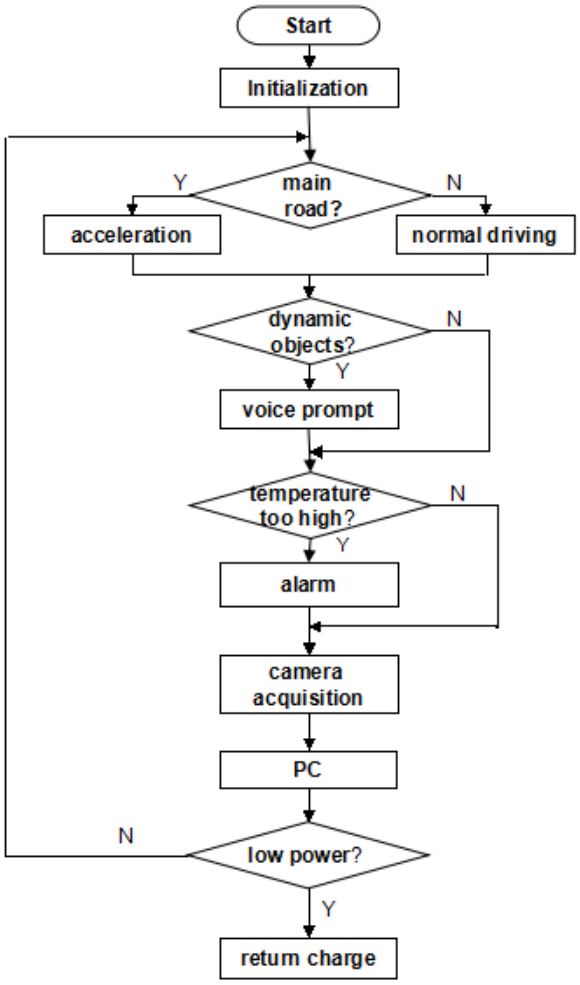
security patrol site. Through speed encoder converting speed information through calculating distance information, and calculate the distance with the initial point, through the Windows platform show the current position, and patrol in each cycle to initialize the positioning the origin, to avoid errors due to numerous patrols the accumulative positioning error caused by the higher problem. This time, we need to know the real-time car location in order to take timely measures to guarantee the security patrol site. We calculated the converting speed information into the distance information through speed encoder.And calculate the current position and the distance from initial point, then through the Windows platform show the current position, and patrol in each cycle to initialize the positioning the origin, so to avoid the problem of high positioning error which is caused by numerous patrols of the cumulative error.

Finally, the car tests its battery by AD collection and conversion of auxiliary controller. When the car battery power is lower than the preset value, the car will stop patrol, automatically return to the starting position for charging.

The smart security patrol car's perfect sensor function can take a comprehensive testing of various environmental indicators of the patrol location, and detect the threat of fire, theft and other potential safety factor in the first time. Intelligent tracking and obstacle avoidance, power management, speed regulation and real-time positioning function can make the unobstructed patrols, security patrol efficiency, greatly saves manpower and material resources, has the very strong development potential and market competitiveness.

III THE SOFTWARE DESIGN OF PATROL CAR

System chosen K60 and MSP430 single chip microcomputer to data processing, and using C language to develop the software part to make the software has good characteristics such as good readability and good portability [17] . The application of the whole system adopts the modular design is a subroutine call way, each block design is relatively independent, convenient for modification and adjustment in the late. Program flow chart is show in figure.5



IV THE TEST AND ANALYSIS

Since the localization algorithm is done on the basis of the patrol car range, in order to guarantee the accuracy of the positioning, the car really exercise the distance between X and Y processor measured data repeated testing, test results are shown in table 1

Tab.1 The travel distance and distance measurement test results

Test times	1	2	3	4	5	6	7	8	9	10
X(m)	10	20	30	40	50	60	70	80	90	100
Y(m)	9.7	19.5	30.7	39.3	50.8	59.2	69.1	79.2	89.2	99.3
Relative error	3%	2.5%	2.3%	1.8%	1.6%	1.3%	1.2%	1.0%	0.8%	0.7%

At the same time, test the accuracy of the ultrasonic detection, which said A has close to the object, B says more far away from the object, C said object did not move, test results are shown in table 2

Table.2 Test results of ultrasonic intrusion detection personnel

Test times	1	2	3	4	5	6	7
First range（m）	3.1	3.0	3.2	2.9	3.1	3.0	2.8
Second range（m）	2.0	4.1	2.2	3.0	2.5	3.5	2.9
State judgment	A	B	A	C	A	B	C
Right or not	Y	Y	Y	Y	Y	Y	Y

Whether the patrol car can drive in dark place or not is depends on the lighting system, then testing the stability of the lighting system, test results as shown in table 3

Tab.3 Lighting system stability test results

Test times	1	2	3	4	5	6	7
Light (lux)	140	130	120	110	100	90	80
Provide light or not	N	N	N	Y	Y	Y	Y
Normal driving or not	Y	Y	Y	Y	Y	Y	Y

Error analysis: ① through the light code disc to measure the distance of the road, its principle is to record the number of pulses and then turn into the distance, since the driving and count cannot be totally synchronous, this will cause the error, as can be seen from the test results, the maximum relative error is 3%, with the increasing of distance, the relative error is reduced, thus can be analyzed in the process of actual patrol, range and measure the distance gap is not big; ②In the process of driving ,the car's shake will influence the accuracy of the count and the influence on the result of the experiment is bigger, but it can be seen from the test results, the ultimate test error is not large, so the distance data processing can be completed on the positioning of the patrol car.The principle of ultrasonic ranging similarly, we can see from the test results can that ultrasonic can correctly detect the invasion of personnel, in the process of patrol base will not produce false alarm, guarantee the effectiveness of the patrol.

V CONCLUSION

The smart security patrol car's perfect sensing function, precision motion control algorithm, the ability of real-time communication and reliable actuator all shows its broad prospect of application. Its independent patrol function cooperate with security personnel to patrol work, greatly reduce the human and material resources investment intensity, effectively avoid safety oversight and economic losses that caused by human factors . On the other hand, a variety of sensing detection function of The smart security patrol car can be real-time detection patrol of various environmental parameters, thus fully ruled out a variety of hidden danger in time, can be strong guarantee the patrol time is in good state of safety. The smart security patrol car appears as human use of technology in the new period, the product innovation to solve the problem of life and it also has a flexible and efficient, convenient and practical, it's easy to spread the advantages and can be widely used in the community, schools and other places, so it has a good application prospect and development space.

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The research and design of intelligent household robots

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***Abstract*—To research and design an intelligent household robot that can be controlled, By controlling the chip microcontroller provide such as intelligent home control, use of communications equipment for the operation is interrupted, and by spreading tiny sensors in each node to determine abnormalities. The smart home system connected to the Internet, information exchange and communication; make the smart home system with independent storage and retrieval of information, in order to realize intelligent identification, positioning, tracking, monitoring and management, in order to be able to observe in real time outside home situation at home. The basic physical model has been designed to achieve, including automatic control, manual control, regular patrols, as well as real-time monitoring of mobile phones, to achieve light intensity, temperature, humidity, flue gas, fire, theft, and other dynamic hydrological monitoring, can advance to handle, and the police to inform the owner or relevant units, and can automatically forward extraction obstacles, scavenging, tracking nursing, speech perform other functions.**

***Key words*—Intelligent Robot Sensor**

PREFACE

i RESEARCH BACKGROUND AND SIGNIFICANCE

WITH the development of computer technology、modern communication technology and automatic control technology ,intelligent household system has entered the family ,household intelligent development and construction will be the future of the country and the inevitable trend of the economic development .Although now intelligent household system has a certain development ,and also on the market in the corresponding products .But from the development of the overall come to see, it is not optimistic .The lack of authoritative product serious impact on the development of intelligent household. With the improvement of science and technology, the development of economy, people's material life level is improving, more and more is also high to the requirement of home environment, as part of the intelligent household, Intelligent household robot development foreground is very considerable. By the intelligent household robots replace man to finish cleaning and hygiene, extracting the obstacles, looking after the old man and the child and other housework. Provide appropriate temperature humidity and lighting conditions, in order to reassure residents. Otherwise, with anti-theft monitoring and gas fire water security as the main content of the home intelligent security systems can make household more concentrate on others things. Such an effective complete intelligent household family services and home security robot is not only a great prospect of application of high and new technology industry project. And it is a hotspot in the research of the intelligent robot now. In today's rapid economic growth, household services should keep pace with more convenient, more efficient, more efficient, safer and more environmentally friendly development pace. Fully achieve "users want, is our pursuit of" principle, as one of the typical representative, intelligent household robots, is a worth studying choice!

ii DOMESTIC AND FOREIGN RESEARCH PRESENT SITUATION ANALYSIS AND EVALUATION

Since the late 1980 s in China since the introduction of the concept of smart home, home smart home gradually rise, from the coast to the mainland, intelligent household industry get rapid development. While it is not like the United States, Japan, on the residential intelligent system of technical standards, but with the help of the concept of smart home and technology began to promote the construction of intelligent residential district, smart home system is gradually into ordinary families. But because the development time is shorter, the development of smart home in China there are a lot of obstacles and problems, such as smart home lack of engineering technical personnel, management

level is low ;Industry norms and standards lag ;The level of the smart home products and technology content is low, intelligence is not obvious, the high-quality goods are rare. In 1999, the ministry of construction survey and design department, the office of housing industrialization of union to organize the implementation of the national residential intelligent technology demonstration project, the goal is to improve the quality of residential use function, the housing and upgrading, promoting the housing industrialization, at the same time for a set of suitable for intelligent residential district around the technical system. The demonstration project startup, marking the construction of intelligent residential area in our country has entered a new stage of development. Someone is intelligence household in 2005-2005 in China, is in a stage of smart home .Domestic products have been mature, ordinary people have the ability to accept the smart home. Our country well in the 2000 years of urban and rural residential technology industry project implementation plan ", the intelligent construction well-off demonstration area listed in the national key development direction. Therefore promote the intelligent from intelligent building to intelligent residential district, and even the family of intelligent direction .Requirements issued by the ministry of construction "by 2010, 60% of large and medium-sized cities to realize intelligent housing.

Abroad, in 1984 the United States in smart home system, some economically developed countries have successively put forward the corresponding solutions, now in the United States, Singapore and Germany have a wide range of applications. In 2003, Singapore has nearly 30 residential area of nearly 5000 households configuration with a family of intelligent system, there are nearly forty thousand households in the United States, smart home is now at the speed of extraordinary popularity in foreign countries. In terms of smart home products, mature intelligent household system, access to the network function of information appliances is increasing; Industry standards, it is gradually forming, such as family Bus System HBS (Home Bus System), by companies such as Hitachi, Mitsubishi, Panasonic Toshiba joint is put forward, by the Japanese electronic machinery industry association set together with the waves technology association. But foreign design model mainly monomers villa, the use of smart home are relatively independent, can not meet China's large population and housing centralized management and demand. At present, domestic and foreign technology in the field of difference is very small, only 2 to 3 years.

ⅲ RESEARCH IDEAS AND MAIN YEARS TO COMPLETE THE TASK

Research, design a can control the household intelligent robot, including automatic control, manual control, regular patrols, and mobile phone real-time monitoring, can achieve the light intensity, temperature, humidity, smoke gas, fire, theft, water, such as dynamic monitoring, can dispose in advance, and inform host alarm or relevant units, and can be extracted automatically, obstacles, cleaning the garbage, tracking care, voice execution, and other functions.

Through such as single chip microcomputer control chip for smart home control, use of communication equipment for interrupt operation, and through the spreading in each node of the micro sensor, judge anomalies .Connect the smart home system with Internet, information exchange and communication, the information stored in the smart home system with independent and extraction, in order to realize intelligent identification, location, tracking and monitoring and management, to be able to real-time observation home outside the household.

Ⅰ DESIGN SCHEME

1.1 The hardware design scheme as a whole

Using a core controller controls the controller and some advanced features, sub control sensors, wireless communication module, etc. Independence between modules needs to merge, as far as possible to separate modules. Control idea briefly as follows:

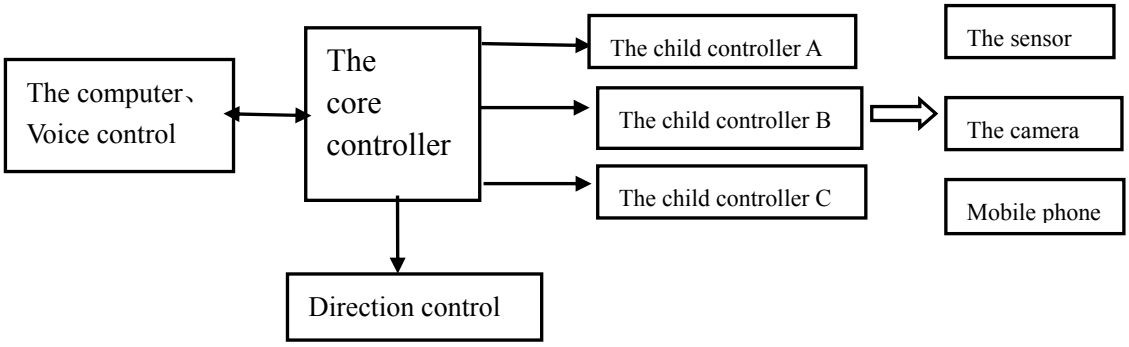

Figure1 Hardware block diagram of the overall control scheme

1.2 Module design scheme

Predetermined destination, by the robot's automatic path finding and constantly adjust the final destination region, in March, stops by the wireless communicate with computer control center, the related indoor equipment, detailed description is as follows:

(1) Using chip control intelligent machines marching, steering, etc., should also consider the car to synchronize with the steering control, forward and backward.

(2) Through monitoring indoor smoke temperature sensors to monitor indoor temperature, smoke density, can be sent to the measured temperature, smoke control center.

(3) Intelligent robot can control air conditioning or heating and cooling device power on and off.

(4) Through light sensors to indoor and outdoor sunlight, inform the control device of the curtain, by its motor open (such as indoor light from the darkness) or close the curtain (outdoor light intensity).Should pay attention to during the day, night can't open the curtains, so due to the time of judgment.

(5) Using flame sensor and ultrasonic sensors, capture the parameters such as flame azimuth, distance, control the car direction, forward to distance the flame distance open fan will blow out or use hydraulic hoses or pumps to douse the flame.

(6) By using infrared or heat sensors to man's existence (displacement or temperature), after good monitoring standard setting, when someone illegally from the window and door into, can monitor, judgment and sound an alarm to remind the owner.

(7) Combined with ultrasonic sensor and electric tracking (or other can identify should trace method) to realize intelligent robot with hands adjustment direction, travel, etc.

(8) Can be controlled by voice intelligent robot forward, turn left, turn right, backward, stop moving direction, etc.

(9) In the car in front of the cameras can real-time video the result is stored in the computer, when encountered unexpected alarm, should be able to notice to the host cell phone, the host also can use mobile phone in the computer picture or to be obtained directly by the camera field again to the host or through video (similar to QQ or micro letter inside of real-time video communications functions) transmission.

Specific implementation plan is as follows:

(1) Using tracking sensor information collected 51 single-chip microcomputer and tracking sensor is route automatic identification, by tracking the black thread sensor outputs high level of the black line is detected, the sensor output low level of the black line not detected, and through real-time scanning sensor output signal to control the car without the route in real time to walk on the black line.

(2) Use 51 single chip computer gathers the data output of temperature and humidity sensor DHT11. DHT 11 serial port to send altogether five hexadecimal data, specific as follows: 8 bit high temperature, low temperature 8 (the default is 00) eight, high humidity, low humidity eight (the default is 00), calibration eight, at the same time also to collect smoke sensor information, the dangerous state, output low level security status, output level MCU receive the temperature data through a serial port, parallel port to receive smoke judgment after data processing, and then the LCD1602 display.

(3) 51 single chip microcomputer temperature data collected by NRF905 sent to the receiver, the receiver also through NRF905, after receiving the temperature data through processing, determine whether the program set within the temperature range (23 to 26 degrees Celsius), if it is not for heating or cooling (now with the light on behalf of the cool, buzzer rang on behalf of the heating), if not set limits, it does not perform the heating or cooling.

(4) 51 microcontroller serial data acquisition DS1302 time, at 8 am to 6 PM during the collection of the photosensitive sensor light signals, determine the indoor light intensity, light intensity will output low level, weak light output high level, and then through the NRF905 sent to another receiver, the receiver by stepper motor and reversing simulation curtains opened or closed.

(5) 51 single chip microcomputer real-time scanning all flame sensor output, once detected flame, the flame sensor as output all the way from high level to low level, the controller will control the car is on fire, the ultrasonic detecting distance and obstacles (candles) in front of the display on the LCD1602, AT the same time start the fan to put out the fire (here the fan the fire fighting is also simulated, due to the particularity of voltage and the fan, the wind speed is too small, not enough to blow out the candles), via a serial port communication and GSM module, AT the same time to the preset mobile phone to send text messages through HUAWEI the AT command, content is: "SOS: your house is in danger!!".

(6) Car in front of the electric infrared sensors, infrared sensing people or other animals from the microcontroller through the acquisition of the electric output, which is detected, the sensor output high level, then the single-chip microcomputer control buzzer, alarm.

(7) Trace is combined with three ultrasonic sensors and front, respectively, the left and right three directions, single-chip microcomputer test three ultrasonic sensors distance data respectively, and then decided to move forward, turn left, turn right.

(8) Voice function is through the LD3220 speech recognition, then serial transmission to the single chip microcomputer and single chip, through the SYN6288 speech synthesis, including "ok, immediate action" "ok, immediately" "left" "right" "ok, stop right", etc., at the same time to control the car forward, turn left, turn right, backward, stop, etc., can also be a dialogue with simple car at the same time, there are: ask "what's your name," "how old are you" "your birthday" "tired?" "I love you", "goodbye", a "small strong" "two months" "January 18" "tired" "Bye bye" "I love you, too."

(9) The car in front of the wireless camera installed, connect to computers by receiver and acquisition card and PC are installed on the computer, can real-time display the car in front of the screen, can be recorded and stored at the same time. To install software on computer and mobile phone Splashtop remote, mobile phone remote operation can be carried out when the computer , and can view real-time images, video or storage.

Mutual cooperation between the function module is as follows:

One (1) to (5) (6) (7) implementation scheme for using 1, 51 single-chip microcomputer through the selection of switch function 1, 3 road tracking sensor information collected, no.6 flame sensor information, and pyroelectric sensor information, drive motor driver chip L298N, control the car forward backward turn left turn right, and for tracking or flame detection, found that the flame or illegal personnel, alarm and SMS can be detected after fire extinguishing equipment can also control the fire fighting.2 at the same time, the microcontroller functions, that is, tracing, ultrasonic sensor information through collecting order 3 road, is used to detect the distance, then drive the car to or forward.

(2) (3) (4) implementation scheme for 2, with 51 single-chip microcomputer temperature and humidity sensor DHT11, through gathering YL_15 smoke sensor, light sensor, clock chip DS1302 data, such as the temperature and humidity sensors and smoke sensor data in the LCD1602 display, at the same time drive NRF905 through different address to send signals to temperature data and the window close. One needs a single chip microcomputer temperature control receiving NRF905 send the address of the temperature data of 1, then determine the heating or cooling, so as to keep the room temperature in determining the scope; Curtain control needs a MCU receives the NRF905 send the address of the 2 light

data, used to decide whether to open the window or close the window, but it's important to note that open the curtain can only open one, close, open, close one.

(8) Implementation scheme for through the voice chip LD3220 speech recognition, by single-chip microcomputer to drive the car again.

(9) Implementation scheme to collect data through the camera, and through real-time image acquisition card and computer PC display, through mobile phone remote control software Splashtop remote control computer.

Corresponding to the circuit principle diagram, in turn, are as follows:

(1) The main chip L298N for STC89C52 and car motor driver module

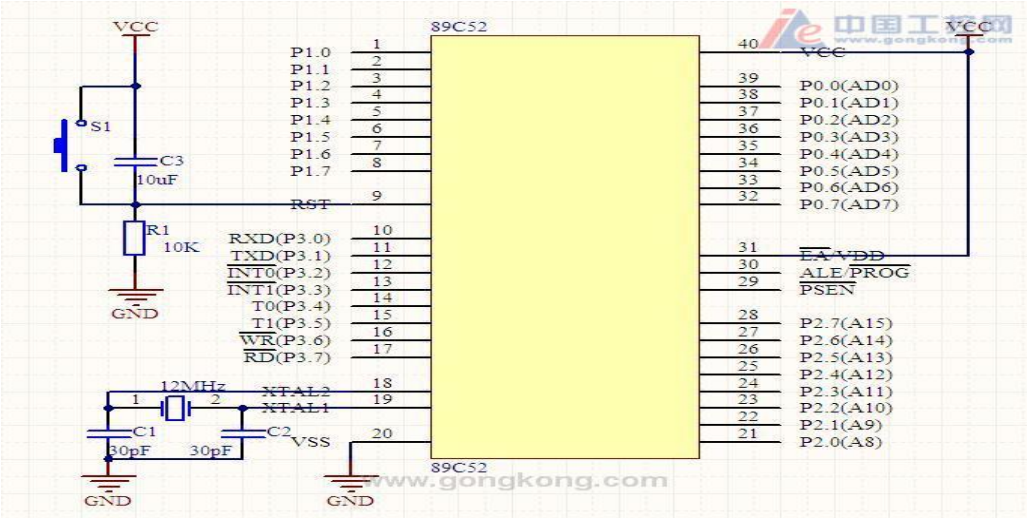

Figure 2 STC89C52 minimum system schematic diagram

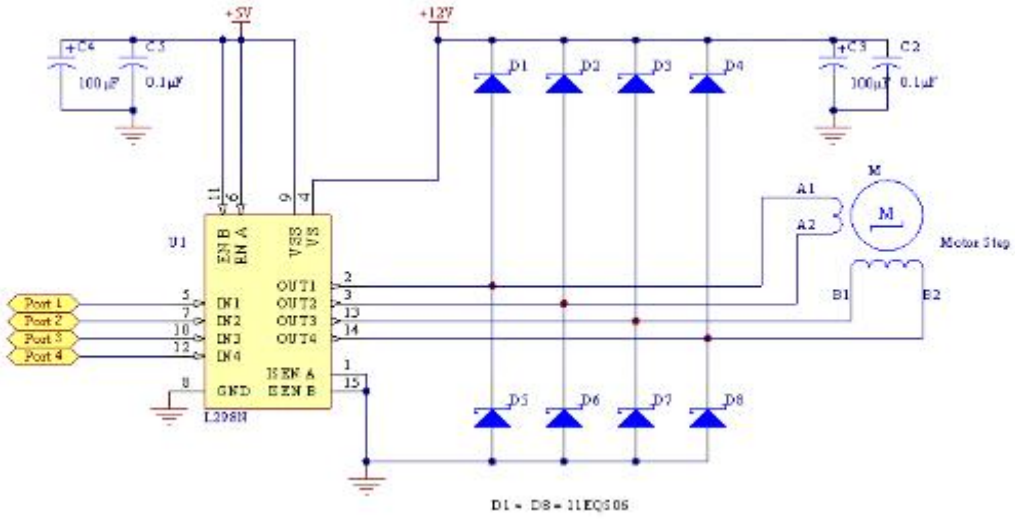

Fig.3 L298N schematic diagram

(2) Application of DHT11 temperature and humidity sensor and MQ smoke sensor, gas leakage monitoring device can be used for family and factories, suitable for liquefied petroleum gas, butane, propane, hydrogen, methane, alcohol, smoke detection, etc.

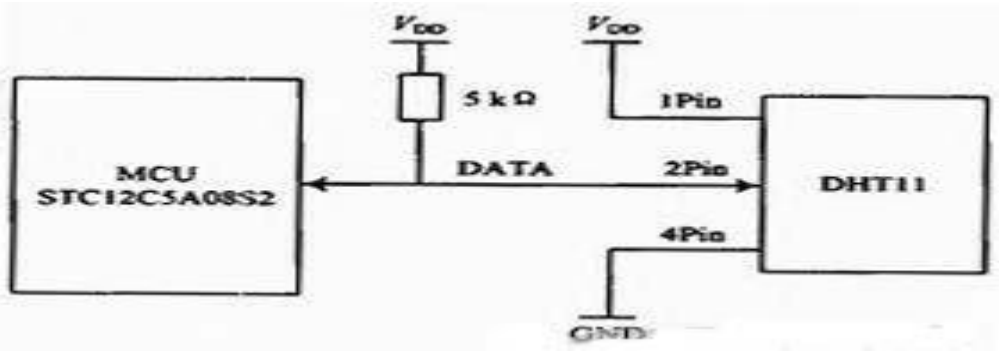

Fig.4 DHT11 temperature and humidity sensor and MCU connection diagram

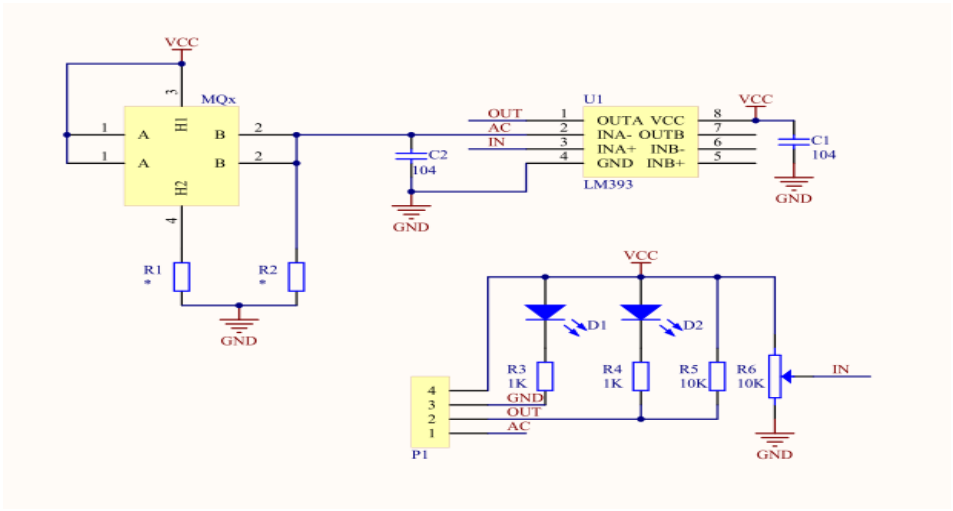

Fig.5 MQ smoke sensor principle diagram

(3) Application of NRF905 wireless module

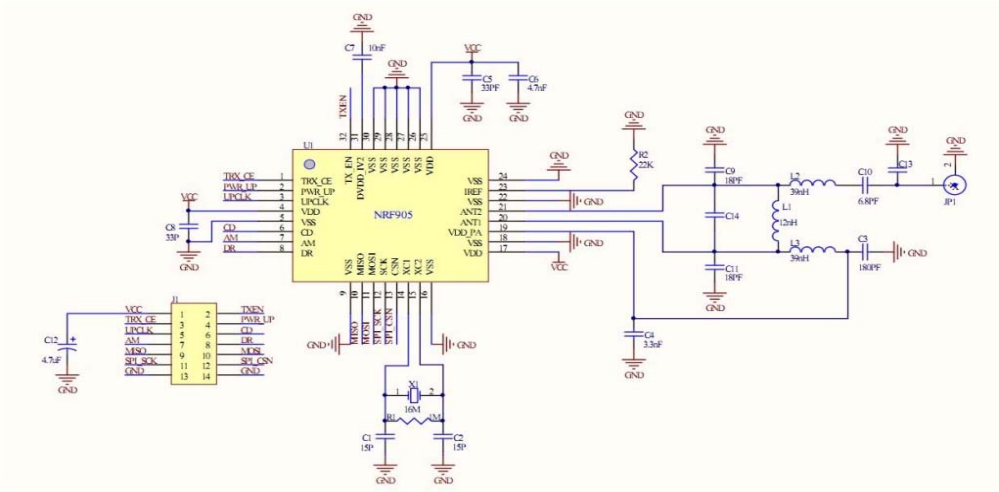

Fig.6 The principle diagram of the NRF905 wireless module

(4) Application of photosensitive sensor

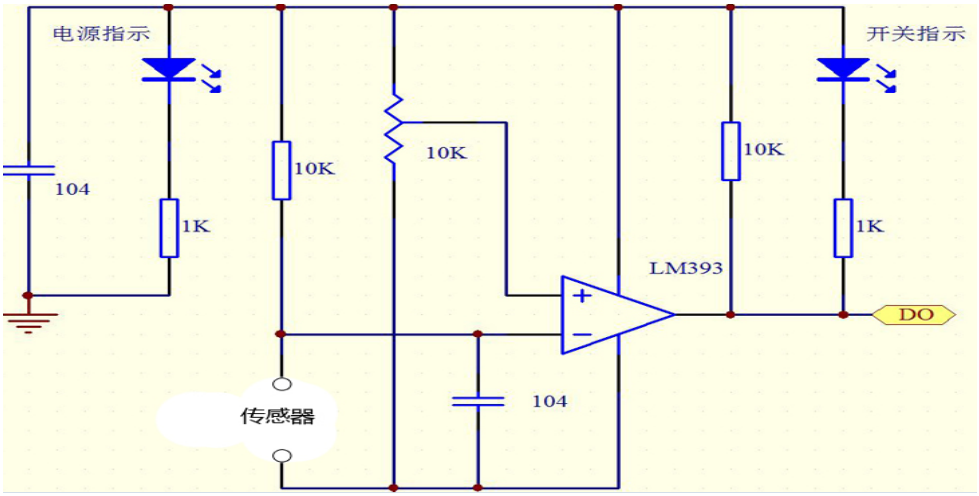

Fig.7 Photosensitive sensor principle diagram

(5) Application of six-way flame sensor

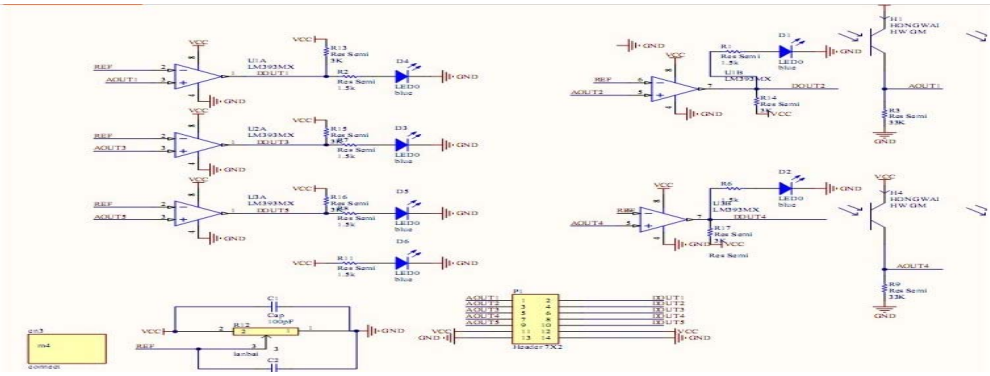

Fig.8 The principle diagram of the six-way flame sensor

(6) Application of infrared pyroelectric sensors

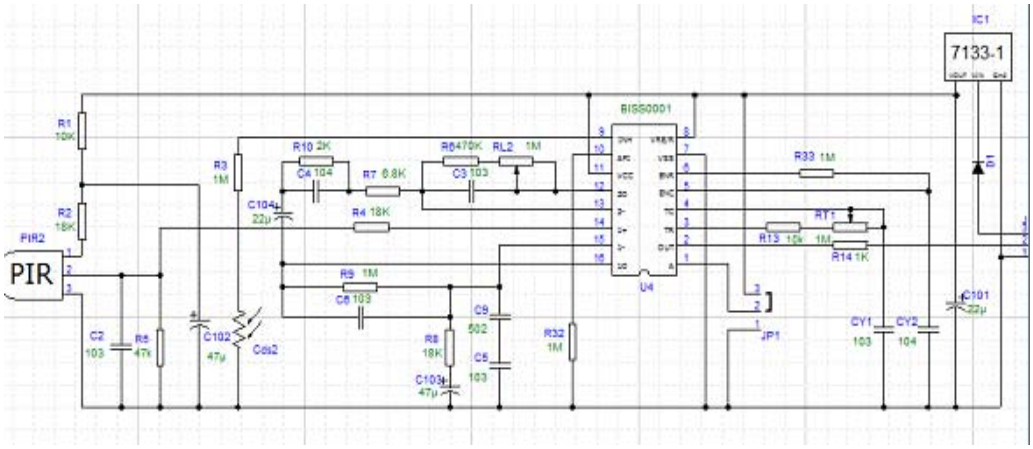

Fig.9 The principle diagram of the pyroelectric infrared sensor

(7) The application of ultrasonic sensors

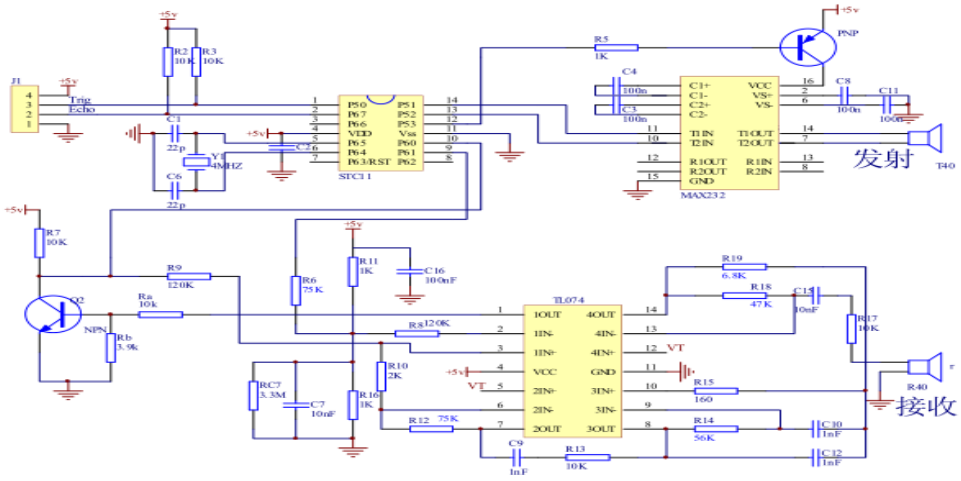

Fig.10 The principle diagram of the ultrasonic sensors

(8) Application SYN6288 speech synthesis module and LD3320 speech recognition module

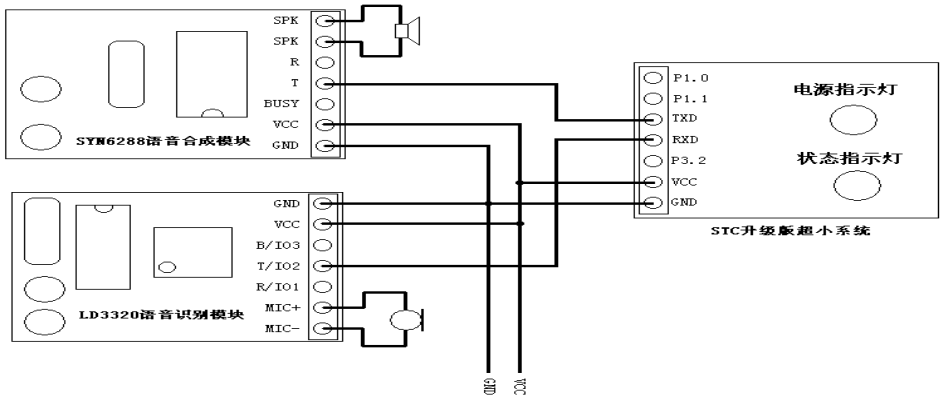

Fig.11 Voice control module connection diagram

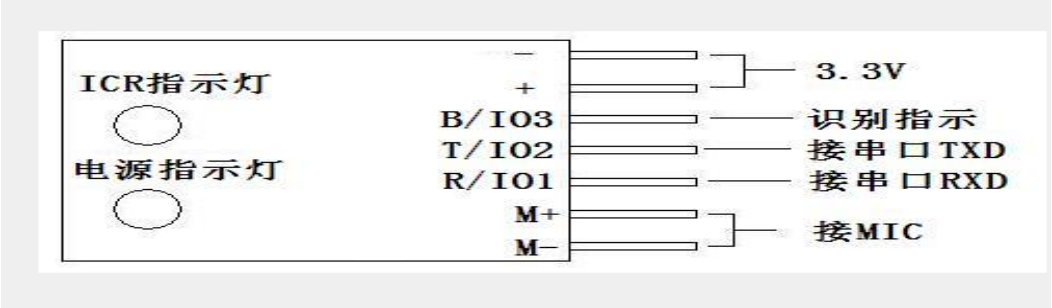

Fig.12 Speech synthesis chip pins

2. DEBUGGING RESULTS

Based on the physical model of debugging, has completed more than nine functions, the results are as follows:

(1) With black tape posted any route, in the shape of the machine to the per capita can adjust itself according to the route direction, the direction to realize intelligent patrol forward.

(2) Robot can monitor temperature, humidity, smoke and lighting conditions, and the temperature data, such as lighting conditions through wireless module were sent to the control center one and two.

(3) A child control center to receive real-time display temperature data, and judgment, if is beyond the scope of the set value, will be for heating or cooling. If set in the normal range, it is not to rise to cool.

(4) For light judgment is controlled by time setting. By default, the control time of the curtain is set to eight in the morning to 6 PM, according to the received light, second child control center can accurately judge window or close the window.

Between six and eight in the morning in the evening, the child control center 2 doesn't work, the curtain has been closed.

(5) When burning candles near the robot, it carried the flame sensor sensing, will feedback to the central processor, a fire extinguishing instruction - that is, turn on a fan of "strong" wind fire, and real-time display candles for the distance from the car, at the same time also to the host cell phone to send text messages (such as SOS: your house is in danger!!).

(6) When someone close to reach the preset distance, the robot will automatically alarm, this feature can be used for home empty monitoring Physical model diagram as follows

indoor if anyone illegal invasion.

(7) Adjust state to tracing, robot according to the direction of the pedestrians ahead, automatically adjust the direction of travel, realize tracking function.

(8) Said to the robot "walking", "left", "turn right", "back" and "stop" password, it will make the corresponding action.

(9) Connect the intelligent robot on the wireless cameras, wireless terminal frequency adjustment together on computer, computer terminal can receive real-time machine carry camera clear picture information feedback, provides the user with the remote real-time video recording, footage, etc.

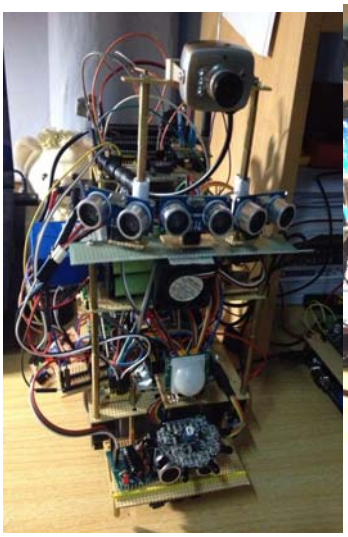

Fig.13 Left side view of the model

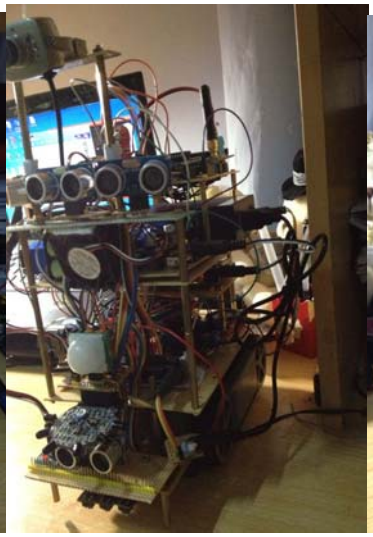

Fig.14 Front view of the model

Fig.15 The overall view of the model

3. Conclusion

This project with smart home as the theme, using intelligent robot to simulate the function of smart home system, try is widely used in intelligent household contribute strength on the way to explore, to satisfy people's needs. Through the design and testing has been completed are expected to function .From the project to the concluding along the way. We from the initial preliminary understanding of the smart home system, through extensive access to information, consult teachers and classmates to consult, to intelligent household robot is more and more familiar with, until finally complete physical model under the guidance of instructors. This year, we have learned is far beyond our expectations, can not only improve the basic skills of scientific research, but also raised questions and problem solving skills, literature retrieval ability, reading ability, teamwork and communication skills in English. Have pay will have harvest, which is helpful for later work we learn. We sincerely thank the year guidance teachers and students for our guidance and help, our achievements have you a credit.

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Automatic track stage lights based on ultrasonic positioning

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***Abstract*—The idea is to use ultrasonic location system to track on the stage lights. The stage lighting heat large, artificial lighting control to tracking stage actor impossible for a person to work for a long time, and the dazzling light, give the operator to bring very great difficulty. So we need a tracking device can automatically control the actor. The ultrasonic positioning system is not limited to the stage tracking. Can also expand the scope, application to other engineering field, such as: for workers locate caves. Can the misoperation of workers into the unsafe area to avoid. Also in the mine, to save a life time miss wreckage.**

I. INTRODUCTION

ULTRASONIC ranging technology has progressed to the mature stage, the stage light lamp based on the ultrasonic localization is extending in the ultrasonic ranging technology, namely ultrasonic positioning technology, at present in our country is also at the initial stage.

II. TEST METHODS AND EXPERIMENTAL SCHEME

A. Test Methods

Automatic flash lamp system of ultrasonic positioning stage is composed of a main system and carrying machine system consists of two parts, the main system with single chip microcomputer, wireless transmitting module, ultrasonic receiving circuit, a motor and a light part, as shown below.

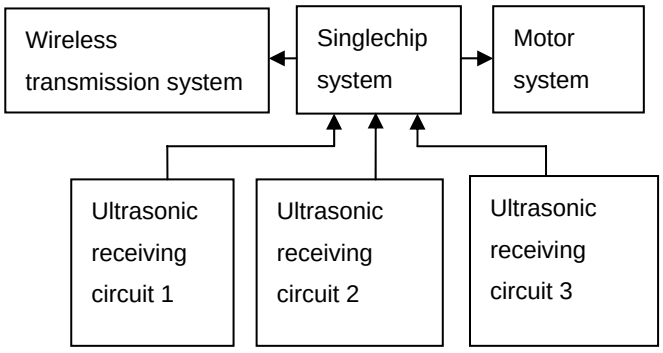

Fig.1 Schematic diagram of the main systemFig.1 Main system diagram

The portable device consists of a singlechip, a wireless receiving circuit, ultrasonic transmitting circuit and battery. Portable machine system diagram as shown below.

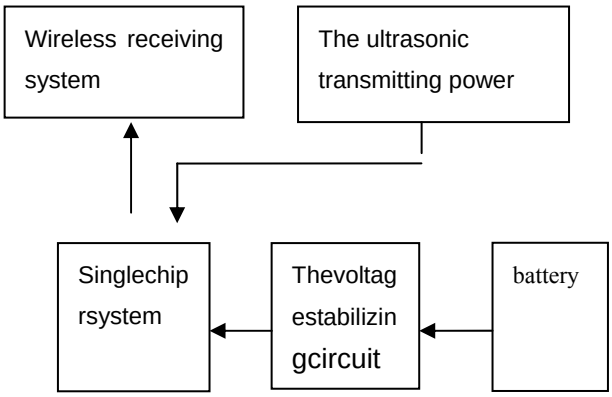

Fig.2 Machine system diagram carry

First with the main system of ultrasonic measurement module light up between the ground and the distance, and placed at least 2 ultrasonic measurement points in the scene, the tracked objects carrying a wireless receiving module, ultrasonic transmitting module. First, there is the main system single-chip transmit radio signals, while the main chip system start time. When the tracked object receives a radio signal, are compared and their ID, after confirmation of ID, carrying machine system in the microcomputer control ultrasonic transmitting module of ultrasonic transmitting. When the measuring point receives the ultrasonic rear main system microcontroller timer stop, and the temporal data record, thus the measuring point and the distance is tracking an object, then according to the determined by tracking the position of the object between the light up

and the distance of the ground, adjust the light up angle to achieve tracking.

B. Mathematical Models

Because of the envelope detection method and detection method has its inherent defect echo, but implementation has certain difficulty, so we choose to achieve the ranging time of arrival measurement method. In order to eliminate the influence of the received signal echo, using sonic relative velocity of light slow characteristics, designed a new arrival time measurement method: the receiving sensor and radio frequency ultrasonic transmitter module is placed in the A terminal, and the emission sensors and radio frequency ultrasonic receiving transducer is arranged in the B terminal, the first radio frequency signal is emitted from the A end, tell the B terminal transmitting ultrasonic, electromagnetic wave due to propagation velocity is much larger than the speed of sound, so you can ignore the propagation time of RF, start timing transmitting radio frequency from A to A terminal, terminal receives the ultrasonic signal, recording the time, you can calculate the A end and the B end with S = V *t (where V is the distance of the speed of sound, because the system test basic constant temperature at 25 DEG C, so the speed of sound desirable constant value 346.575m/s):

Using this method, the mobile node can be obtained respectively to three fixed node distance L1, L2, L3, because each node in the system of distribution in the space, so according to the Pythagorean theorem, we can calculate the projection point on the surface of two-dimensional coordinates of three fixed node to the mobile node distance L11, L22, l33. Projection coordinate set three fixed nodes on the ground of two-dimensional coordinates respectively (x1, Y1), (X2, Y2), (X3, Y3), mobile nodes to coordinate (x0, Y0), coordinate according to the weighted centroid algorithm can be obtained under the type of mobile node

$$\begin{cases} x0 = (x1/l11 + x2/l22 + x3/l33)/(1/l11 + 1/l22 + 1/l33) \\ y0 = (y1/l11 + y2/l22 + y3/l33)/(1/l11 + 1/l22 + 1/l33) \end{cases}$$

III. The Test Results Of Systems

A. *Experimental Data*

Company：cm

Theory / Fact	（50.0，50.0）	（50.0，60.0）	（50.0，70.0）	（60.0，40.0）	（60.0，50.0）
Experiment 1	（55.0，59.0）	（50.0，69.0）	（55.0，71.0）	（60.0，32.0）	（61.0，58.0）
Experiment 2	（56.0，57.0）	（51.0，68.0）	（53.0，70.0）	（58.0，40.0）	（63.0，60.0）
Experiment 3	（52.0，54.0）	（52.0，69.0）	（55.0，76.0）	（57.0，37.0）	（62.0，58.0）
Experiment 4	（57.0，56.0）	（51.0，68.0）	（56.0，74.0）	（60.0，34.0）	（63.0，59.0）
Experiment 5	（54.0，53.0）	（52.0，68.0）	（53.0，75.0）	（60.0，35.0）	（62.0，59.0）
Average	（54.8，55.8）	（51.2，68.4）	（54.4，73.2）	（59，35.6）	（62.7，58.8）

Table 1 the whole system testing record table (a)

Company：cm

Theory / Fact	（60.0，60.0）	（70.0，40.0）	（70.0，50.0）	（70.0，60.0）	（70.0，65.0）
Experiment 1	（63.0，68.0）	（73.0，31.0）	（76.0，50.0）	（71.0，64.0）	（74.0，61.0）
Experiment 2	（62.0，66.0）	（78.0，35.0）	（70.0，49.0）	（78.0，69.0）	（74.0，61.0）
Experiment 3	（59.0，67.0）	（79.0，37.0）	（79.0，49.0）	（74.0，69.0）	（79.0，61.0）
Experiment 4	（64.0，69.0）	（77.0，34.0）	（77.0，49.0）	（75.0，69.0）	（74.0，60.0）
Experiment 5	（63.0，67.0）	（76.0，35.0）	（75.0，50.0）	（78.0，70.0）	（77.0，61.0）
Average	（62.2，67.4）	（76.6，34.4）	（76.8，49.4）	（75.2，68.2）	（75.6，60.8）

Table 2 the whole system testing record table (b)

B.Test Results

a. Positioning Range

According to test results, this system basically can be achieved for the mobile node localization of 120.0cm*120.0cm on the surface of the ground in the two-dimensional Cartesian coordinate system.

b. The Average System Location Error

The average X axis positioning error （4.8+1.2+4.4+9+2.7+2.2+6.6+6.8+5.2+5.6）/10=4.1（cm）

The average Y axis positioning error （5.8+8.4+3.2+4.4+8.8+7.4+5.6+0.6+8.2+4.2）/10=5.2（cm）

c.The Average Positioning Accuracy Of System

The average X axis positioning accuracy: （120.0-4.1）/*100%=96.6%

The average Y axis positioning accuracy: （120.0-5.2）/120.0*100%=95.7%

C. Conclusion

The system uses STM32 microcontroller as the main control chip, combined with wireless transceiver module and the transmitting and receiving ultrasonic sensor, the design and implementation of stage light lamp system based on the ultrasonic localization.

After the test, under the selected experimental conditions, the launch distance of the ultrasonic sensor is more than 600cm, the basic positioning can be achieved in the dance of the 500.0cm*500.0cm in the rectangular coordinate system, of which the average X axis positioning accuracy is 96.6%, the average Y axis positioning accuracy is 95.7%.

Because the wireless transceiver module and precision of the system is not up to, still need to improve on it, so as to achieve the positioning in a very short period of time, this work needs to be improved.

This system successfully will solve stage artificial playing light tracing labor, convenient, accurate, and is also suitable for need of automatic tracking light work.

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Embedded License Plate Recognition System of Surveillance Video

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***Abstract*—With the surge in the number of cars traffic management is moving towards the direction of the development of intelligent transportation systems. License plate recognition technology based on computer system plays an important role in intelligent transportation systems. And the common PC-based license plate identification system has defects in high price、weight、 complicated operation and safety. The system proposed in this paper identifies the license plate and is embedded together by median filtering, Sobel edge detection, global thresholding, texture features based on approximate positioning, tilt correction, scanning the ranks, character normalization, character refinement, the formation of a license plate recognition system with small size, good stability, feasible and high accuracy, easy to install and use the advantages of different classifiers based on character recognition technology. When identifies real-life license plate recognition system faces complex conditions, we carried out 300 cases of different license plate recognition experiments under different circumstances, the accuracy rate is as high as 93.67%.**

***Key words*—** License Plate Recognition　Embedded System　Character normalization　Sobel Edge Detection

I INTRODUCTION

WITH the development of Chinese socioeconomic and road transport, intelligent traffic transportation technology has become the research focus on the field. License Plate Recognition plays an important role as a core component of the intelligent transportation in road traffic management, community safety management, parking management fees and other occasions. Although some foreign technology has matured, the license plate in China covers several types of characters, including Chinese characters、Latin letters、Numbers, and differences between other fonts, so license plate recognition system in the west is not suitable for China. In the domestic existing license plate recognition system, most of the products are not popular because of the large cost, and some of them use buried coil detection, infrared detection, radar detection technology, those technology has many shortcomings, such as buried coil detection tears up the road, the infrared detection needs additional external detection equipment, radar detection needs to adjust trigger position. In addition, many universities laboratories have carried out relevant researches. However, demands of these products on the environment is high, different lighting conditions will affect the recognition rate. Therefore, how to locate license plate accurately, recognize character and improve the recognition rate is still an important task. In view of the above defects of license plate recognition technology we design a video license plate recognition system based on embedded technology. This article is based on ARM embedded license plate recognition system, and use real-time operating system--Windows CE to implement video acquisition, image processing, license plate extraction, document storage, and other functions, and we make use of Visual Studio 2005 to realize the friendly human-machine interface display which is easy to control. At the same time, the system we designed has the advantages of high feasible, a light and small size, the higher recognition rate, easy to install, etc.

II SYSTEM DESIGN

A.The system hardware design

We use Samsung S3C2440 microprocessor, in order to achieve a compact and powerful system, in the hardware part, and we design the serial Interface, camera interface, LED display and other peripheral circuits, and customize the Windows CE operating system based on the hardware platform. S3C2440

adopts ARM920T core, 0.13μm CMOS standard macro unit and the memory unit. Low power consumption, simple and delicate, static is its characteristics and this design is especially suitable for low cost and low power applications. The core of S3C2440 processor is a 32-bit RISC processor-ARM920T. ARM920T adopted independent 16 KB instruction cache, an advanced microcontroller bus architecture of 16 KB data cache, structure of the memory management unit and Harvard cache architecture. Each of them is composed of 8 characters long line. The above characteristics of S3C2440 microprocessor can make it fully fulfill the task of image data processing.

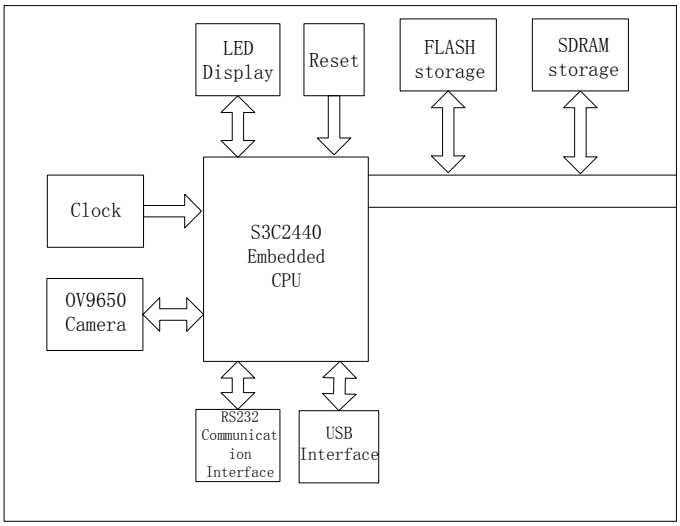

Fig1 Diagram of system hardware

By the way, S3C2440 provides a camera interface, which is used to receive 8 bits of signals from the input data of cameras, three input synchronous clock signal coming from the camera, and it also outputs a master clock signal and a reset signal. The master clock signal frequency of Camera interface is 96 MHZ. The frequency will be output to the camera after frequency division processing, and video camera produces pixel clock signal line, frame synchronization clock signal and synchronization clock signal according to the clock signal, then they reverse input into S3C2440. Systems use OV9650 camera to realize the camera, photography, and other functions, in order to get the images. OV9650 is a type of CMOS camera produced by semiconductor companies in the United States. Its traits contain low power consumption, high sensitivity, high resolution (1300 x 1028 pixels), and it also supports a variety of common image format sand automatic image control. These characteristics meet the resolution and speed requirements of monitoring images.

Windows CE is a multitasking real-time embedded operating system, which has a friendly user interface and great communication function. It is designed by Microsoft for mobile applications, information equipment, consumer electronics and other design of operating system. This system can realize the photography of vehicle picture, image processing, and the extraction and storage of license plate.

We simplify the embedded system, and remove some unnecessary interface and equipment. The hardware model is shown in figure 1.

B.The system software design

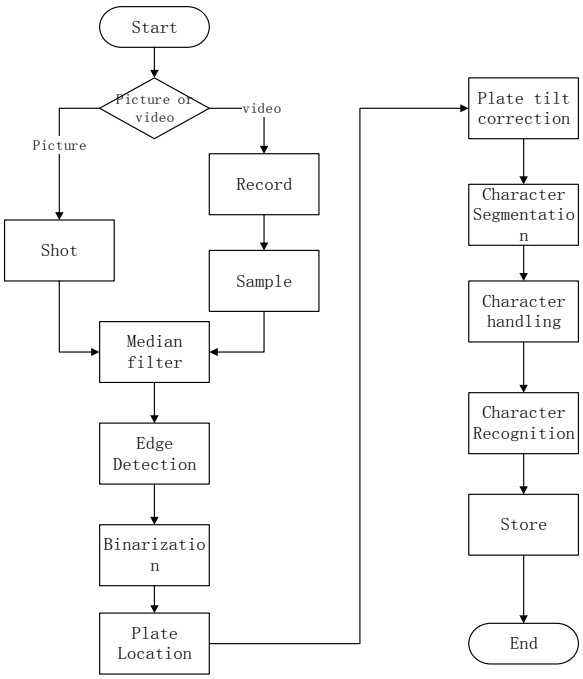

Fig2 Software flow pattern

First of all, In view of the image characters background, noise and border, and different disturbances, we do median filtering de-noising to it. We get information of the edges of the image by using Sobel operator, and in order to highlight the outline of the target area we use binarization processing. License plates will be extracted by the approximate location of texture feature. Secondly, after locating the license plate segmentation and normalizing the characters, we can identify them and compare experimental results. Program flow chart is shown in the Figure 2.

III LICENSE PLATE EXTRACTION TECHNOLOGY

A.Median filtering

When the license plate recognition system has been applied in the outdoor area, they will be affected by the weather, complex background and lighting conditions. After denoising processing, subtle fracture can be linked, and tiny mutation can be soften. First of all, we scan all the pixels in the window, and find the median, then we change median to make it into the standard value among sorted values. Figure 3 shows the result of the experiment.

Fig3 Original image(above) and results of median filter(below)

B.Sobel Edge Detection

Edges of the image reflect boundary area, the brightness, textures and surface orientation change such important information. In addition, the image edge detection can also delete extraneous details and noise. The system uses the Sobel Edge Detection method. Two convolution kernels of Sobel edge operator show in Figure 4. Each point in the image should be done with these two nuclear convolution kernel to obtain a maximum value of the vertical edges of the respective, other horizontal edges to obtain the maximum value of the nuclear. Value the maximum value of the point as two convolution output. The results are shown in Figure 4.

$$A = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad (1)$$

Soble edge detection operator

Fig4 Result of edge detection(above) and results of binarisation(below)

C.Binarization

Binary images can reduce invalid information, highlighting contour information of the target area, thereby they increase the speed of the subsequent processing. Threshold selection method used in this article is the global threshold method improvements, and the pixel gray value is less than the threshold point set to 0, and the pixel gray value is greater than the threshold value is set to 255 points. A method to initialize the threshold value is:

$$T = G_{max} - (G_{max} - G_{min})/3 \quad (2)$$

Where, G_{max} is a maximum grayscale value, and G_{min} is the minimum gradation value. Plate binarized image is shown in Figure 3 right.

D.Positioning method based on texture features

The starting point of license plate location is determining the license plate by the feature of car license plate area. License plate has its color characteristics, dimensions features and character features, etc. The plate has the edge point, a rich texture and a fixed aspect ratio rectangular relative to other areas of the area. These special features of the plate and the background can be used to distinguish.

Positioning process:

(1) The first step is to detect the approximate location of the license plate of the column range. Scan the entire image, and then calculate the number of edge points, jump points, and the license plate number of edge

points between regions. If a column is within a range of values satisfying the variation in the interval, marks the starting point of this line, and then repeat the process.

(2) The second step is to detect the plate boundaries. Get the license plate of the line range through the previous steps. In order to verify the range of the line, we set the maximum and minimum range of lines, the time for each edge point in the line number, the interval between the start point and the end point.

As the image edge points shown, the start and the end of each line are concentrated, and only a few lines are deviated. A statistical analysis about the distribution of these two points is produced. The most frequent start and end points are selected as the boundaries of the plate. Some appropriate areas are found and the approximate positioning complete through the above steps. Approximate positioning results are shown in Figure 6.

Fig5 Approximate localization results(above) and result of accurate localization(below)

In order to eliminate the pseudo-plate region, each region of the candidate area adapt aspect ratio calculation method. Accurate positioning is shown in Figure 6 below.

IV LICENSE PLATE TILT CORRECTION

A.License plate tilt correction

Because the camera and the plate may be located at different heights (due to vibrations from the road slope and the vehicle), the license plate image show a certain degree of inclination. This study developed a simple operation and high accuracy tilt correction. Process of this method is described as follows:

Firstly, scan the left half of the image and calculate an average height of white pixels, denoted h_1, and then scan right half and calculate by the same way, denoted h_r. Note the width of the image w, and then the slope k is determined by the following formula:

$$k = \frac{2(h_l - h_r)}{w} \quad (3)$$

B.Character Segmentation

The ranks of the scanning method is to select a character segmentation. Firstly, use the line scanning methods to scan the location of the binary image, the upper and lower bounds. Secondly, the column scanning method is selected for scanning the position of the left and right borders of the binary image. Based on them, each character can be accurately divided. The experimental results show that this method even can efficiently handle the plate image which blurs, adherents and cracks characters. The main steps of character segmentation are shown below:

(1) Volatility is determined by the character boundary. Area from top to bottom plates were scanned and the scanning position of the first white pixel is marked as top boundary. Then, scan the position from the bottom to the top, and the white pixel which is the first scanned is marked as the bottom boundary.

(2) Determine the character of the border aroun d. Scan column from left to right, and the position of the first white pixel is marked as left border. Refer White_num as the number of columns of pixels, and the recording White_num = 1 is the initial number of pixels, and then White_mum gradually plus 1with the increase of the number of columns. Likewise get character height recorded as iHeight.. The letter R represents the proportion of each license plate character height and width. iHeight/ White_mum aspect ratio is scaned by computer. If iHeight/White_mum> 2 × R and no white pixels are in the entire column, character segmentation is not over until an entire column and iHeight/White_mum = R cannot find the white pixel, and the work of

split is not completed. In this case, confirm the right boundary of the first character.

(3) If scaning the White_mum=1 to iHeight/ White_mum=R the entire column of white pixels are not found, you must add the character image and force divided characters. To avoid duplication, the expansion is of a rectangle of pixels

(4) After the division of the character position information is placed in the structure Rect, Rect structure is then inserted into the back of the list CharRect1, and set the specified location.

(5) Repeating steps (b) to (d). If the list CharRect1 number is nWeight-1, then confirm the last letter of the right boundary and use the list CharRect1 to place seven characters on license plates.

(6) Each character in the list CharRect1 scan height and the width of the exact location. Finally, the last list is assigned to the CharRect2 CharRect1.

C.Character normalization

Character normalization is based on the template prepared in advance in order of the various characters of a uniform size of the pattern. After the normalization process of the character, dividing the height and width of the character is associated with a standard character comparison. According to zoom matrix to determine the vertical and horizontal zoom ratio. And the left border of the border remains unchanged. According to the standard characters, determine the lower boundary and the right boundary. The final step is to define a new structure to work out a rectangle. Size normalized character is 16 × 32.

D.Character thinning

After normalization of the characters having the same size. However, to make more complicated and difficult to identify the font does not have a uniform diameter, which exceeds the width of a single pixel of the stroke. Refinement process is based around a certain processing algorithms, which extract the character width of a single character stroke, and eliminates redundant information and then we get the character and the basic structure of the skeleton comprising the features of the image. Principles that we need to follow include:

(1) Should maintain the continuity of a character stroke, the stroke in order to prevent breakage.

(2) Should be as close to the center line of the character skeleton stroke, the width should be a single pixel.

(3) The original geometry and topology features should be retained and line endpoints should not be deleted.

(4) After the refinement without serious distortion.

In this study, the following method is adopted to calculate the structure of the target region. The background area pixels are labeled 0 and the pixel of the destination region is marked as a boundary region and at any point of the boundary region of at least one joint point is 0 pixels. Marker should P1, Pi (i = 2, 3 ..., 9) is a neighbor point. Markers and neighbors point as shown in Figure 6.

P_3	P_2	P_9
P_4	P_1	P_8
P_5	P_6	P_7

Fig6 The marked point and neighbor points

Region of the 3×3 image having 9 points: P_1, P_2, ... P_9, P_1 is the center of the area. If $P_1 = 1$, and satisfies the following four conditions, the P1 is deleted.

(a) $2 \le NZ(P_1) \le 6$

(b) $Z0(P_1) = 1$

(c) $P_2 \times P_4 \times P_8 = 0$ or $0(P_1) \ne 1$

(d) $P_2 \times P_4 \times P_6 = 0$ or $Z0(P_4) \ne 1$

NZ (P_1) is non-zero number of points P_1, P_2 ... P_9, Z0 (P_1) is the pixel scale diversification. Conditions (a) deletes some internal things and the point is the only one of the neighboring pixel values. Condition (b) limits the process to a single pixel region. Conditions (c) and (d) exclude the possibility that P1 is a boundary point. Figure 7 shows some of the stored under any conditions P1.

1	1	0
1	P_1	1
1	0	0

1	1	0
1	P_1	1
0	0	0

1	0	1
0	P_1	0
1	1	1

Fig7 Conditions of P1 preservation

All boundary points are progressively checked. If these points are in line on the above conditions, we will mark it as 0. If the point is marked as 1, these points are reserved. Repeat the above process until no more points are deleted, the remaining points form the structure of the character area.

V CHARACTER RECOGNITION

Character recognition means to extract the relevant features to be recognized by the character information. First, analysis and classification; secondly, templates and license plate character recognition algorithm application; finally, the template is to identify the most similar character, enabling character recognition. The main steps include character recognition feature extraction and character classification, character, and character-building model library reorganization. And characteristics of the selected character feature extraction in character recognition systems are two key factors.

A.Feature Extraction

Character feature extraction is to select a set of parameters as a feature vector, which is the most representative character features, samples are the best features of the properties measured to determine the ability of the system identification. Currently, the widespread use of license plate character features include two categories: structural features and statistical features.

Character recognition when using structural features and statistical features have a trade-off. Structural characteristics are more suitable for distinguishing between similar characters, but they are unstable and difficult to extract. Using statistical features help identify robust algorithms, but it is less able to distinguish similar characters. So this paper, structural features and statistical features combine to extract characters. First, feature extraction grids for rough classification; secondly, extract the internal structure of distinguishing between similar characters. Compared to a single feature extraction method, which can greatly improve the recognition rate, shortens the identification time. Specific procedures are as follows:

First, the extraction grid features. Taking the character "6" as an example, it is divided into eight parts, and this partition is the case is shown in Fig 8. The number of black pixels in each section as a feature of its eight.

Fig8 Eight characteristics of a number(left) and four characteristics of a number(middle,right)

Secondly, the internal structure of the extraction. From the previous steps, we can see that some of the character grid characteristics are similar, such as "B" and "8", "Kat" and "Su", it is difficult to distinguish. Therefore, it is necessary to extract the features of the internal structure distinguishing between similar characters. Should be found in both the horizontal and vertical columns, draw four lines in between. Four rows of the black pixel is calculated by the four characteristics, respectively as shown in Figure 7. Finally, all the black pixels should be counted as one of the features 13.

B.Character classifier design

In China, the standard form of civilian license plates are X1X2 × X3X4X5X6X7. Here, X1 represent the provincial division by Chinese characteristics; X2 is a Latin capital letter; X3-X7 letters or Arabic numerals, which in addition to "I" "O" "D" Up there are two letters outside.

In order to improve recognition speed and rate, we designed three character classifier. They are Chinese characters classifier, the Latin alphabet classification and digital - letters classifier. License plate recognition from left to right, the sequence number corresponding to the selected classification.

C.Fuzzy Decision character recognition

First, according to the position of each character classification by different classifiers. Second, the template character recognition characters are compared. Third, the degree of matching the minimum value, the character recognition result corresponding template.

VI EXPERIMENTS AND RESULTS ANALYSIS

The license plate recognition system is designed to identify the effect of the following table, the test experiment was carried out in Changchun in China,

in order to ensure a comprehensive, specialized license plate number of the experiments conducted outside the province identified and selected a different time and weather, in each case 50 vehicles tested, the test results with OV9650 image video camera captured in Table 1.

Taking into account the actual axis of the taking lens and the plate plane angled probability coefficient is taken as 90 degrees of the coefficient of the coefficient 0.7,60 0.2,30 0.1 degrees. Were tested by the community on the entrance door 900 car image, the recognition system reached 97.3% in the sunny accuracy rate reached 96.1% in the rainy accuracy, misty day in reaching 92.5% accuracy rate. We can conclude that the proposed license plate recognition system can identify passenger license plate under complex background.

VII CONCLUSIONS

In this system, application software is based on Windows CE embedded operating system and dedicated to identifying civilian license plates. First, the license plate image preprocessing. Then, correcting the tilt of the plate, separated by a single character segmentation. Finally, according to the characteristics of Chinese characters, we apply a template matching algorithm to identify license characters. The system is designed to identify the Chinese license plate design, and by a large number of image tests. Finally, the license plate recognition experiments to prove this study system designed for Chinese license plate recognition rate more than 90%.

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Table1 Result of recognition

Weather conditions	angle formed by the lens axis and the plane of the plate (degrees)	Categories	Correctly identified (cars)	Recognition errors (cars)	Recognition rate
Sunny	90	Picture	49	1	98%
		Video	49	1	98%
	60	Picture	49	1	98%
		Video	48	2	96%
	30	Picture	47	3	94%
		Video	46	4	92%
Comprehensive	\	\	48.65	1.35	97.3%
Rainy	90	Picture	49	1	98%
		Video	48	2	96%
	60	Picture	48	2	96%
		Video	47	3	94%
	30	Picture	46	4	92%
		Video	46	4	92%
Comprehensive	\	\	48.05	1.95	96.1%
Misty day	90	Picture	47	3	94%
		Video	47	3	94%
	60	Picture	45	5	90%
		Video	45	5	90%
	30	Picture	44	6	88%
		Video	43	7	86%
Comprehensive	\	\	46.25	3.75	92.5%

A Wireless Rechargeable Remote Control Switch Based on the Piezoelectric Ceramic Piece

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Abstract **— The installation and wiring of traditiona lelectrical switches, especially the lighting switches, are time-consuming,laborious and high costs. Also the control is too single and it often needs to replace batteries for the rem ote control.To overcome these shortcomings,based on the piezoelectric ceramic piece,a wireless rechargeable remote control switch is designed.The characteristics of this control sw itch are that the piezoelectric ceramic chip provides trigger voltage for circuit.Through the coding circuit of single chip microcomputer,identifing the pulse,providing data to the Launch module.Using the radio frequency technology, it communicates w ith the receiver, which then gives control signals to the e lectricity equipment to control it work.The entire system can easily achieve inte-lligent wirless remote control. It is environmental protection w ithout batteries maintenance and of high reliability and high practiclvalue.**

Key words **—Piezoelectric ceramic piece;Wireless charging;Radio frequency**

I. FOREWORD

AS people's living standards improve, people's pursuit of intelligent control is always the goal.The traditional electrical switch (especially lighting switch) gradually reflect shortcomings that need wiring distance is long, low design freedom; Even with the remote control also requires the use of a battery-powered, no green; each switch can control an electrical device, not smart. This article describes the wireless remote control switch to the piezoelectric ceramic structure and based STC15 Series MCU Wireless RF communication technology as the core, can play the role of long-distance wireless remote control switch, and with wireless charging function, high environmental protection, economic efficiency.

II. PIEZOELECTRIC CERAMICS APPLICATIONS AND PROSPECTS

Piezoelectric ceramics occupies a very important position in modern functional ceramics, with a wide range of uses. Since the 1880s, the Curie brothers first discovered on the piezoelectric effect of quartz crystal, the research and development of production of piezoelectric materials and piezoelectric devices extremely quickly, in 2000 global sales of approximately piezoelectric ceramic products for more than $ 3 billion, in recent years, piezoelectric ceramics in global annual sales volume growth rate of about 15 percent. The piezoelectric ceramic is a new functional electronic materials with high intelligence, with the continuous research and improvement of materials and processes, technologies increasingly wide application of piezoelectric ceramics and piezoelectric generator has a simple structure, no heat, no electromagnetic interference, clean and easy to achieve miniaturization and integration, etc., and therefore can meet the energy needs of low-energy products and become one of the hot research.

Japan, the United States, Europe and other developed countries for self-powered piezoelectric power generation system has been studied for many years, has made good progress, particularly in the application of Japan to lead the world.

During 2006-2009, the East Japan Railway Co., Ltd. in Tokyo train station had three "power floor" test, the goal is to achieve the passengers can generate 100 watts of electricity light bulb 0.1 seconds automatic ticket gate pass. 2010 Shanghai World Expo, the Japanese Pavilion piezoelectric generator floor, visitors can be gently steps lamp lighting, which makes a lot of people pleasantly surprised. According to another report, Japan's NEC

and other companies jointly developed a new luminous road signs, road buried under piezoelectric generator to drive the LED luminous signs, basically reached the practical level can be self-powered.

Currently, most of the domestic researchers also remain in the study of piezoelectric energy storage, and the piezoelectric energy storage technology has matured, and has been successfully practiced on a small electronic products. But did not put this energy storage technology is applied to the piezoelectric life to them. In order to make full use of clean energy living among, and the piezoelectric energy storage to the social life, so we have a wireless control switch for the entry point based on piezoelectric ceramics research started.

III.SYSTEM COMPONENTS

Wireless rechargeable remote control switch is mainly composed of five parts. Piezoelectric ceramic trigger circuit which generates a trigger signal to the microcontroller to identify and coding; wireless charging device for microcontroller (coding) and transmitter power supply, the entire modules use low-power devices; MCU encoding and transmitting circuit as a whole, single-chip encoder circuit the output value of the fixed code transmitter circuit, the transmitter circuit will be encoded in the 433Mhz frequency carrier to transmit; receiving circuit receives the RF signal is valid, then into the microcontroller decoding circuit decoding circuitry to decode the information received, the conversion paired external auxiliary control signal circuits; peripheral circuit will control the zoom control signal decoder output relay, in order to control the electrical equipment, to achieve switching action. System block diagram shown in Figure 1.

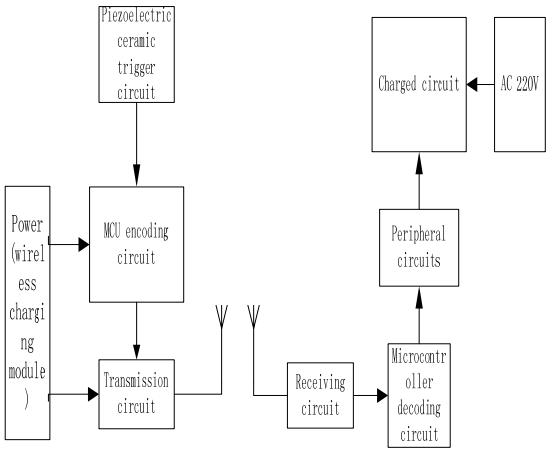

Fig.1 .Overall block diagram

IV.SYSTEM FUNCTIONS

A. Piezoelectric ceramic trigger circuit

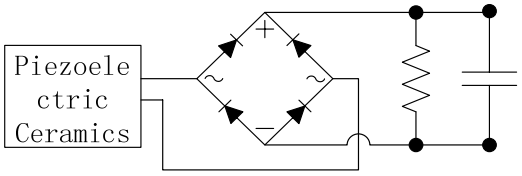

Fig.2 .Piezoelectric ceramic trigger circuit

Greater degree of development on the next generation sensor technology relies on wireless microelectronic devices for improved energy technologies that extract energy directly from the environment. Piezoelectric transducer is the use of ambient vibration induced piezoelectric structural deformation, thereby causing material inside the separation of positive and negative charge centers, resulting in polarization voltage, the polarization voltage to drive the electrode plate directional flow of free charge output power.

The piezoelectric ceramic and the regulation tank circuit effectively connected together as shown in Fig. Trigger circuit consists of a piezoelectric ceramic piezoelectric ceramics, bridge rectifier and energy storage circuit. The upper and lower surfaces of the piezoelectric ceramic plates are attached to the electrode, the electrode plates and the rectifier bridge and a direct contact. Fluctuations in piezoelectric ceramics, piezoelectric force structure due to electrical conversion and generate alternating current. Generating an AC current flows through the DC

rectifier bridge and produce a more stable trigger voltage DC energy storage circuit, the trigger voltage can ensure that the microcontroller to identify and encoded and sent.

B. Wireless charging device

Wireless power technology (wireless charging) allows the receiver across the air, such as paper or plastic housing can achieve energy transmission, indeed greatly facilitate the application of this technology is a recent breakthrough in the development and gradual practical.

Wireless power supply with the "magnetic coupling resonance" This new technology consumes power only the traditional electromagnetic induction technology millionth power when the transmitter is powered, it does not emit electromagnetic waves outward, but just around the formation of a non-radiative magnetic field. This magnetic field is used, and the contact receiving end, the receiving end of the excitation resonance, and thus the cost of a very small consumption of energy transmitted. In this technique, the strength of the magnetic field of the Earth's magnetic field strength, however, and is similar to the technology that people have to worry about their own bodies and would adversely affect other devices.

A wireless power module integrates the internal oscillation circuit, a shaping circuit, a detection circuit, the frequency interference suppression circuit that controls the current, the wireless power transmitter circuit.

Wireless charging module is designed for wireless power small portable electronics products, development and design of the charge, with a small, easy to use, high conversion efficiency, no battery power and then, more economical and environmentally friendly.

C. MCU encoding and transmission circuit

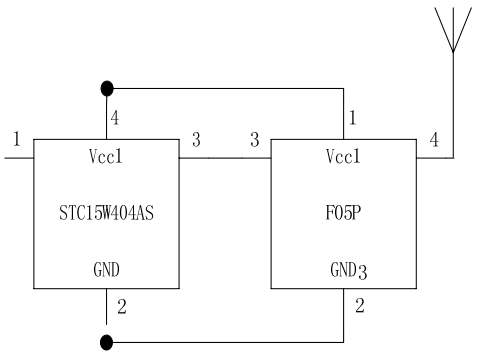

Fig.3 .MCU encoding and transmission circuit

To improve the remote use of time, so the overall low-power high-performance requirements; considering the microcontroller can detect trigger signals, so the best AD converter MCU can bring their own, so the choice of this STC series 15w404AS microcontroller. STC15W404AS microcontroller is enhanced 51CPU, 8-12 times faster than conventional 51; FLASH-type large-capacity SRAM; 8 channel 10-bit high-speed ADC; two high-speed asynchronous communication ports.

Transmission circuit with integrated transmitter module, choose Anyang City, Henan Institute of Electronics Limited production of the new century F05P low power transmitter module, shown in Figure 5. F05P using SMT technology, resin package, small size, acoustic frequency stabilization, internal modulation circuit and has a current limiting resistor, suitable for short-distance wireless remote control alarm and single-chip wireless data transmission. F05P has a wide operating voltage range and low power consumption, ASK modulated.

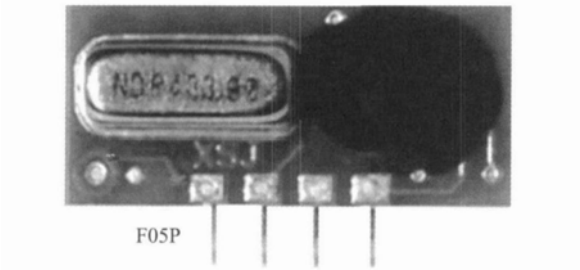

Fig.4..Transmitter module FO5P

D. Receiving circuit

The receiving circuit shown in Figure 5.

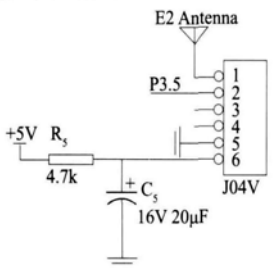

Fig.5.Receiving circuit

Receiving circuit with integrated receiver module, the choice of Anyang City, Henan Institute of Electronics New Century Limited production J04V type receiver module, shown in Figure 6. J04V small size, low power, low-voltage super-regenerative receiver module, the output noise interference and high receiver sensitivity.

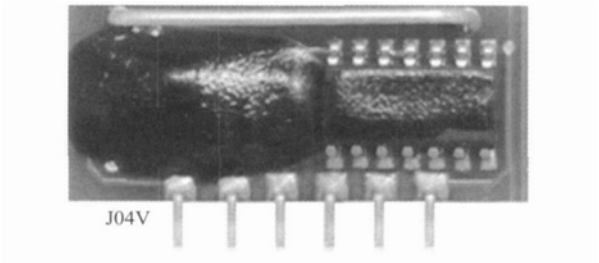

Fig.6.receiver module J04V

E. Microcontroller decoding and peripheral control circuit

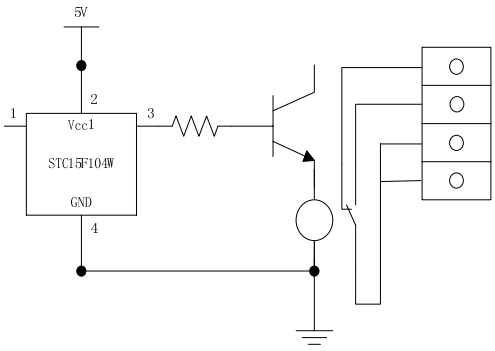

Figure.7.Microcontroller decoding and control circuit

To maintain symmetry and reliability of the entire system, the receiving part of the selection and launch microcontroller part of the same type STC15 microcontroller. This STC15F104E microcontroller is 8 feet, its function and other STC15 microcontroller similar, but lower power consumption. Each receives from the receiver J04V encoder, the MCU will send a control signal to the external circuit; peripheral circuits primarily relay. SCM control signal after amplification transistor drive relays. Pull the relay coil, then the controlled device access 220 V AC circuit; coil release, the controlled device access to 220 V circuit is disconnected, in order to control electrical equipment, to achieve the role of the switch.

F. System Diagram

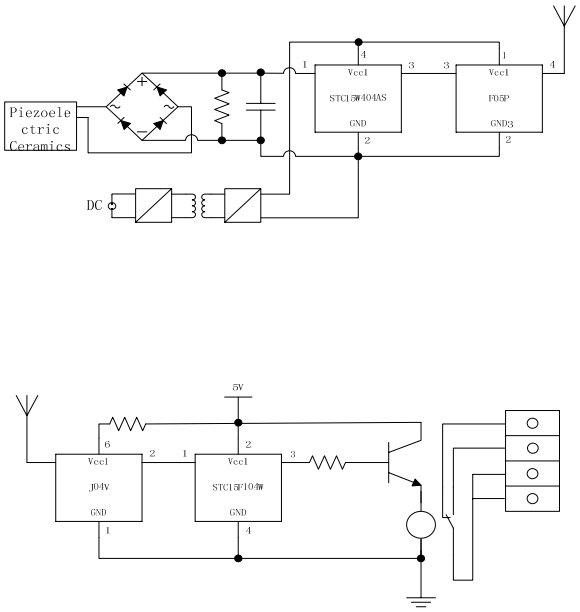

Figure.8.System Diagram

V. WORKS COMPLETION REPORT

Whenever squeeze piezoelectric ceramics, 15 microcontroller with AD can identify the sender wanted to send a trigger signal data, the receiver can also receive data decoding circuit decoding device can be better to send control signals to control the relay closed, normal light bulb can. Overall, the work can better achieve the purpose.

VI. CONCLUSION

This design is based on piezoelectric ceramics rechargeable wireless remote control switches can meet people's lives and work requirements.Good performance piezo-electric conversion power conversion, and low energy consumption, easy miniaturization, it has a very broad application prospects. Unlimited charging concept design with green, and greatly improved the life of the remote control. Free pipe interior decoration, free wiring, not cutting the wall, improve construction efficiency and reduce construction costs and improve design freedom. Terminal equipment and the control voltages of up to 5V, will greatly enhance the control of the switch at the time of the safety.

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Personnel Identification and Intelligent Management System Based on Multi-sensor and Foxtable

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***Abstract*—With the promotion of the opening laboratory , we designed a more scientific and user-friendly management system for personnel identification and intelligent management in laboratory, which is based on various sensors including fingerprint sensor , Charged-coupled Device, infrared photoelectric sensors and ultrasonic sensors to achieve monitoring personnel access, fingerprint recognition, face recognition and other functions. While taking advantage of Foxtable data management software to develop an information management software, it can record, query and print the information of the laboratory and generate the attendance records, equipment use records and other records. The system has been put into service in CIEE laboratory of Jilin University , which can assist the teachers in managing the laboratory more simply and efficiently. Also, the system has good portability, which is not only for laboratory management in universities, but also for the administration of warehouse, company and other workplaces.**

***Key words*—fingerprint recognition ; face recognition ; personnel access monitoring; Foxtable; intelligent administrative system**

INTRODUCTION

LABORATORY, as the output of scientific achievement, with its construction being standardized gradually, it is not only increasing the intensity of the daily management work, but also exposing many questions. Jilin university has attached great importance to the construction of laboratory and has invested a large amount of manpower and material resources. A variety of laboratory equipment is convenient for experimenter to conduct scientific research, and also makes the teacher statistical management more onerous, which includes the usage, maintenance and borrowing of laboratory equipment. While the opening laboratory, promoting as a great innovation in laboratory construction, improves the students' scientific research level, it also increase the difficulty for the management of laboratory. In face of such a large amount of information and workload, the existing management mechanism isn't enough for effective management.

A majority of laboratory management system at home and abroad use single software or hardware for laboratory management. Software of information management system has a friendly interface and statistical functions, but without the support of hardware, it is hard to get the real-time and accurate reflection of the laboratory comprehensive information; A single hardware management system administrates with IC card or video monitoring in the majority, but has a deficiency in the fields of information storage, personal identification and data statistics. Since laboratory information is scattered, and person and equipment information is plentiful, it is becoming an inevitable trend for combining a wide variety of hardware and software to administrate the laboratory.

Therefore, we produce a more humanized and more scientific laboratory personnel identification and intelligent management system. This system is based on multi-sensor data fusion technology. At the same time, we established the database combined with the application of computer technology in information management direction, and designed a set of information management system. As a result, huge information processing problem will be solved[1].Summing up the above, it can be more practical, simple, efficient and clear to administrate the laboratory with the combination of hardware and software.

1 THE SYSTEM DESIGN

Personnel identification and intelligent management system collects data by multiple sensors . When the system works, the one who wants to get in or out of the laboratory needs to identify his fingerprint. After the optical fingerprint sensor gets fingerprint image, the fingerprint characteristics are obtained by high performance DSP processor, and judges with the fingerprint characteristics which stored in the fingerprint library of FLASH chip previously to identify his identity[2].The fingerprint code will be sent to MCU. MCS-51 drives a LCD12864 to display the personnel identity information, and communicate with computer by serial port. Infrared sensor and ultrasonic sensor constitute the personnel monitoring module, the order of the pulse signal by two pairs of infrared sensors can determine the people's movement direction. Ultrasonic sensor measures and calculates the number of them[3]. MCS-51 drives a LCD1602 to display the current number of indoor people, and communicate with computer by serial port. If someone enters illegally (without a fingerprint verification or trying to follow after other person who has already verified the fingerprint), computer will estimate whether the number of scanning fingerprints is different from the number of people in and out of the laboratory or not, and if they are different, the violation alarm rings, at the same time, the image acquisition module is activated, real-time images will be collected by the optical image and sent to the computer, then recognize the face's owner through the software. In conclusion, we can obtain the comprehensive and real-time information of laboratory based on the multiple sensors.

One of the system's characteristics is combining software with hardware. Foxtable is used to establish the database and empolder the management software. Foxtable provides serial-port communication method to communicate with MCU[4]. The laboratory information management software has functions of inputting or seeking personnel basic information, experiment equipment information, fingerprint attendance record and so on. What's more, it can generate the corresponding reports. Face recognition part is actualized on the Matlab software. Foxtable can make a visit to Matlab.

In conclusion, this system can implement personnel monitoring and violation alarm, fingerprint recognition, face recognition, etc. The system's overall diagram is shown in figure 1:

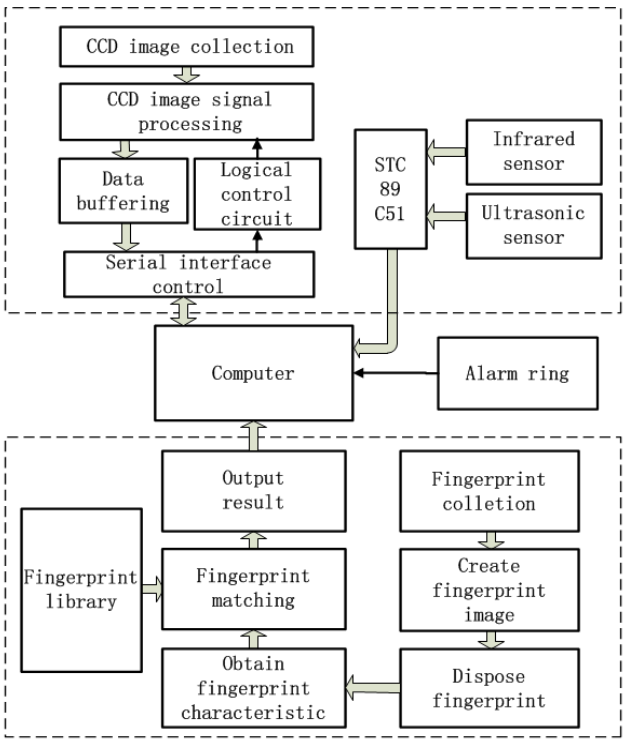

Fig.1 The system's overall diagram

The system's diagram is shown in figure 2:

Fig.2 The system's diagram

2 THE DESIGN OF PERSONNEL MONITORING MODULE

Personnel monitoring module is composed of the ultrasonic sensor, infrared sensor，MCU, serial communication module, display module, power supply module. Personnel monitoring module overall diagram is shown in figure 3.

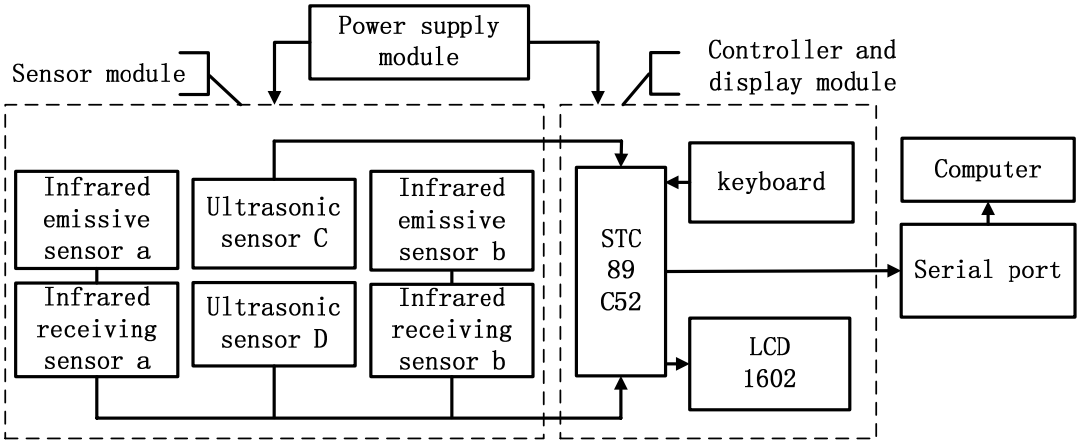

Fig3 Personnel monitoring module overall diagram

The module uses STC89C52 as the controller and C language for programming. Infrared sensor uses INT0 and INT1 of the MCU for processing. If no person passes the module, the infrared sensor produces low level. Once someone gets through, infrared sensor generates a pulse signal to apply for the interruption. Fix the two pairs of identical infrared sensor side by side, the controllers can judge one's movement direction by two pulse's sequence[5].Ultrasonic program is between the two interrupts, tests ultrasonic signal detection reflected by objects to obtain people's width and then determine the number of people. LCD1602 displays real-time personnel number and so on, and its data is sent to the computer by a serial port.

3 THE DESIGN OF FINGERPRINT IDENTIFICATION MODULE

3.1 Fingerprint identification technology compendium

Fingerprint characteristic is unique, so we choose fingerprint recognition method to discern people's identification. First we use fingerprint image-collection sensor to acquire the fingerprint image in fingerprint identification technology[6]. Subsequently, we need locate and extract the fingerprint characteristics from the fingerprint image[7]. It is the core of the fingerprint identification technology that compounds fingerprint characteristics in one synthesis template[8]. After acquiring the fingerprint template, it is demanded to contrast the template with those in the fingerprint database established previously to determine its owner's identity,

3.2 Module design

The module consists of MCU, high performance DSP processor, optical fingerprint sensor, CD4052 analog switch, FLASH chip, A/D conversion module, keyboard and display module, and power supply module. Optical fingerprint sensor has a planar glass which let the subjects put their fingers on it. Irradiating the planar glass, different areas of the fingerprint reflects light differently, and the sensor collects optical image signals from each coordinate point and converts them to electrical signals. They are converted to digital signal by A/D converter subsequently. We choose DSP processor to extract the fingerprint image signal characteristic value, and it synthesizes fingerprint characteristic template and stores the template in FLASH chip to generate fingerprint library[9].Buttons can switch the fingerprint entry or fingerprint identification functions. In identification mode, after the subjects' fingerprint characteristic has been generated , it contrasts those information with the fingerprint feature templates in fingerprint library, recognizes the subjects' identity, and DSP processors will send the fingerprint code to STC89C51, and STC89C51 sends data to computer through the serial port and drives LCD12834 to display the subjects' identity. Both DSP processor and the computer serial-port

communication need STC89C51's TXD and RXD, and we use CD4052 analog switch so that the two-way signal can timeshare the signal path to ensure the smooth communication.

Main software flow is as follows: First, MCU tests whether the keyboard is pressed or not. If there is a key pressed, MCU judges that it is fingerprint inputting key or fingerprint identification key. If the pressed key is fingerprint inputting key, it will test whether there is a finger pressed on the fingerprint sensor. If there is a finger pressed, fingerprint sensor will send the fingerprint image to MCU. MCU extracts the fingerprint characteristics into buffer 1, the green light flashes. Detecting finger again, the fingerprint characteristics are saved in buffer 2 and the green light flashes once more. The software merges the fingerprint characteristics stored in the two buffers to a total template. When pressing the key for fingerprint identification, it will detect whether the finger is pressed or not. If the finger is pressed, it will get the fingerprint image from the sensor, generate a fingerprint template according to the original image, search in fingerprint library, and compare the fingerprint in it with this fingerprint to determine the identity. Fingerprint identification module software flow diagram is shown in figure 5:

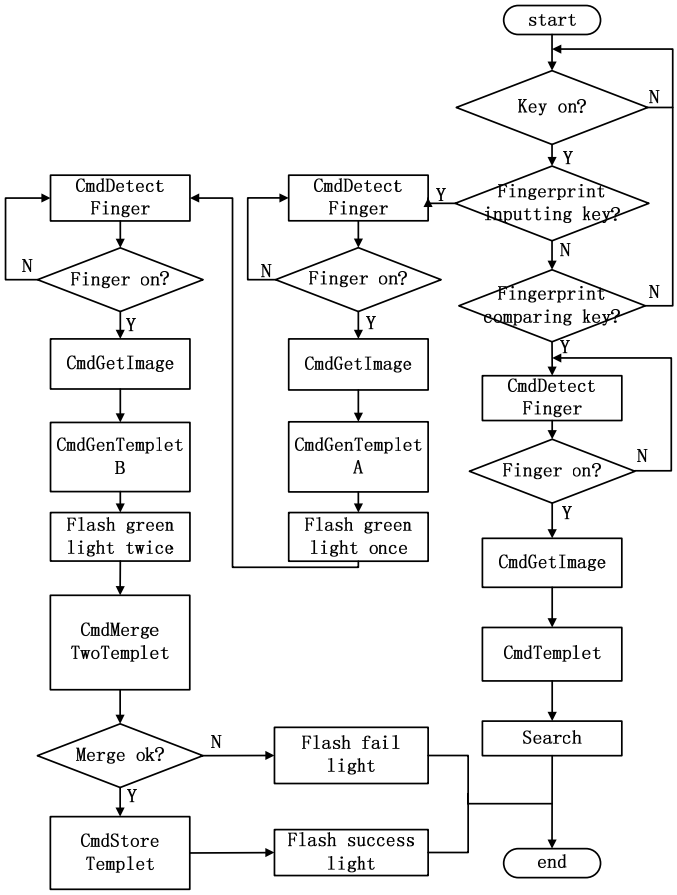

Fig.5 Fingerprint identification module software flow diagram

4 THE DESIGN OF FACE RECOGNITION MODULE

When someone breaks into the lab, image acquisition module is activated, and the alarm sounds at the same time. The module acquires image data by the CCD sensor , which can directly switch the light signal into electrical signal. The signals is produced by the CCD module, and after its denoising and AD-conversion treatment, it will be transmitted to PC to display and storage by the USB interface. Matlab is a numerical calculation and visualization mathematical software. Its basic element is matrix, so it is suitable for image processing. We use Matlab platform to invoke the image for face recognition.

First, it uses imread function to read a stored image. Then it uses rgb2gray and imhist function to gray-process the image, and draws its histogram. It transforms the image from RGB space to NTSC space, and takes the second frame (brightness of the image) while taking red, green and blue data of the image and store them in the matrix of R, G and B to

make it calculate easily. Calculating the size of matrix with size function, it customs the threshold values of face range, creates zero matrix with the same size as matrix G, gets the histogram and image after processing. Some noise appears in the image, and it uses the strel function to create a linear structure unit, eliminates noise through the opening and closing operation. Finally, it acquires the face range through the loop statement, gets the face reign through the linear operation, and then gets a final deal. After getting human face information from real-time image, it compares them with the face image stored in the library to determine the identity[10]. Face recognition diagram is shown in figure 6:

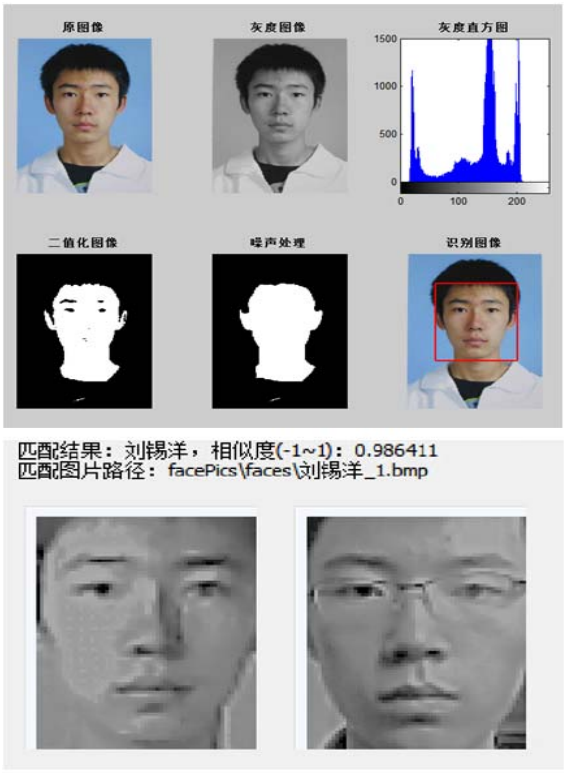

Fig.6 Face recognition diagram

5 THE DESIGN OF INFORMATION ADMINISTRATION SYSTEM SOFTWARE

Information management system software is developed by Foxtable[11]. Foxtable achieves the function of Excel, Visual Basic and Access with its more simple and intuitive data processing and programming method. In addition to using self-built database, it can also link other database as a data source. Foxtable provides a serial port communication method for the data exchange with other controllers. And it uses BASIC language for programming.

The software consists of equipment management, personnel information management, violation records, face recognition, laboratory activity records , report generation, external data import, system settings module, etc. Each module has respective navigation. Taking the personnel information management module as an example, the module contains personnel basic information, personal work inputting, attendance summary, periodic tasks and performance appraisal such five tables. The software interface is shown in figure 7. Each table can query, input and modify through the corresponding window. The window interface example is shown in figure 8.

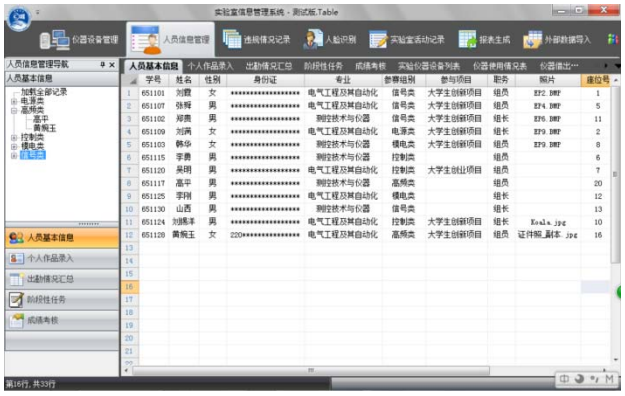

Fig.7 Information administration system software interface

Fig.8 Software window interface demonstration

At the same time, this information management software can generate and print various records such as equipment application, staff attendance sheet, work introduction, etc. It can link the external software for face recognition.

6 THE TEST AND ANALYSIS

For the personnel identification and intelligent management system based on multi-sensor and Foxtable is used with multi-sensor data fusion technology[12], it makes the measurement results closer to the actual. After the system is installed in the opening laboratory of Jilin University, we choose a random hour for data statistics and the results are shown in table 1. As it can be seen from the table, the relative error of the number entering the lab is 1.613% , which the fingerprint recognition module and personnel monitoring module records. The absolute error of the leaving ones is 1.887%. The relative error of the personnel monitoring module records is 1.11% and other absolute error is 0. In the fingerprint identification module, the cause of the error is the dirt covered on the finger , which affects the acquisition of fingerprint image. In the personnel monitoring module, the cause of the error lies in the error of ultrasonic ranging sensors that affect the judgment of the controller for the number of in and out. In conclusion, using multi-sensor measurement, the system can analysis and compare the data of sensors to reduce the error in order to reflect the information of laboratory more accurately and clearly.

Tab. 1 The results of staff turnover statistics

	Entering number	Leaving number	Indoor number
actual number	62	53	9
fingerprint identification module number	61	52	9
absolute error	1	1	0
relative error	1.613%	1.887%	0
personnel monitoring module number	63	53	10
absolute error	1	0	1
relative error	1.613%	0	1.11%

7 CONCLUSION

Personnel identification and intelligent management system based on multi-sensor and Foxtable ,with the combination of hardware and software, makes the management of laboratory more simple, intuitive and efficient. The system achieves monitoring personnel access, fingerprint recognition and face recognition. At the same time, we use Foxtable to develop a set of information management software, which can record , query and print the information of the laboratory and generate the attendance records, equipment use records and other records.

By actual test, the system can more accurately and clearly reflect personnel information of laboratory. It has good practicability that greatly improves the efficiency of laboratory management and saves quite a lot of manpower. With the informatization, intellectualization, standardization of the method, it has played a great role in increasing students' academic level[13]. In addition, the system has good portability, which is not only for laboratory management in universities, but also for the administration of warehouse, company and other workplaces.

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