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BLUETOOTH BASED AUTOMATION SYSTEM WITH SECURED ACCESS

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ABSTRACT

This project aims at providing an efficient low cost and wireless Data acquisition and control system. This concept uses Bluetooth technology to access and control the RTU(Remote terminal) through a mobile or a computer. The modularity of the project allows the user to modify it according to his need. This design imparts wide flexibility and can be applied in industries as well as in homes. The data acquired from RTU is in real time, all the status of Bluetooth, object and relays are displayed with their real-time status and values. The distance from the object is provided by an ultrasonic system which is an affordable and reliable sensor for the job. The project is secured with a triple layer security protocols. The prototype is designed as an object detection which can be used in workspace or industries. The system is affordable, user-friendly and easy to install and debug.

KEYWORDS: Bluetooth, Ultrasonic sensor, Home Automation, Android Application, Secured Automation.

INTRODUCTION

The home automation system is a concept which involves networking of the various devices that are present in a home. Home automation system has many synonyms like smart home, intelligent home. Home automation systems are a hot property in today's market and the demand for such systems today is increasing rapidly.

With the prolific increase in usage of various wireless technologies like Bluetooth, GSM, ZIGBEE, WIFI. Each of these technologies can be used in their own different ways. For building the system used in this project, Bluetooth was chosen as the suitable option. Bluetooth is a standard wireless communication that operates in frequencies of 2400 MHz's. Depending on the Bluetooth device's class it can connect a number of devices and in varied ranges of operating distances.

Bluetooth system was preferred here as due to the rise of Smartphone's usage people have access to Bluetooth all the time. Certain challenges that are there while designing a Home automation system like safety and security, scalability, cost, ease of use etc. The inherent properties of Bluetooth take care of all these challenges. Bluetooth HC-05 module was used in this system for communication purposes.

Most of the automation industry useWiFi or Bluetooth for its applications[1].WiFi is not preferred for implementing such a system because of the high power consumed by it and its high data rate [1-2]. Project [1-2] use ZigBee protocols for implementing the wireless connection. The cost that would be incurred by the user for using this system has not been mentioned [1-2]. The high-cost system is not accepted by every user.

Project [5] uses XBee transceivers for controlling home activities and functionalities. This system would not be a cost-effective system as XBee transceivers are costly. The remote control of system [5] is done by using a microcontroller. Project [3-4][6-7] used Bluetooth for designing their home automation systems. Reference[3] uses the internet to give commands to a remotely located Bluetooth module, so the user doesn't need to worry about the location of the Bluetooth modules. Reference[4] uses an android app based GUI for controlling purposes. Project[6-7] use Bluetooth Low Energy[BLE] for implementing their systems. The power consumption was reduced by usage of BLE and such

systems can function for longer durations[6].Reference[6] aimed at creating a central controller that controls working of all components in the home. Project[7] aimed at creating a unified standard that allows various brands of Bluetooth Low Energy devices to connect to each other.

From the overall review of all the system uses only Bluetooth module and microcontroller, so the overall cost of the system is minimal. Since the system uses PIC microcontroller the system will be very rugged.

PROPOSED SETUP COMPONENTS

2.1. General purpose PCB board

It is an off the shelf PCB which has footprints of GPIO(general purpose input output), power supply, rectifier, LCD16x2, Serial D9 port, 4x4 Keypad matrix. The RTU is designed on this board.

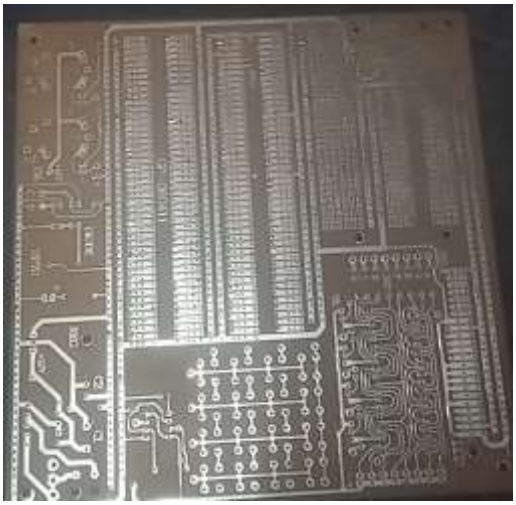

Figure 1 General PCB board

2.2. Microcontroller

The microcontroller user in this setup is pic18f4550 It is a high performance, enhanced flash, USB microcontroller with nanowatt technology thus, reducing the power consumption. Its features include[16].

- USB 2.0 compliance
- 32KB flash RAM
- Serial communication with MSSP enhanced USART
- Wide operating voltage of(2.0 V to 5.5V)
- Eight user selectable frequencies from 31 KHz to 8MHz
- Four timer modes Timer0 to Timer3
- 10 bit 13 analog channel
- Programmable Code Protection for Security.

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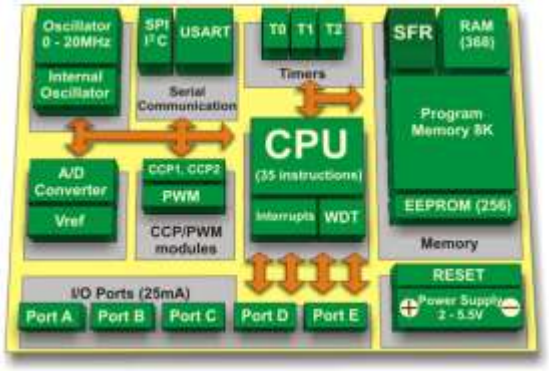

Figure 2 PIC Microcontroller

2.3. Communication

The communication module used in this system is HC-05 Bluetooth module with acts transparent wireless serial connection between the user and the RTU module. The module works on a Serial Port Protocol. The serial port Bluetooth module works on V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband[8]. It has a sensitivity of 80dBm and can transmit at a power +4dBm. It has a low working voltage of 1.8V which makes it appropriate to use. It take power supply of 3.3 to 5V and has integrated antennas with edge connectors. The baud rate can be programmed using UART interface. On the software side, the module works at a baud rate of 9600, 8 data bits,1 stop bit and no parity. It has an auto-connect feature which connects to last device on power as default. The pin code for pairing is"1234 " as a default password in this module[8].

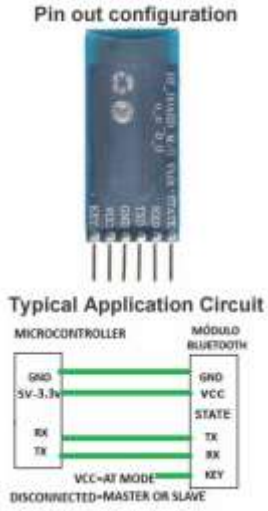

Figure 3 Bluetooth Connection

2.4. Sensors

The sensor used in this system is HC-SR04 ultrasonic sensors which work on 5V. It is a non-contact distance measurement sensor. It is able to measure distance ranging from 2cm to 400cm. It is used in this prototype due to its low cost and high accuracy of 3mm. It has 4 pins VCC, GND, ECHO, TRIG[9]. The sensors work by emitting a minimum 10-microsecond pulse from the trigger. The module automatically transmits eight 40khz ultrasonic burst, if there is any object in front of the sensor the burst gets reflected and is detected by ECHO which produces a 5V high state [9].

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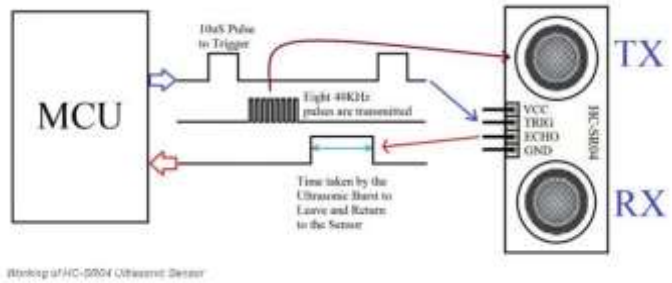

Figure 4 Connection of MCU with Ultrasonic sensor[9]

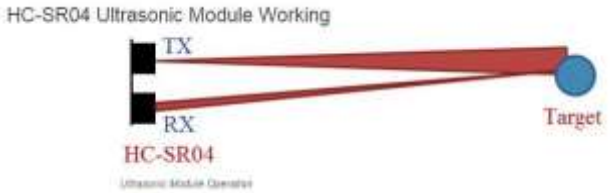

Figure 5 Working of Ultrasonic Sensor[9]

2.5. Display

A 16x2 LCD display is placed on the RTU which displays the status of relays, Bluetooth, and ultrasonic sensors. It is also used for displaying password characters and status.

Figure 6 LCD Displaying various processes

2.6. Security

A three layer security is provided to this system, first and foremost layer of security a 4x3 keypad which protects the RTU from unauthorized access. There is also a provision of resetting the password. The second layer of security is provided by the microcontroller where we can use its feature that is programmable code protection. The protection is provided by a set of " configuration fuses" when the configuration is set it prevents any modification from certain regions of memory. The last layer of security is provided by the customizable Bluetooth commands which are only known to the supervisor thus, preventing any unauthorized controls.

HARDWARE DESIGN

This section concentrates on the hardware setup of the system. We have used a PIC microcontroller due to its ease of programming and interfacing with other peripherals. It is highly reliable with low malfunctioning rate. It has a higher performance rate when compared to other microcontrollers because of its RISC architecture[10]. The schematic design of the system is shown in Figure 7 which shows interfacing of the microcontroller with other peripheral modules. The reason for choosing HC-SR04 ultrasonic sensor module for object detection is its low cost and high

accuracy rate which are idle for designing a prototype. A Bluetooth HC-05 establish a communication between the RTU and the supervisor(mobile phone with Bluetooth Serial Controller 16 android application). The Bluetooth is connected to serial pins of microcontroller and enable communication between Supervisor and RTU. The Relays are controlled low voltage signal from microcontroller thus, to prevent any damage to microcontroller due to the voltage difference a ULN2003 driver is used which properly channel the activation signals using optocouplers. The driver is based on an array of seven NPN Darlington transistor capable of 500mA, 50V output

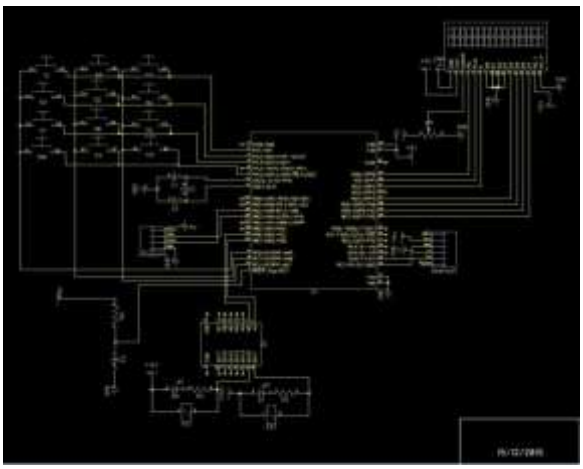

Figure 7 Hardware Schematic of system

The supply is given to the RTU from 220V port which stepped down to 12V using a step-down transformer. The 12V AC is converted to 12 DC using a full wave diode rectifier. The 12V DC to Supplied to the relays the voltage is further stepped down to 5V using 7805 Voltage regulator or DC to DC converter. The 5v is supplied to the microcontroller and other RTU peripherals.

Figure 8 System Prototype

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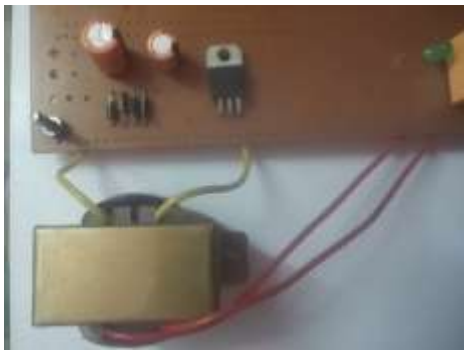

Figure 9 Power Supply

SOFTWARE DESIGN

The software designing includes the functioning and working of the RTU system. Figure 10 represents the flow of the processes of the system. The system starts by asking a four digit password if a person enters less than four digits it fails. After entering the correct password, the user has two options either to reset the password or to continue. After pressing continue button, the ultrasonic sensor starts measuring distance and displaying the value on the LCD screen. The microcontroller is programmed to switch on relay1 for a second when the object passes at 15cm in front of the ultrasonic sensor. The LCD display show number of time the relay1 is switched on, in this system it is coded to count 10 switching of relay1.

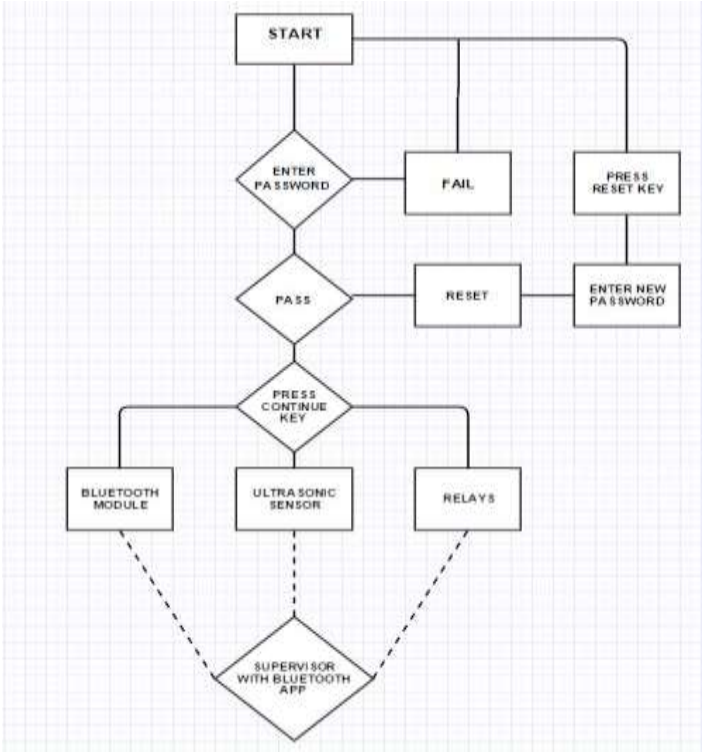

Figure 10 Flow Chart of the System

The Bluetooth module connected to a mobile phone working on android OS. The supervisor (mobile) is able to control and monitor the processes using an android GUI Bluetooth application. The Bluetooth Serial controller 16 android application wirelessly connects to PIC microcontroller using Bluetooth SPP(Serial Port profile).It provides user to

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freely set the commands, visibility, repeatability. It provides u archiving facility using terminal mode where u can save and store communication logs[11].It displays both sent and received data by enabling terminal option.

Figure 11 Bluetooth Serial Controller Setting

The commands used in is setup are:

- CONNECT: It is an undefined command used to change the status of Bluetooth on LCD from waiting to connected
- R1OFF: Its has a string value "R1OFF" when this string is received by the microcontroller it changes the status of Relay1 to zero and sends a low signal on the pin connected to relay1.
- R1ON: Its has a string value "R1ON" when this string is received by the microcontroller it changes the status of Relay1 to one and sends a high signal on the pin connected to relay1.
- R2OFF: Its has a string value "R!OFF" when this string is received on microcontroller it changes the status of Relay2 to zero and sends a low signal to the pin connected to relay2.
- R2ON: Its has a string value "R2ON" when this string is received on microcontroller it changes the status of Relay2 to one and sends a high signal to the pin connected to relay2.
- GET_DATA: Its has a string value "GET_DATA" when this string is received on the microcontroller, it transmits the distance's value measured by the ultrasonic sensor to the mobile and displays the distance measured on the Bluetooth application's terminal.

Figure 12 System Telemetry Commands

CONCLUSION

Bluetooth based home automation system designed can be used for improving the standard of living of people. This system allows people to control the devices in their home more easily and without any physical efforts. Such a system is a boon for elderly people and those with some physical disabilities. The use of Bluetooth makes installation of the system an easier task and integration of new components in future much simpler.

The system uses PIC microcontroller which is the most rugged of its type in the industry and has a long lifeline, so the system will have a long lifeline. The three-layer security system provides additional safety to the user and prevents any misuse of the system.

The android app provides a very user-friendly GUI and hence is advantageous. In future, the system can be made better by using voice and speech recognition and gestures.

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