Home Automation Control and Monitoring System Using BLE Device

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Abstract: The technology is a never ending process and these technologies will tend to improve the quality of any product. To be able to design a product using the current technology which is beneficial to the lives of others is a huge contribution to the society. This paper presents the design and implementation of a low cost, tangible as well as flexible, secure and also the current usage level is displayed in the hand held device, it is used to measure the current consumption. In this home automation, Bluetooth low energy (BLE) and two Adriano boards are used. One is standalone and another one is remote control hand held device, Smart phone android device is not used. The stand alone Arduino BT(AT Mega) board and the home appliances are connected to the input/ output ports of this board via relays.Remote control device consists of anArduino board, keypad and display. The communication between the two Arduino BT board is wireless so that the system can be operated as an remote control device. The system designed using the Bluetooth low energy (BLE) is low cost and scalable that allows variety of devices to be controlled with minimum changes to its core.

Key words: Bluetooth · Arduino · BLE · Remote control

INTRODUCTION

The Bluetooth low energy wireless technology is set to revolutionize the way people perceive digital devices in our homes and office environment[1]. Now they are no longer just the individual devices; instead, with the embedded Bluetooth technology, they form a network in which appliances can communicate with each other. This wireless technology is especially useful in home environment, where there exists hardly any infrastructure to interconnect intelligent appliances. It could be suitably used for [2]home automation in a cost-effective manner. Operating over unlicensed, universally available frequency of 2.4 GHz, it can link digital devices within a range of 10 m (expandable to 100 m, by increasing the transmitted power) at the speed of 1 Mbps. Building upon this theme; we propose a home automation system based on Bluetooth technology. There are certain issues involved in the design of a home automation system. The system should be scalable, so that new device can easily be integrated into it. It should provide a user-friendly interface on the host side, so that the devices can be setup, monitored and controlled. The interface should also provide some diagnostic services so those problems with the system [3], if any, can be tracked down. The overall system should be fast enough to realize the true power of wireless technology. It should also be cost effective in order to justify its application in home automation.

This automation system is entirely different from other home automation system. Mostly home automation system uses android and traditional Bluetooth**.** Bluetooth and android smart phones are not used. Both control and remote sides are uses Arduino board and Bluetooth low energy device (BLE). In this system we can easily turn on/off home appliance using the relay. Current usage level is displayed in the remote and it is used to know the current consumption of the room [4]. BLE to BLE communication is easily paired and the data transfer will also easily takes place in a safer manner. Remote control is easy to operate and low cost.
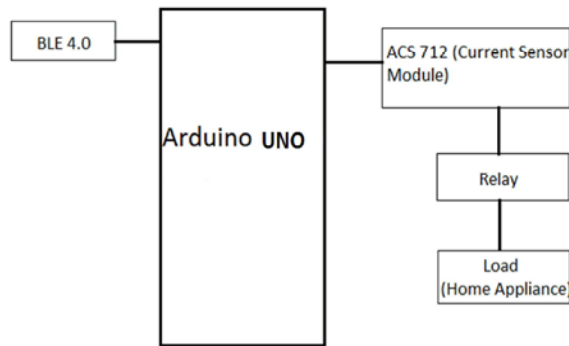

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Fig. 1.1: Block diagram of Home automation Standalone System
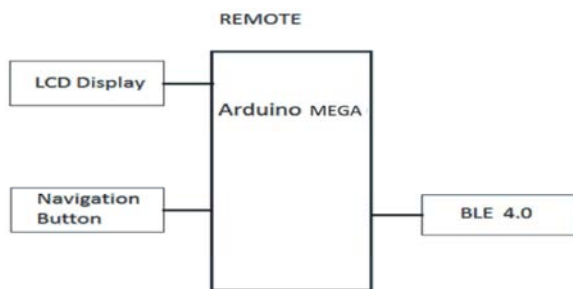

Fig. 1.2: Block Diagram of Remote Control device

Block Diagram: The Figure 1.1 shows the block diagram of Home automation Standalone system. Standalone module consist of a ACS 712 Current sensor and a relay. All these are interfaced with Arduino UNO. Bluetooth low energy (BLE) is integrated with the Arduino UNO, which act as transmitter/Receiver. BLE transmits and receives the data serially to the Arduino UNO board[5], whereas another BLE will receive/transmit the data serially at the remote control device. Relay boards are connected to the Standalone module for controlling the Home appliance.

The Figure 1.2 shows the block diagram of the Remote control device. This remote control look like a normal TV or Air conditioning remote. Remote module consist of TFT Display and Keypad. Keypad act as navigation button which is used to select the options. TFT Display shows the list of home appliances and Current usage level. Bluetooth low energy (BLE) is integrated with the Arduino MEGA[6], which act as transmitter/Receiver. BLE transmits and receives the data serially to the Arduino MEGA board, whereas another BLE receive/transmit the data serially at the Standalone module.

Hardware Description: The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Arduino Mega can be powered via the USB connection or with an external power supply. The power source is selected automatically.

The Arduino Uno which is based on the ATmega328, is a microcontroller board. It has 6 analog inputs, a 16 MHz crystal oscillator, 14 digital input/output pins, a USB connection, a reset button, a power jack and an ICSP header. It contains a microcontroller which supports everything; which is connected to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.The Uno differs from the other boards that it does not use the FTDI USB-to-serial driver chip. An adding feature is that, a Atmega is programmed as a USB-to-serial converter.ACS712 current sensor module provides economical and precise solutions for AC or DC current sensing in industrial, commercial and communications systems [7]. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switch mode power supplies and overcurrent fault protection. The device is not intended for automotive applications. The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die. 5.0 V, single supply operation.66 to 185 mV/A output sensitivity. Output voltage proportional to AC or DC current. Factory-trimmed for accuracy TFT Display with SD reader for Arduino Mega.. These items have been paired to provide you with a working solution to quickly create your Arduino display project First, unpack your items and inspect for damage. The LCD module docks onto the shield which then plugs directly onto the Arduino Mega board. Use caution when inserting and removing the modules to prevent damage to the interface pins. The LCD will function when the Arduino is powered from either the USB interface or external power adapter.4x4 Keypad Matrix is used for load numeric into micro controller. It consist of arranged containing four lines and four columns. It is connected to the development system by regular IDC 10 female connector plugged in some development system's port. Four microcontroller's pin should be defined as outputs and other four pins should be defined as inputs. In order the keypad to work properly, pull down resistor should be placed of the

microcontroller's input pins, thus defining logic state when no button pressed. Combining zeros and ones on the output pins it is determined which button is pressed.

Software Description: The Arduino IDE is used to program the Arduino microcontroller. Open the sketch and type the respective program and save properly. Compiling the program and load the program to the board. Arduino IDE programming is very easy to understand [8]. Beginners prefer the Arduino to make the Project. In this project BLE to BLE communication in main part. Serial communication is used to type the AT commands and main thing is enable the COM/LPT port.

Proposed Work: This project has a standalone and remote control module. Standalone module is designed using the Arduino UNO board, whereas the remote control module is designed using the Arduino MEGA board. The ACS712, current sensor is connected to the standalone module Arduino UNO digital pins. This sensor senses the current consumption reading. BLE (Bluetooth low energy) is connected to the respective transmitter and receiver pins. BLE is used to transfer the current consumption reading to the remote control module. Many projects are done the Android and Bluetooth communication. Still now no one has communicated the BLE to BLE for home automation purpose. Communication is established using the AT commands. Both modules consists of BLE for communication purpose and each one act as transmitter and receiver so that both play a role for master and slave. When current consumption reading is sent to the remote control device, Standalone module BLE act as Master. Relay is connected through the Arduino UNO digital pins, which acts as switch for turn on/off the home appliances. In a remote control module, keypad and TFT Display are connected through the Arduino MEGA digital pins. TFT display shows the list of rooms and list of home appliance and also provides ON/OFF options for the home appliances. Keypad act as navigation button to move a other option for display menu and also provide the ON/OFF button. Keypad is used to select the options. When the commands are passed through the BLE, the BLE act as Master. BLE will be connected to the respective transmitter and receiver pins..

Algorithm:
Step 1: Include the header filesand select the COM port for Serial communication.

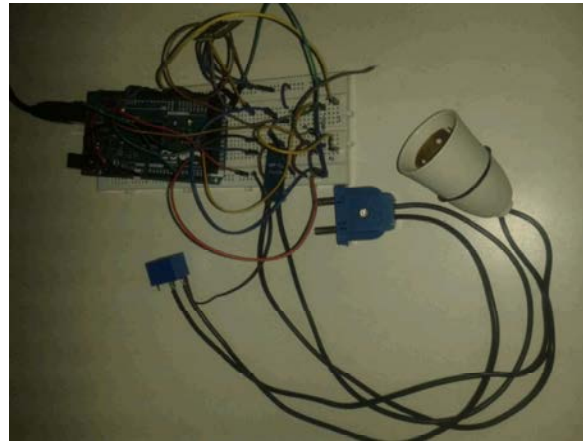**Step 2:** Initialize and create functions and get the sensor value from the processor.

Fig. 1.3: Standalone Module

Step 3: Allocate the digital port for collecting data from sensor and for transmitting the data to the receiver end.

Step 4: Enable the BLE to BLE communication using AT commands

Step 5: Collect the sensor value and transmit the data from one BLE to another BLE and it will be displayed on remote control module.

Step 6: Enable and initialize the Keypad and TFT Display.

Step 7: In the Display, the list of room in a house and list of Home appliance in a room will be shown.

Step 8: Keypad is used for selecting the options and to turn on/off the home appliance

Experimental Results: Standalone module consist of a ACS 712 Current sensor and a relay. All these are interfaced with Arduino UNO. Bluetooth low energy (BLE)is integrated with the Arduino UNO, which act as transmitter/Receiver. BLE transmits and receive the data serially to the Arduino UNO board, whereas another BLE receive/transmit the data serially at the remote control device. Relay boards are connected to the Standalone module for controlling the Home appliances.

The above Fig 1.3 shows the standalone module. This remote control looklike a normal TV or Air conditioning remote. Remote module consist of TFT Display and Keypad. Keypad act as navigation button for selecting the options. TFT Display shows the list of home appliance and Current usage level. Bluetooth low energy (BLE) is integrated with the Arduino MEGA, which act as transmitter/Receiver. BLE transmits and receive the data
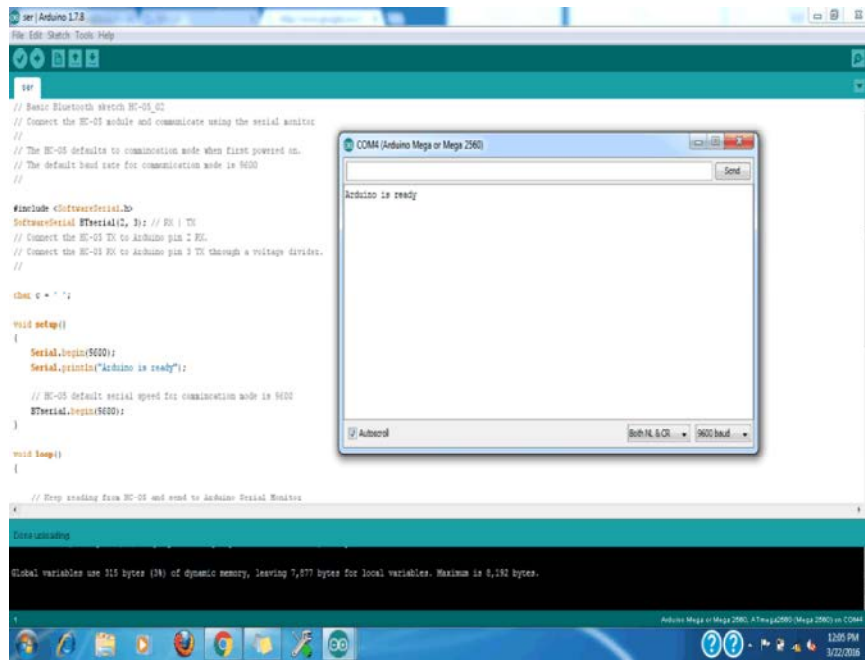
Fig. 1.4: Remote control Module

Fig. 1.5: BLE to BLE communication In the Fig 1.5. the BLE to BLE communication is shown as a screenshot.

serially to the Arduino MEGA board, whereas another BLE receive/transmit the data serially at the Standalone module.

The Fig 1.4 shows the remote control module. Many projects are done the Android and Bluetooth communication. Still now no one has communicated the BLE to BLE for home automation purpose. Communication is established using the AT commands. Enable the Serial communication for AT commands establishment. In this BLE to BLE connection is made as wireless transfer so that the data are securely. One time the connection is paired manually and then the next time, it will automatically get paired.

CONCLUSION

Many home automation system are done using Bluetooth and Android connection. Android using home automation system can be used by a particular person only. Because that particular android phone is not expected to be in home always. But in this project android smart phone is not use. Both the sides, BLE device is only used. Traditional Bluetooth device have limited number of specifications whereas the BLE device is a low cost one and the Data transfer speed is also high and secure. This remote looks like a normal remote, so it is easy to operate.

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