Power and Audio control using Smart Automation
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Abstract— Over the recent years smart systems have rapidly gained popularity. The existing smart systems have different types of wireless communication technique. Many provide unique facilities like security, comfort etc. The working range of such systems vary. Most of these systems provide automation for the entire house but not to the user specific locations. In this smart system, the user can change the control perimeter according to requirement. The android based wireless communication is equipped with two peripherals, the 2.1 surround sound system and the extension box. The control data fed into the android application is sent to the modem. The separation of the data is done in the modem. The system uses wireless mode of communication, with one being Bluetooth and the other RF.

Keywords— Amplitude modulation, Mobile computing, Open wireless architecture, Receiving antennas.

I. INTRODUCTION

Home Automation can be defined as the use of computers to control the home functions automatically and remotely. Home Automation is a technology which is constantly upgraded by integrating modernized features to cater the public needs. The main feature of Automation is remote monitoring and controlling applications. When it comes to remote controlling it is necessary to achieve the task of being able to send and receive data wirelessly [1]. In paper [1] the ASK modulation technique has been briefly explained. This paper speaks about two important aspects at home/work area and they are light and sound. To achieve this, the control modem is designed which consists of the transmitters of the smart extension box and a wireless 2.1 surround sound system. The control modem receives its data from an android application via Bluetooth signal. This data is decoded within the Arduino mega and the transmitters are triggered. Signals from the transmitters are transmitted using RF frequency of 2.4GHz (speaker) and 433MHz (extension box) which are received and decoded using processing algorithms at the receiver end.

II. SYSTEM DESIGN

The smart system consists mainly of a module that acts as the main control for the system design shown in figure 1. The modem controls the 2.1 surround sound system and the extension box. This modem receives the data from the user through a user interface. An android software, programmed to collect the user data, communicates with the modem via Bluetooth.

Figure 1. System Design

The modem controls the data that is sent to the receivers of the speaker and extension box. The speaker requires two inputs one is the audio and the other is the control. Whereas the extension box has one input and that is the control. Once the data has been fed by the user using the android app and sent to the modem, the modem acts as a transmitter and transmits the control and audio for the speaker at 107.9MHz and 2.4GHz respectively. The modem can also simultaneously transmit the control signals to the extension box at 433MHz.

III. CONTROL MODEM

Control modem is designed to be an independent module which consists of transmitters to control the smart extension box and 2.1 surround sound system. These help to control various home appliances in various rooms and to control audio.
The control modem can be placed anywhere in the house provided it is supplied constantly with 5V dc. The input also consists of Audio signals that is transmitted via Aux cable. Audio input can be fed into system from any of the Audio Generating Devices like television, laptops, mobile phones etc.

From the block diagram it is observed that system includes Bluetooth Receiver, Arduino MEGA, Audio transmitter, NRF Transmitter and RF transmitter. Arduino MEGA is the brain of the control modem which helps to control the transmitters. The Audio signal obtained from the audio devices is directly connected to Audio transmitter which modulates at 107.9MHz frequency. To establish connection between the control modem and the speaker, NRF transmitter is used. A 4-bit RF transmitter sends data to control the switching function of the smart extension box. An android application is designed to achieve the controls via Bluetooth. The Bluetooth module used is HC-05. It is designed to create a transparent wireless serial connection setup. The module requires 5V DC power supply. When the command is given from the android application, the data is sent serially using the Bluetooth in Smartphone to Bluetooth interfaced with Arduino in the control modem. The data is processed in Arduino MEGA and is sent to the respective transmitters for controlling the smart extension box and 2.1 surround sound system.

Smart Extension box is a device which has a prominent role of connecting various electrical appliances like computer, speaker, charger etc. It works wirelessly. The extension box consists of four 3 pin sockets, to connect various devices. On the top side of the box, four connecting switches are designed to play the role of connecting MCB to the required parts of the house and can control them. The four connecting switches are placed on the sides of the box. The extension box is designed such that one 3 pin socket and one side connecting switches ON simultaneously. There are 3 main circuits designed to operate at 12V DC. This is obtained by the power circuit which steps down the 230V AC mains to 12V DC. The switches are controlled wirelessly from control modem through radio transmission. It is a smart extension box because a wireless 433MHz transmitter and receiver module is used.
A. RF transmitter & receiver module

The RF based wireless remote-control system of 433MHz frequency which uses ASK modulation technique is used for establishing connection. In order to implement the wireless transmitter and receiver communication system [1], a HT12E encoder and HT12D decoder ICs are used. In transmitter module the encoder HT12E IC converts 4-bit parallel input to 4-bit serial output that are connected to a transistor which pulls the signal down to ground. This serial data is sent to RF transmitter for transmission. The RF receiver receives the serial data and sends it to HT12D decoder IC which converts it into 4-bit parallel data. The switching characteristics of the required socket and connecting switches, according to the data received from the receiver is done by the relay module which is controlled by the control module. The antenna length in the receiver is calculated as follows: Formula for Wavelength

\[ \lambda = \frac{C}{F} = 69.284 \text{m} \quad (1) \]

Where,
C = Speed of Light.
F = frequency of the wave.

Formula for length of Helical Antenna,

\[ L = \frac{\lambda}{4} = 69.2844 = 17.32 \text{cm} \quad (2) \]

V. CONTROL MODULE

Control module plays an important role in switching on the sockets by controlling the data. ATMEGA328P is the brain of the control module. The data from the receiver is given to ATMEGA328P which buffers it to the relay module. According to the parallel input data from the receiver the switching of the relays happens. Also, it controls the 4 RG LEDs in the extension box indicating the state of switches.

VI. RELAY MODULE

Relays are used to control the switches electronically or electromechanically. Control module sends data to the relay module which controls all the sockets and switches. 12V supply is given to relay module from DC supply. Once the relay module is switched ON, it provides the power path for the two relays to be switched ON simultaneously where one of the relay is used to switch on the socket and other one to switch on the connecting switches.
VII. 2.1 SURROUND SOUND SYSTEM

2.1 surround sound system defines a home entertainment system should be like in a modern form, function and design. The speaker has left, right speaker drivers and one subwoofer hence named as 2.1 surround sound system. The speaker consists of custom developed circuits such as Crossover [2], Amplifier circuits and Supply drivers tuned to perfection and maximum processing power for the latest audio technologies.

![Figure 7. Block diagram of 2.1 surround sound system](image)

2.1 surround system consists of two high frequency channels (left and right speaker drives) and one takes in low frequency channel (subwoofer). Separating frequencies is achieved by using a crossover circuit [2]. The audio signal is wirelessly transmitted using audio transmitter which is tuned to 107.9 MHz frequency. This is received by an audio receiver which uses phase locked loop method to acquire the original signal. This signal is fed into a crossover circuit. Audio crossovers are a type of electronic filter circuitry used in a range of audio applications, to split an audio signal into two or more frequency ranges. Crossovers are made entirely of passive components which splits the incoming stereo audio signal to 3 parts. The left channel, right channel and a center subwoofer channel. Each channel has a second order low or high pass filter. After which it is fed into Audio amplifier.

A. Audio amplifier

Audio amplifier is an electronic device which basically increases the strength or amplitude of the audio signal that passes through it. An audio amplifier amplifies low-power audio signals to a level which is suitable for driving loudspeakers. To achieve this specification an amplifier of 75W, which is TDA7294 is used. The IC TDA7294 is a 100W Class D audio amplifier supporting a wide range of operating voltage, and it can power both 4 ohms and 8-ohm speaker driver. The values of the resistance and capacitance in crossover circuits is given as.

\[ fc = \frac{1}{2\pi \tau} = \frac{1}{2\pi RC} \]  

\[ fc = 338.63 \text{ Hz (340Hz approx.)} \]

B. Speaker control

The speaker control module, plays an important role in controlling the speaker. This control circuit consists of an NRF receiver module and an Arduino Nano. This module is responsible to control the performance of the Speaker and the RGB LED lights. The NRF transmitter sends the controls at 2.4 GHz to Arduino Nano. The function of the microprocessor, is to process the incoming data package so as to feed the other two driver circuits. The NRF Receiver, has four control signals which among them one controls the speaker power and other three controls the RGB led color code lights.

VIII. RESULT AND ANALYSIS

The time delay analysis of the smart extension box was done using Arduino clock of 16MHz frequency. The time taken for the socket to switch on after receiving the input from the transmitter has been recorded in micro second and millisecond to get the accurate average time delay. The average obtained was 332ms and 321ms respectively.

![Figure 8. Analysis of Smart Extension Box](image)

Cost Analysis:

- Current consumed = 0.15mA
- Total voltage = 230V AC
- Power = Current * Voltage = 0.15m * 230 = 0.034 W
Power consumed per month =
0.034W * 24 hrs. * 30 days = 24.48 Whr.
cost per unit = 9,
Total consumed units = 24.48/1000 = 0.02448
cost for 0.02448 units = 0.02448*9
Therefore, Rs 0.22032 per month.
Rs 2.6 per year.

The result analysis of speaker is shown below. Figure 9 shows voltage v/s frequency graph. From this graph, the frequency response of left, right and subwoofer speakers in volts. By varying the frequency, different voltage values have been recorded for left, right and subwoofer. Cutoff frequency is seen approximately at 350 Hz.

Cost analysis:
Current consumed = 100mA
Total voltage = 230V AC
Power = Current * Voltage = 100m*230= 23 W
Power consumed per month =
23W*24 hrs.* 30 days = 16560 Whr
Total consumed units = 16560/1000 = 16.56

cost per unit = 9

cost for 16.56 units = 16.56*9 = 149.04
Therefore, Rs 149.04 per month
Rs 1788.48 per year

IX. CONCLUSION

The proposed system finds its application in wireless communication with implementation of smart portable technology which includes the Smart extension box and 2.1 surround sound system. Controlling specific parts at home with an automated system using Bluetooth, Arduino mega and android application is discussed in this paper. The Smart extension box proves helpful when it comes to use in electric gadgets and appliances when they are connected far away. As it is wireless it provides ease and convenience in use. It gives freedom to control all the rooms in the house using the side connecting switches if connected to the main MCB board. The objective of playing audio tracks wirelessly using audio transmitter and receiver module at a distance of 25-30m within a house is achieved using 2.1 sound system. User can place it anywhere he wants and control it using his Smartphone. With the help of Bluetooth, the motive of controlling the home appliances using a Smartphone is achieved. The key advantage is that this system can be installed/uninstalled easily providing the user with freedom of choice whether to use the automated technology or the traditional method.

REFERENCES