Low Cost Energy Efficient Remotely Controlled Smart Home Security System

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Abstract: The paper aims to develop a low cost, energy efficient smart home by integrating technologies like RFID, IR sensing, clap switches, GSM and DTMF to remotely control the electrical appliances. This paper also aims to provide security to the user by identifying unexpected access to the room and alerting the home's occupants. With this system, owner of the house can remotely track and control the status of electrical appliances using GSM module when he is out of the home. Clap control system is there to control appliances just using clap when someone is inside the room. We have used two IR sensors to detect whether any person is present in the room or not, thus adding extra security to the system at very low cost. Apart from all the necessary power supplies required for operation of the whole system, we have used an extra 9 volt battery which will be used during power failure.

Keywords: Smart home; low cost; energy efficient; remotely control; security.

1 INTRODUCTION

Electrical power crisis is now-a-days becoming a big threat for the whole world. But many of us are not that much aware of saving electricity at our home. We often forget to switch off our home appliances when we go out. So we have to either come back to home to switch off the appliances or leave it switched on which causes wastage of money and time [1]. This kind of scenario can be avoided if we opt for technological solutions which will automatically serve this purpose. This situation paves the path for smart home technology. A smart home or e-Home is such a house that integrates many technologies to produce a highly advanced system that can help the user to monitor and control various electrical appliances remotely as well as centrally. Thus smart homes use 'home automation' technologies to provide home owners with 'intelligent' feedback and information by monitoring many aspects of a home and carrying out various functions depending on the feedback provided the user. Apart from remote monitoring, a smart home must be capable of providing necessary security to the users by identifying unexpected

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access to the room and alerting the home's occupants.

The system developed by us is highly cost efficient because we have replaced IoT with GSM module and DTMF. The GSM and the DTMF module are used to remotely communicate with the system and control without using a dedicated server. Here we do not need a dedicated mobile application to control the devices. Further, low cost GSM mobile phone will be enough for operation.

All the power calculations are done in normalized (R=1) manner.

Power dissipation from GSM module =1.6 W [2] and under sleep mode it consumes 1 mW. [2] Power dissipation from IR sensor module =150 mW [3]

Power dissipation from DTMF module = 35 mW [4]
Power dissipation from 555 timer = 20.25 W [5]
Power dissipation from Microphone = 1.5 W [6]

So, total power consumption per second is very very less. Thus our research deals with developing a energy effective smart home.

Our research consists of 5 modules according to Figure 1:

- Central controlling unit;
- Monitoring unit;
- Device and appliance interface;
- Communication system
- User feedback module.

The central controlling unit consists of three microcontrollers (89c51), which receives input from remaining modules and control the whole system.

The monitoring unit consists of a RFID reader module which communicates with RFID tags. Whenever a RFID tag is detected by the RFID reader module, it indicates the presence of the main user in the room, who can operate the electrical appliances using a clap switch. Two IR sensors are included in the system to calculate the number of members present in the room. These IR sensors also provide security against burglary.

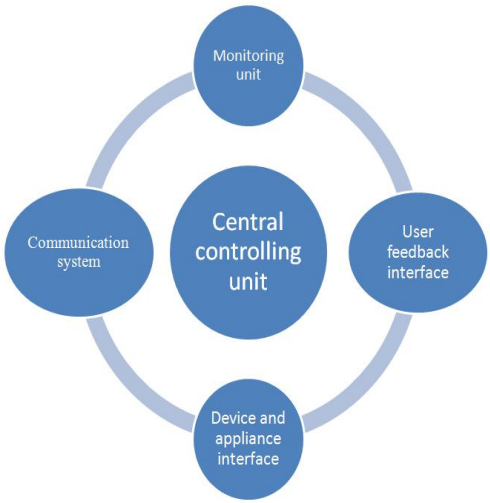

Fig. 1. System module.

The device and appliance interface system is made up of clap switches which helps to control the electrical devices centrally.

The communication system consists of a GSM module which gets activated if no members are present in the room and the electrical appliances are still working. The GSM module informs the user about the situation.

The user feedback system consists of DTMF module, which allows the user to remotely control the electrical appliances

The complete block diagram is as shown in the Figure 3. The hardware architecture of the system includes three microcontrollers, one RFID reader module, one GSM module, one DTMF decoder, one GSM phone, two IR sensors, one 555 timer, one microphone condenser and lastly four relays connecting to four electrical appliances which are to be controlled by the whole system. 5 volt or 9 volt dc regulated power supply will be enough for the working of the whole systems as micro-controller works on 5 volt supply where as relays are operated by 9 volt power supply.

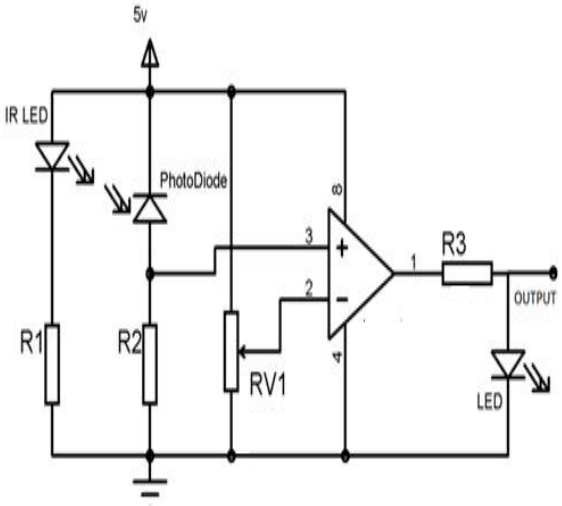

Fig. 2. Circuit diagram for ir interfacing. The clap control gets activated if Microcontroller2 receives a digital strobe signal momentarily at its pin2 indicating that the RFID tag has been placed in the RFID reader module.

2. HARDWARE ARCHITECTURE

One RFID reader module is interfaced with one of the microcontroller. RFID (Radio-frequency identification and detection) reader is a device which is used to communicate with RFID tags by receiving signals from the RFID tags. The RFID reader module is a wireless transceiver- a device which can receive and transmits signals simultaneously. Another important part of the RFID module is the passive RFID tag, also called transponder- device which receives radio waves and transmits different data or signal. It has no

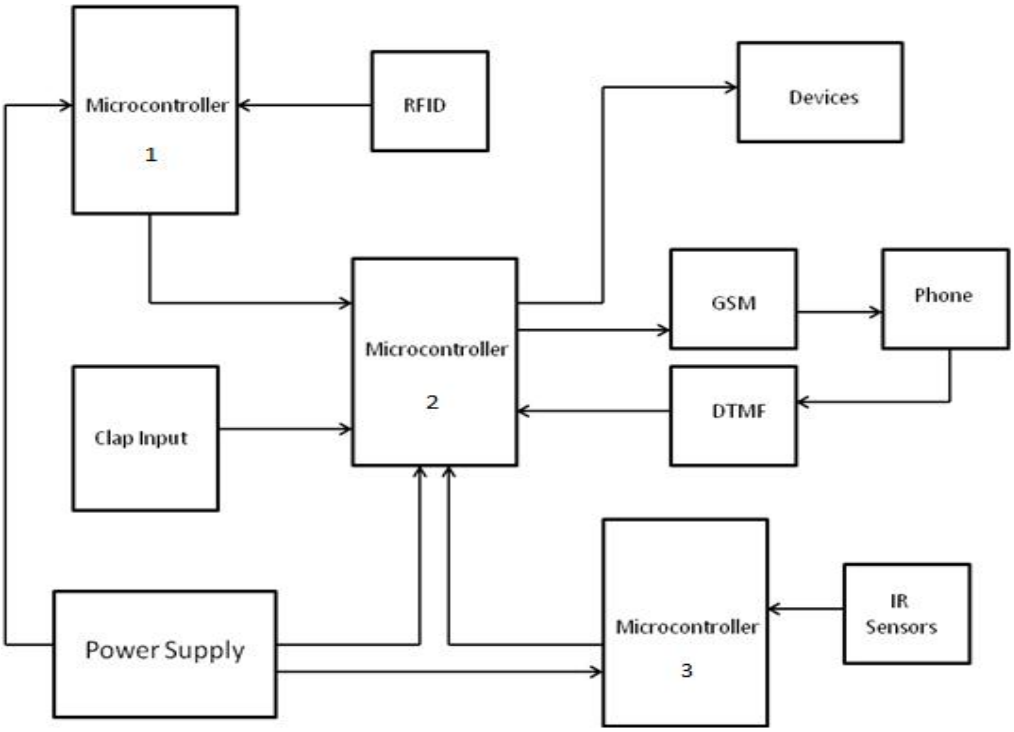

Fig. 3. Block diagram.

direct power source. The tags draw power, by electromagnetic induction, from the RFID reader, which sends out electromagnetic RF waves that induce a current in the tag's antenna. So whenever a tag enters into the range of RF field created by reader, the tag gets energized and a unique serial ID is transmitted by the tag's antenna to the RFID reader. This unique ID is transmitted by the RFID reader module to the microcontroller. Upon identification of the unique ID, the microcontroller sends a strobe signal to Microcontroller2 momentarily. This indicates the presence of the main user.

Another microcontroller is used in this system for IR sensor interfacing. These IR sensors are developed according to Figure 2. An IR sensor is an electronic device which is used to sense objects. An IR sensor can detects any motion by detecting the IR waves emitted by our bodies. These sensors are used to measure IR radiation only. All objects generate different form of thermal radiation. These kinds of radiations are not observable to our eyes, but can be sensed by an IR sensor. An IR sensor consists of an infrared LED emitting IR waves and an IR photodiode which is sensitive to infrared light of the same wavelength as the one produced by the infrared LED. When infrared light drops on the photodiode, the resistances and output voltage change in proportion to the received magnitude of the infrared light. When an object is near IR radiations emitted by the IR LED strikes the object, then turn back with some angle. These IR radiations are detected by the photodiodes, thereby detecting the object.

Two IR sensors, interfaced with the microcontroller, are used for counting the number of people moving in or out of the room. Microcontroller3 sends a strobe signal Microcontroller2 if the counter value is not equal to zero.

Clap switch consists of a microphone condenser and one 555 timer operating in mono-stable mode as shown in Figure 4. The microphone condenser converts clap sound obtained as the input to electrical impulses. Upon receiving the electrical signal from the microphone, the 555 timer generates a digital HIGH signal momentarily, which is converted to logic LOW by an inverter (as

Fig. 3. Block diagram.

the microcontroller works with LOW signals) and is fed to Microcontroller2. This strobe signal indicates that a clap has been obtained as input. After receiving the first strobe pulse from the 555 timer, the microcontroller continuously checks for any further input from the 555 timer for 15 seconds time interval. During this 15 second interval the microcontroller counts the number of pulses it received and increments a counter. Depending upon the counter value, status of four electrical appliances which are connected to Microcontroller2 via relays, are changed (ON/OFF will be OFF/ON i.e their electrical state is toggled).

Now depending on signals on the pin1 and pin2 of Microcontroller2 we have 2 cases:

Case1: pin1 is HIGH; pin2 is HIGH-

Indicating the presence of RFID tag in the RFID reader module and presence of people in the room. The Microcontroller2 continuously checks for strobe signal from 555 Timer indicating clap inputs. Now depending on the number of claps, status of all electrical appliances connected with Microcontroller2 via relays will be changed.

Case 2: pin1 becomes momentarily LOW and pin2 is HIGH

Indicating that the RFID tag has been removed but there are people present in the room. Hence the Microcontroller2 continuously checks for a strobe signal from microcontroller3, indicating that the room is empty. Until and unless a strobe signal is received the clap portion remains activated. Once a strobe signal is received, the microcontroller2 sends the last status of each electrical appliance to the user via a GSM module. Now the user can remotely control various electrical appliances using DTMF decoding.

GSM module is used here because of its fast data transmission rate and wide spectrum application [7]. GSM module is always connected to power supply and it is used to remotely communicate with the user.

The architecture of GSM consists of many sections out of which one section can be used to send SMS to any GSM phone. As soon as the GSM module gets activated, Microcontroller2 reads status of each electrical appliance connected to the microcontroller via relays. It sends the status of all appliances by the SMS section of GSM to user's phone. The user can now observe the status of electrical appliances present in a room and control from anywhere in the world by using DTMF decoding. To control the devices from a remote location, the user needs to call the number provided in the GSM module and press a number on his phone keypad. The caller thus generates a dial tone consisting of two frequencies. This dial tone is transmitted over the communication line and is decoded by the DTMF decoder into digital code and is fed to the Microcontroller2. Each digital code [8] corresponds to a particular number which can be used to control electrical appliances.

3 CONCLUSION

The CLAP controlled automatic switching systems are very cheap compared to other automation techniques. Clap control system is blessings for physically disabled person or any older person as they do not need to walk to the switch-board to turn on a fan or a light. They just can use claps to control the appliances.

On addition, this system provides security to the user by identifying unexpected access to the room and alerting the home's occupants timely.

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