Home Automation System with GSM Support

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1 Introduction

Home automation system in simple terms refers to automation of day to day appliances that is used in homes. Automation of homes can be divided into two broad categories:

1. Controlling
2. Monitoring

Home automation is achieved through either monitoring or controlling. In our project we try to cover both monitoring and controlling and a combination of both.

Home automation satisfies the resident's needs and desires by making it more convenient to adjust or control attributes such as lighting, temperature, entertainment systems, and other electrical as well as non-electrical appliances. In addition to that, home automation may also include safety and security of residents.

Home automation can be really advanced and might allow the residents to control certain parameters in numerous different ways such as gesture recognition, or sensors or voice commands and so on. Nonetheless, all these technologies favor in comfort of the residents.

We aim to perform microcontroller based home automation with the help of wired sensor technology. In our home automation system, devices will get triggered automatically based on certain conditions so that the resident won't have to manually control them.

2 Objectives

The fundamental objective of this project is to gain a more comprehensible knowledge about real-time applications of several electronic components along with a few sensing devices and also to acquire proper idea about interfacing a micro-controller with various electronic components.

Specific objectives of our project are as follows:

1. Automatic Light Switching based on Visitor Count

   To switch the lights of a room off by counting the number of people in the room. If the visitors in a room are 0, the system will switch off the lights after a minimum time period has elapsed.

2. Home Security System

   This includes detection and hopefully prevention of possible fire accidents. Detect leakage of LPG gas and notify the user in via. mobile networking.

3. Touchless Automated Trash Can

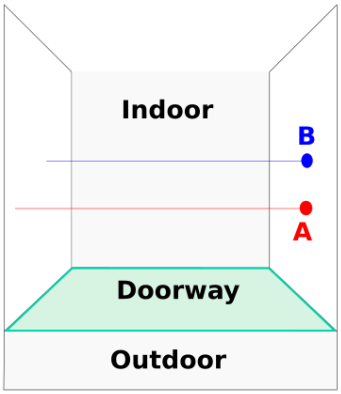
   Design a system such that whenever a motion is detected within the range of the sensor it opens the lid of the trash can automatically and the lid remains open as long as the sensor detects motion.

3 Method and Materials

3.1 Automatic Light Switching based on Visitor Count

The main component used for automatic light switching is Ultrasonic Sensor. The ultrasonic sensor is used to reckon the number of person entering and exiting a room and determine the number of visitors.

The fundamental principle behind people counter is that two separate US sensors are placed at the front and rear of the doorway such that one sensor is proximal to the indoor and the other is proximal to the outdoor as show in the following diagram:

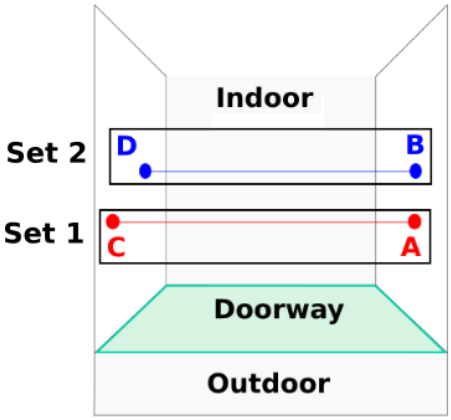


Suppose a sensor A, is placed at the front and another sensor B is placed at the rear of the doorway so that when a person enters the room, sensor A gets triggered first and only then sensor B gets triggered. As a result, the time at which the transmitted signal reflects back will be less for sensor A and it implies that a person just entered the room. Conversely, when a person leaves the room, sensor B gets triggered first, and sensor A gets triggered second which implies that a person just left the room.

One major flaw of this system is that even if more than one people enter a room simultaneously the sensors are only able to interpret them as a single person. So in order to overcome this limitation, we use four ultrasonic sensors in sets of 2 instead of just 2 sensors.

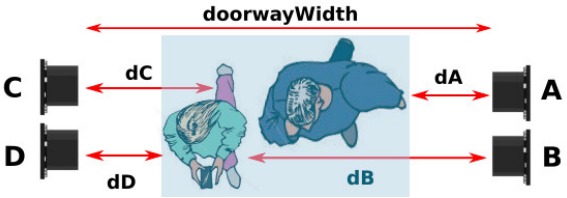
This four sensor arrangement will also have contribution in improving the accuracy of the system. Since width of most doorways are not that large, sensors from either set may get triggered at the exact same time. In such cases, having an extra sensor will help to reduce or completely eliminate errors in counting.

Here is a schematic representation of arrangement with four sensors:



As illustrated earlier, set 1 will be placed at front of the doorway and set 2 will be placed at the rear end of the doorway to determine whether a person is exiting or entering.

The logic behind using 4 sensors for estimating the number of people walking past the doorway is fairly simple. First we calculate an approximate width of the obstacle in the doorway as follows:




```
obstacleWidth = doorwayWidth -
        (min(dA,dC) + min(dB,dD));
```

This "obstacleWidth" can be then compared with a standard value to predict the possible number of people walking past the doorway.

3.1.1 Algorithm

Step 1: Collect data from the sensor

- Time values tA, tC, tB and tD are the time-stamps at which the respective sensors detects the transmitted sound wave after it reflects back.
- Distance dA, dC, dB, dD are more or less the length of the pulse transmitted from the respective sensors and are proportional to tA, tC, tB and tD respectively.

Step 2: Count the number of visitors inside the room based on data obtained from the sensors

```
obstacleWidth = doorwayWidth - (min(dA,dC) + min(dB,dD));

if (tA < tB || tA < tD || tC < tB || tC < tD)

    if (obstacleWidth > certainStandardValue)
        visitorCount = visitorCount + estimatedPeopleEntering;
      else
        visitorCount++; // at least one person entered

else if (tB < tA || tB < tC || tD < tA || tD < tC)

    if (obstacleWidth > certainStandardValue)
        visitorCount = visitorCount - estimatedPeopleExiting;
      else
        visitorCount--;
```

Step 3: Turn the lights off if there is no one inside the room.

```
    if visitorCount == 0 && lightON {
        delay();
        turnOffLights();
      }
```

3.2 Home Security System

Under home security system, our primary goal is to notify the home about possible leakage of flammable LPG gas via. mobile networking. This security system serves the sole purpose of notifying the user about possible fire accidents so that the owner can take necessary actions to prevent them. In a way, this makes our home just a bit more secure.

For the sake of this, first we need to determine whether there is a gas leakage. A gas sensor is a device which detects the presence or concentration of gases in the atmosphere. Based on the concentration of the gas, the sensor produces a corresponding potential difference by changing the resistance of the material inside the sensor, which can be measured as the output voltage.

Basically, the sensor is designed in such a fashion that whenever it detects presence of flammable gas in the air, it gets triggered. The concentration of LPG gas detected won't matter as much because in normal air its concentration is usually 0. Once the sensor has been triggered, it sends a signal to the microcontroller unit.

The second part of this design, is notifying the user about the leakage that has just been detected. This is done via. mobile networking. A GSM module is interfaced with the microcontroller such that it broadcasts a predefined message to user in the form of an SMS as an alert signal about the leakage on his/her cell phone.

3.2.1 Algorithm

Step 1: Acquire a signal form the sensor.

Step 2: If the leakage is detected notify the user via SMS.

```
if (leakageSensorSignalHigh)
    broadcastSMS();
else
    noop; // no operation
```

3.3 Touchless Automatic Trash Can

The concept of a touchless automatic trash can is also pretty much straightforward. The first thing that we require is a trash can with a LID whose lid opens when a foot is placed at the bottom of the trash can. Now, a PIR sensor is placed at face of this trash can to detect movement. A servo-motor is placed at the bottom of the trash can just beside the part where placing a foot would open the trash can.

The PIR sensor detects motion by evaluating fluctuations in the amount of infrared radiation within a certain range of its proximity. The infrared radiation impinging upon the PIR sensor varies with respect to temperature and surface characteristics of the objects right in front of it.

Living creatures emit certain heat energy in the form of infrared radiation when they move. Therefore, when someone appears in front of the sensing element or when ever someone comes within the sensor's range, the sensor will detect a motion by sensing fluctuations in temperature or the amount of IR radiation in that region. The sensor converts the resulting change in infrared radiation into a change in the output voltage, and transmits it to the controlling unit. When the microcontroller receives such signal from the PIR sensor, it will deploy a output signal of certain magnitude, which sets the servo motor interfaced with in into motion, allowing the trash can's lid to open automatically.

Finally, if the person in front of the sensor moves away, the parameters around the environment will get restored and the sensor will stop transmitting a signal to the controller.

3.3.1 Algorithm

Step 1: Acquire a signal form the sensor.

Step 2: Send a pulse to the external circuit to turn the server motor if the signal from the sensor is high.

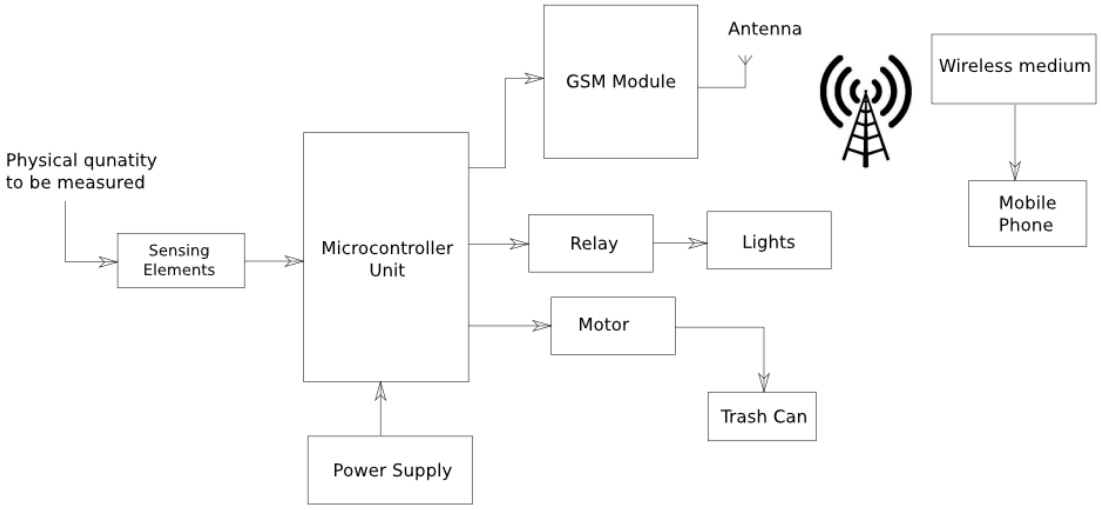
```
if (motionSensorSignalHigh)
    transmitSignalToPowerMotor();
```

Step 3: The trash can has an auto closing mechanism so there is no need to perform anything to close the lid. If the sensor signal is low simply halt the signal from the controller so that the servo motor turns off.

```
if (motionSensorSignalLow)
    stopSignalPoweringMotor();
```

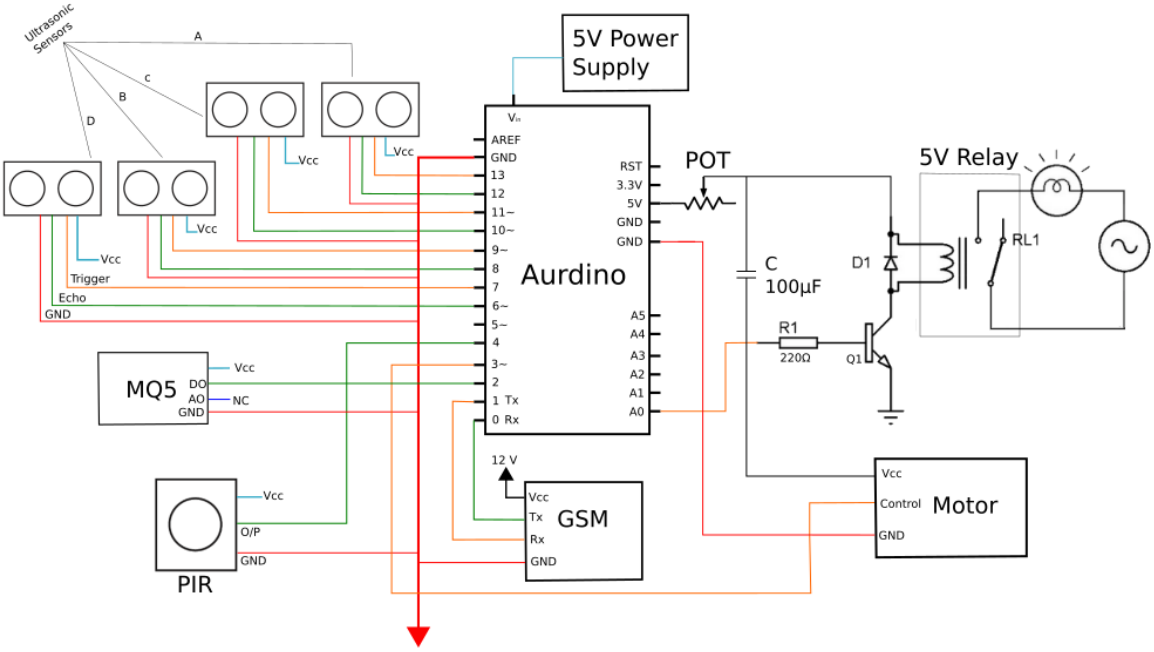
4 Block-diagram and Overall Circuitry

Block-diagram of the proposed system:



As seen in the block diagram the micro-controller will be the heart of the system.

A schematic circuit representation of the system is as follows:



5 Expected Outcome

We expect the following outcomes on completion of our project:

1. With the help of ultrasonic sensors we hope to achieve the number of visitors inside a room with at least 90% accuracy. And based on that visitor count, we have anticipated that the lights will get automatically turned off after a certain delay when all the number of visitors inside the room is zero.
2. We have expected our GSM based home security system to broadcast an SMS to the mobile phone of the dweller, whenever there is an LPG has leakage so as to alert the leakage situation and help the person take preventive measures.
3. The touchless trash can is designed such that we expect its lid to automatically open when the sensor detects the motion in its periphery or within its range.

6 Conclusion Of the Synopsis

In conclusion, an Arduino UNO based home automation system will be designed. The mechanism with which we aim to achieve this system are only explained in brief and design considerations have not been explicitly highlighted hereby this synopsis. We hope to receive further guidance and help from the project supervisor on that part of the project.

Furthermore, since a general idea of what mechanisms will be used for our system design has been mentioned, we would also like to reflect on the materials or components that we will require for completion of this project.

The necessary materials are listed in the table below:

S.N.	Equipment	Model	Quantity
1	Microcontroller	Arduino UNO	1
2	Ultrasonic Sensors	HC-SR04 or any other	4
3	LPG Gas Sensor	MP5 or MP6	1
4	Passive IR Sensor	HC-SR501 or any other	1
5	5V Relay Module	–	1
6	GSM module	GSM800A SimCom with antenna	1
7	Servo Motor	Recommendation required	1

Beside these equipments, different types of wires and cables along with other minor circuit components such as resistors, potentiometer, capacitors, power supplies and batteries, and a generic bread board is also required. If possible a trash can with lid should also be provided.

Finally, suggestions for improvisation and optimization of the system will be highly appreciated.