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Inspiring Excellence

Intelligent Home

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DECLARATION

We hereby declare that this thesis report is based on the findings from experiments conducted by ourselves. Results and experiments of other researchers are mentioned in the reference. To our knowledge, this thesis, neither in whole nor in part, has been previously submitted for any degree.

We also declare that all the authors made equal contribution for the completion of this paper.

Signature of Supervisor

Signature of Authors

ACKNOWLEDGEMENT

Firstly, we would like to thank the Almighty. Then we would like to thank our parents for their unconditional support, without which we could not have come this far.

Secondly, and most importantly, we would like to express our gratitude and sincere thanks to our supervisor DR. MD. KHALILUR RHAMAN. We would like to thank him for his supervision of our work. We are in debt to him for his support and guidance with his vision about the future of automation. We feel privileged to have known him for he is a man with a vision.

Next, we would like to thank Shifur Rahman Shakil, Research Assistant to Khalil Sir, for his help with knowledge about electronic equipment, ICs, sensors, etc.

Lastly, we would like to say thanks to our friends Maisun Ibn Monowar, Duke Joseph Mondol and Ahmad Tausif Choudhury for their help, support and appreciation.

ABSTRACT

As of 2011, the electricity consumption per capita of Bangladesh is 258.62, according to the World Bank[1], whereas the consumption per capita were 228.68 and 251.63 in 2008 and 2009 respectively. Which means that this figure is increasing every year. Which, in turn, means that we are spending a lot of money to pay our electricity bills and soon will be spending a lot more. If we do not take steps to save energy, not only will our electricity bill rise sky high, but the limited resources of nonrenewable energy will also expire before we know it. Almost all of us keep the tap running while brushing our teeth; most of us forget to turn off the lights and fans before leaving our rooms. No one does any of this intentionally, but that is no excuse to waste energy. The home automation system is such a technology that can help us save energy. It has such interfaces so as to automatically turn the lights and fans on or off as we enter or leave a room; turns the tap on only when we need it to, and turns it off when we are done. Our goal is to come up with a home automation system that may also provide some necessary measurements against accidents at home, like smoke or gas detection in the kitchen, so that the stove gives a signal to turn it off, voice control for the television, etc. Our thesis is based on such a system that will make our lives a lot easier while effectively saving both resources and money.

TABLE OF CONTENT

CHAPTER ONE

1. Introduction

Intelligent Home is a project on home automation. Home automation is a system used to control the basic functions of a house remotely and of course, automatically. The basic factors of a well-designed home automation system is composed of a computer or, in this case, a microcontroller with proper programming, connected with the equipment and devices needed to be controlled and maybe a backup power for the microcontroller [2]. If there are components that need to be controlled remotely, an internet or GSM connection is also required.

Home automation is not a new concept. It has been done many times before. There are many different kinds of home automation. Some are as simple as turning the lights and fans on and off of a room automatically; some are used for security such as triggering an alarm in case of unauthorized entry to the house; others can be as complicated as unlocking the key using face recognition. The purpose of all these are the same: making one's life easier.

In reality, the challenge is to replace the modest switches normally used to turn the lights and fans on and off. That is because they are usually placed in a convenient place of the room which allows the user to turn them on and off quickly, easily and without much effort. So, the home automation system must work through this so that it can provide additional benefits for the users without taking away the integrity and the rationality that a switch defines[3].

Thus, the purpose of home automation should be to make it easier for day to day activities of individuals. Not only that, it should help save money. For a broader perspective, it should help save energy and resources.

This thesis consists of several modules for home automation including bathroom, bedroom, kitchen and living room. These are broken down into smaller parts, called modules, so that they can be implemented easily. The modules are Bedroom module, Bathroom module, Kitchen module, and Living Room Module.

The Bedroom module, has one component part; the Bathroom module, has two component parts: the Basin and the Commode; the Kitchen module, also has two component parts: Temperature Sensing and Gas Sensing; the Living Room module has one component part. They are all discussed in details later in this paper. Theories and structures of the implemented circuits are also discussed in later chapters.

- Chapter Two discusses about the Bedroom Module and its components.
- Chapter Three discusses about the Bathroom module and its components.
- Chapter Four discusses about the Kitchen module and its components
- Chapter Five discusses about the Living Room module and its components.

For all our modules, we used Arduino as our microcontroller.

1.1. Motivation

Home automation makes life easier. Not only it helps save energy, it also helps save time. People do not need to worry about whether they have turned off the switches after they have left home. This concept motivated us to pursue this project as our thesis.

Think of how many times you have you have left home for work and during a traffic signal, you suddenly remember that you have not turned off the light and fan of your room. Everyone else is also either at work or at school. The earliest someone will be home is at 3 pm. Therefore the light will stay on for no reason for at least 6 hours.

Let's say that the light bulb uses 40 watts. So, for six hours, it uses 240 watts. In Bangladesh, the expense for every unit of electricity is BDT 5.19 [4]. One unit means 1 kWh (kilowatt-hour). So, for six hours, you incur a bill of BDT 1.2456. This may not seem significant as an isolated incident, but think about how many times you have done it in a month. Think about how many of your family members have done it in a month. If there are four people in your house, and each of you have done this at least four times in a month, this means in a month your electricity utility bill increases to BDT 19.9296. In a year, it increases to BDT 239.1552.

Now, let's talk about the resources wasted. In Bangladesh, the primary source of electricity is from gas fueled power stations. As of August 2015, it contributed 62.26% of the total power supply[4]. We all know that gas is a natural resource that is being used up very quickly and soon, we will not have enough to run anything, let alone electricity.

Think about how much resource can be saved if you have not forgotten to turn off that light. People make mistakes. It is not possible to remember to always turn the light off. This realization motivated us to work on our bedroom module, which deals with turning off the lights and fans of a room, when nobody is inside it. As mentioned earlier, this will be discussed in details in chapter two.

Water is a scarce resource. Although the earth is filled with 72% of water, the amount people can use is very small and the amount available to drink is smaller still. For this reason people from the western world are astonished when they hear that in urban areas of Bangladesh, people do not have to pay per unit for water. Yet we waste so much of it.

Every morning, when we wash our face, or brush our teeth, we turn the tap on to its highest capacity. We do not just stop there. While brushing our teeth, we keep the tap turned on for the entire time. It takes about thirty seconds to fill up a one Litre bottle. It takes us at least four to five minutes to brush our teeth properly. Which means, roughly, we waste eight to ten Litre every day. In simple terms, we misuse water to a great extent.

Think about how much water we can save if we do not keep the tap running. Thus, to save water in our day to day life we were motivated to work on the Basin part of our Bathroom module, which is discussed in details in chapter three.

Our motivation for the commode part of the Bathroom module came from the idea to avoid awkward situations in toilets. Too often have we entered a public toilet to see that the previous occupant of the toilet did not flush and thus, due to our emergency we need to do the unpleasant work. This role is also reversed, when sometimes we forget to flush and then one of our family member

face that same grotesque situation. Only as they are our family, the may get upset with us and put us in an awkward position.

An easy way out of these cumbersome prospect would be automatic flush, discussed in details, also in chapter three.

The following graph shows the major factors of home fires during 2007 to 20011 in the United States of America [5].

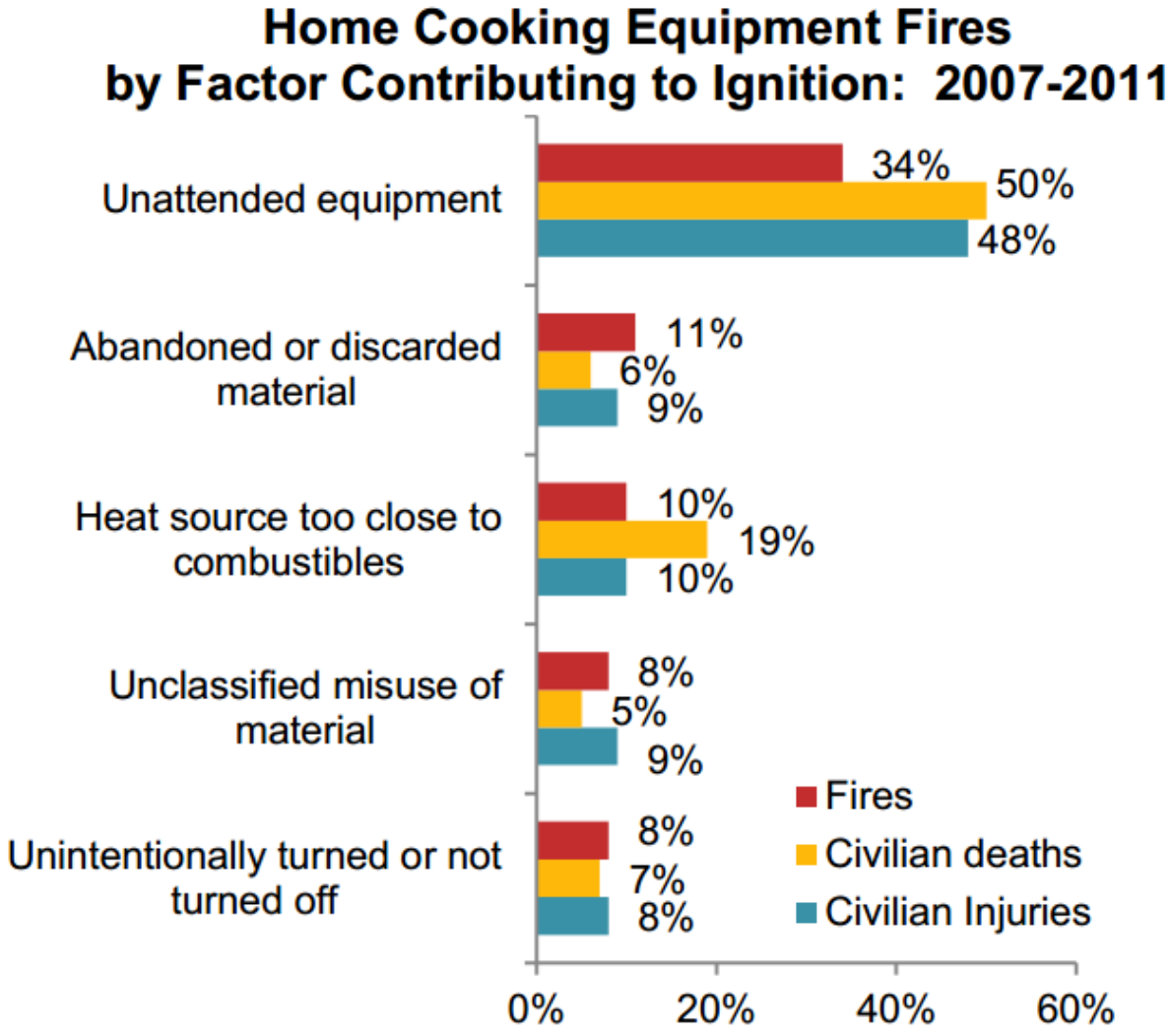


Figure 1.1: Home cooking equipment fires by factors contributing to ignition: 2007-2011[5]

According to the National Fire Protection Association, the leading cause of fire in the United States of America are unattended cooking equipments[5]. This alone contributed to 34% of home fires in USA[5].

This is not so different in Bangladesh. Home cooks often take breaks in between the cooking time to watch television or to read a magazine. Apart from that, it is also not possible to constantly keep an eye on the cooking every time. Whatever the reason, when the cook leaves the cooking unattended for a long time, due to a high rise in temperature, which burns the food and then ultimately leads to a home fire. This was the major motivation for the Temperature Sensing part of our Kitchen module, discussed elaborately in chapter four.

The equipment that was involved in most of the fire is range or cooktop or stove in USA during 2007 to 2011 as shown in the following graph[5]. It is a high as 57% [5].

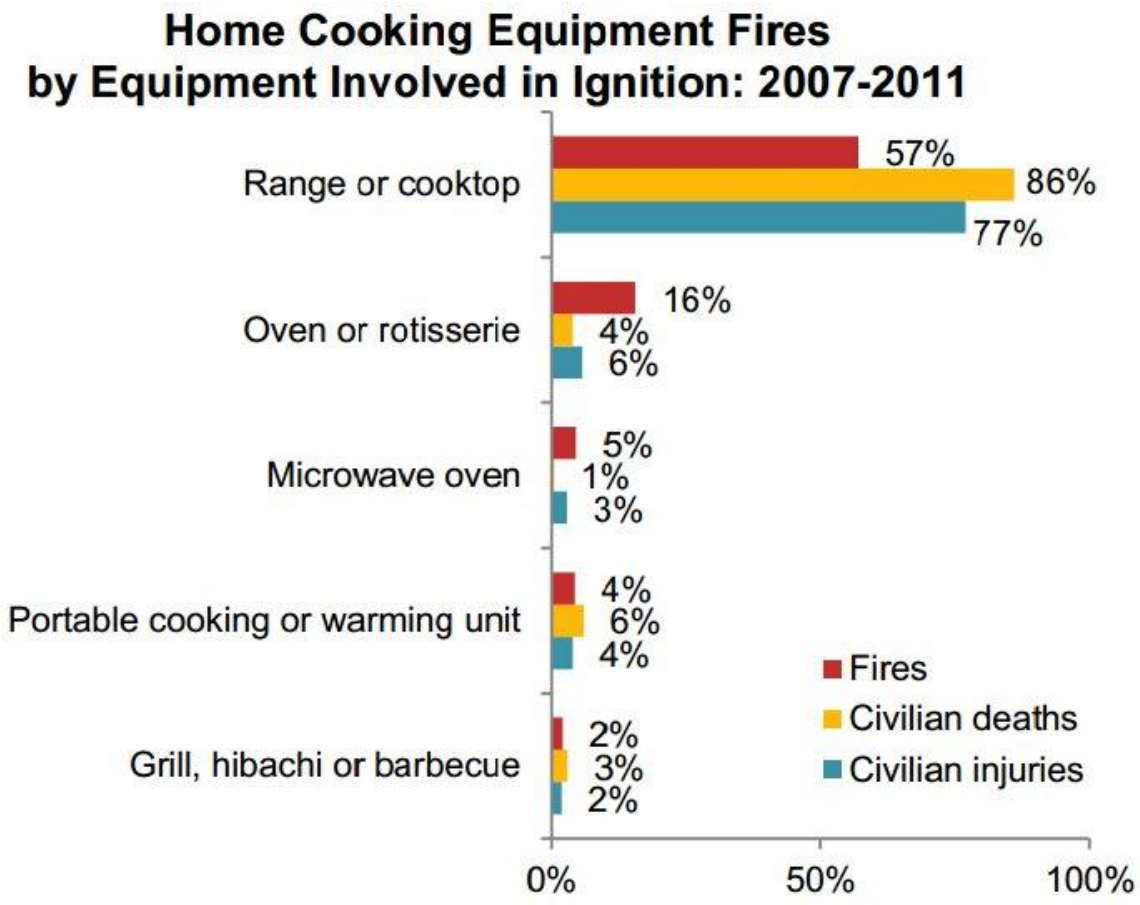


Figure 1.2: Home Cooking Equipment Fires by Equipment Involved in Ignition: 2007-2011[5]

It happens too often that, after a cooking is done, the home cook forgets to turn off the stove, or does not turn it off properly. As a result, a gas leak occurs. Even the slightest spark could therefore lead to a huge combustion. To stop such occurrences, we were motivated to work on the Gas Sensing part of our Kitchen module, elaborately explained in chapter four.

When you want to watch the news at eight, more often than not, you cannot find the remote. When this happens, frustration runs high as you look for the remote. To overcome this obstacle to find the remote and then turn on the TV, we worked on the living room module which controls your TV via voice control. This whole topic is discussed in details in chapter five.

1.2. Literature Review

As mentioned earlier, home automation is not a new concept. Others have worked with it to make life easier. All of our modules also have some versions that have been experimented with by other people.

The Bedroom module is based upon many works. Primarily, it is based upon room visitor counter[6]. Most people work with motion sensors to control the light and fan switches of a room[7], but we chose the visitor counter because it the cheaper alternative.

The best way to control the intensity of light is using LDR[8]. This has been used in many projects and thus, to ensure that the light stays off during daytime, we chose it too[8].

In both parts of the bathroom module, a commonly used proximity sensor is used[9]. It ensures cost effectiveness as well.

Many work has been done to sense temperature. There are many sensors to choose from. People choose the sensors according to their preferences. The DHT11 sensors is very popular amongst users working with Arduino due to is easy to connect features and customized library for Arduino[10]. the data transfer

rate between the Arduino and DHT11 is preferable for most users as well [11].It is also cheap and therefore working with it made perfect sense[12].

Gas sensors are tricky. Although there are a lot of work done with gas sensors, they are mostly expensive. MQ-2 is used due to comparatively cheaper price. Its connection with Arduino is also very simple[13]. The gas sensing components are also very effective and can sense a wide range of gases and can sense even the smallest amount[14][15][16].

The living Room module is primarily based on works done with voice control. This has been done in a lot of projects[17][18][19]. Some of them are mixed together to help us build our Living Room module.

Lastly, for all our modules, we used Arduino. It is the best option for such projects as it is an open source electronic platform[20].

CHAPTER TWO

2. Bedroom Module

2.1. Introduction

On numerous occasions we have all left the light on when we left the room, or just did not care to switch off the ceiling fan. These simple gestures are a reason why we face so many load shedding. Our bedroom module addresses these everyday issues that we disregard so easily. We are calling it bedroom module but it is basically any room module. This is essentially the energy saving part of our project.

In this module we developed a system that controls the electronic equipment i.e. lights and fan automatically upon your presence in the room. If you enter the room the light/ fan turns on and if you leave the room the light/fan turns off automatically. Also if there is day light present inside the room in question then the lights will not turn on at all, thus limiting the wastage of energy during day-time. This way you can be irresponsible but in a responsible way.

2.2. Theory

In this module we have used 2 pairs of IR LEDs to keep a bi-directional visitor counter. When the counter starts the light and Fan of that particular room will get turned on and when the counter reaches zero it will turn off the light and fan. We used an LDR to detect if daylight is present in the room or not.

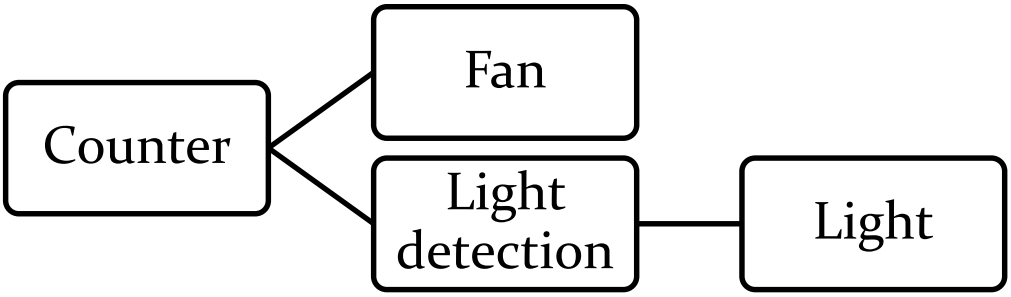


Fig 2.1: Working principle

For the counter, we used IR transmitter and receiver pair as sensor and arduino microcontroller for processing the control algorithm. For light detection we used LDR.

IR Sensors work by using a specific light sensor to detect a select light wavelength in the Infra-Red (IR) spectrum. By using an LED which produces light at the same wavelength as what the sensor is looking for, you can look at the intensity of the received light. When an object is close to the sensor, the light from the LED bounces off the object and into the light sensor. This results in a large jump in the intensity, which can be detected using a threshold.

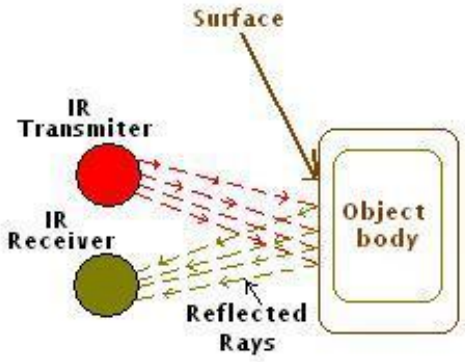


Fig 2.2: IR obstacle detection

By using this obstacle detection theory of IR we developed our visitor counter. We used 2 sets of IR pair to create a bi-directional counter. This counter starts when the IR detects some form of obstacle in front of it. The counter decreases if the obstacle is detected from the other IR pair. The microcontroller determines this orientation of IR (which one should be considered for incoming and which one for outgoing) by setting a delay. When the counter hits zero, the microcontroller switches of the light/fan.

A light dependent resistor or LDR works on the principle of photo conductivity. Photo conductivity is an optical phenomenon. In this phenomenon, the conductivity (or in this case resistivity) reduces when light is absorbed by the substance.

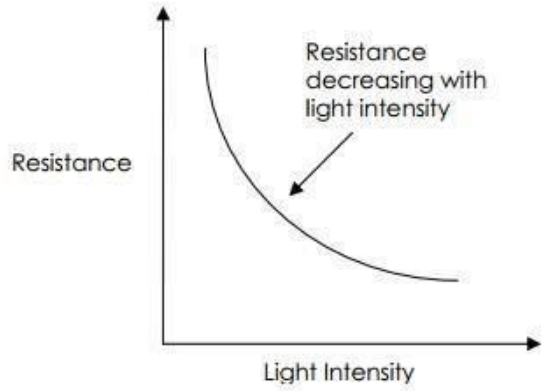


Fig 2.3 Relation between resistivity and light intensity in a LDR

When light falls on a LDR more currents starts flowing which make it seem as though the resistance has decreased. We used this principle for light detection. If the microcontroller sensed a decrease in the voltage in one of its analog pin then it bypasses the whole control algorithm which in turns makes the light to remain switched off no matter what happens inside the room.

2.3. Circuit Diagrams

Basic Circuit for this module consists of 2 pairs of IR receiver and transmitters, Arduino, resistors and jumper wires. We used the built-in LED at digital pin 13 of Arduino for output.

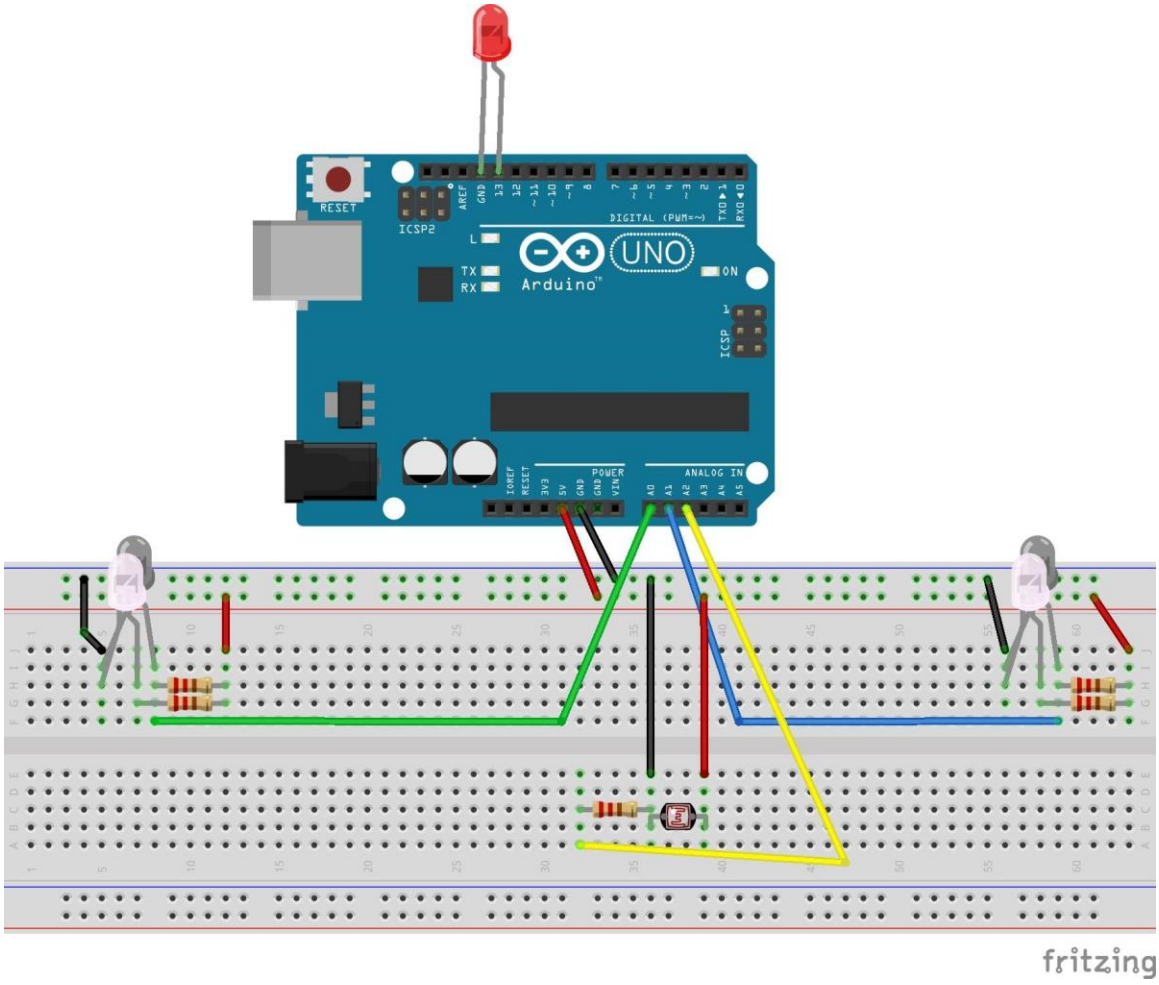


Figure 2.4: Circuit Setup for Bedroom Module

Here the IR receiver/transmitters and LDR is doing the sensing part. Arduino is doing the processing part. And the digital pin 13 is used for output.

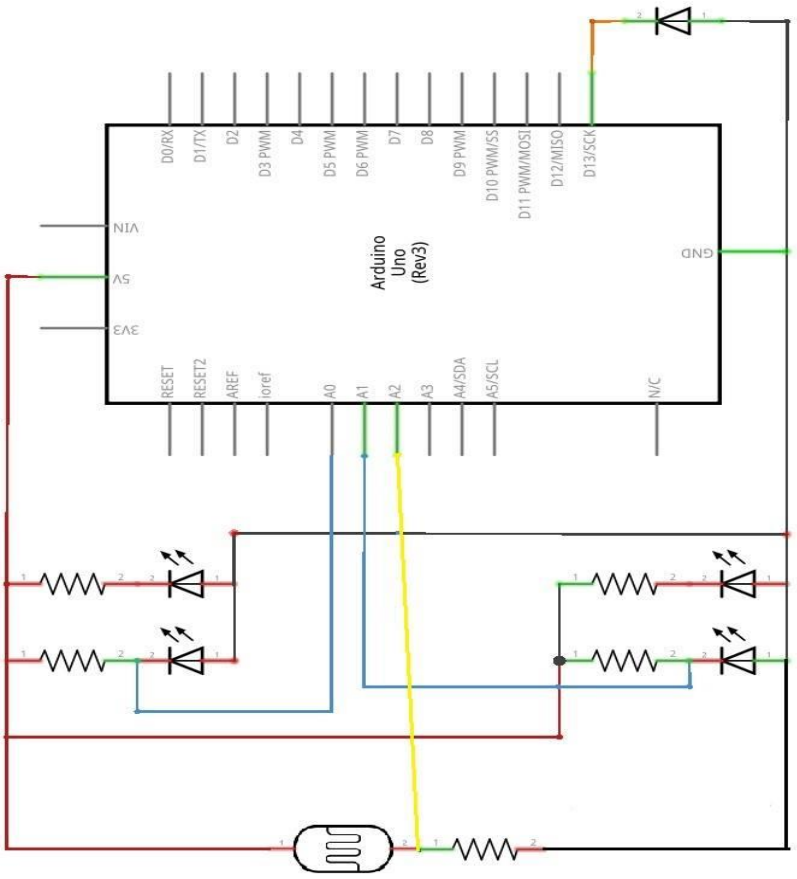
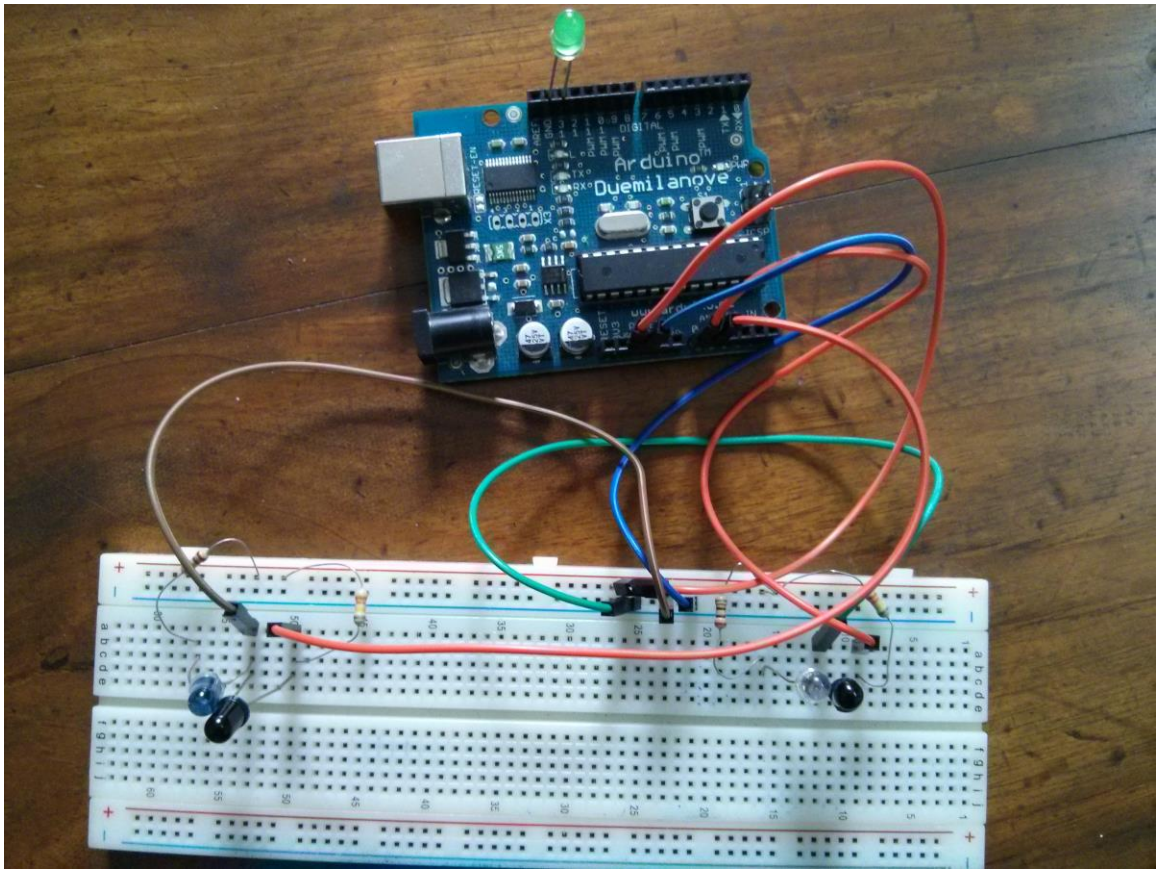


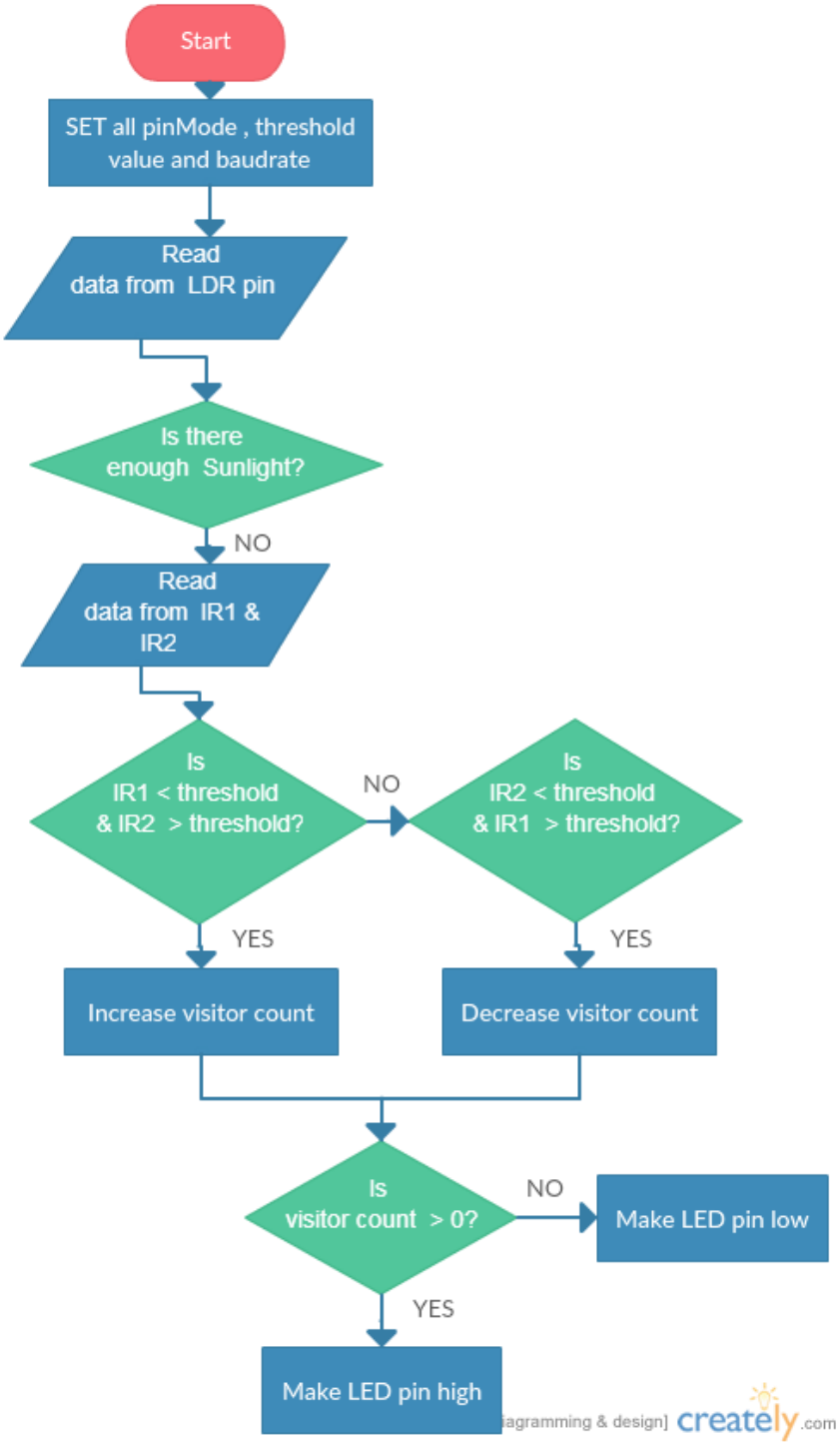
Figure 2.5: Schematic Diagram for Bedroom Module

This figure here shows the inner workings of the circuit. A low amount of resistance (270 ohm) is used before the IR to protect it from burning out. A larger resistance is used to collect the threshold from analog pins (330 Kilo ohm). Same thing is repeated for the LDR.

2.4. Hardware



2.5. Control Algorithm



CHAPTER THREE

3. Bathroom Module

3.1. Introduction

Have you ever wondered how much water you are wasting when you brush your teeth and keep the tap running? Or have you ever thought of how embarrassing it gets when you don't flush the toilet and someone else have to clean your dump? This things we all do but none of us do it intentionally. Whether we intent to do it or not but in the process we waste a lot of water. Our bathroom module addresses this issue.

Bathroom Module is essentially the water saving part of the project. This module controls the water flow as per the user's need. This module consists of two parts,

I. *Basin:* Water flow will be controlled by sensing obstacle under the water tap.
II. *Commode:* Commode will be flushed automatically after every use. It is done by sensing obstacle in front of the commode seat.

The basin module with work on showers too. The commode module is not a water saving part but it is important as much.

3.2. Theory

This module uses the same obstacle detection theory of IR that has been discussed in chapter 2. In this module the IR detects if the obstacle is in a certain range and sends the information to the microcontroller. The microcontroller then controls the water flow accordingly.

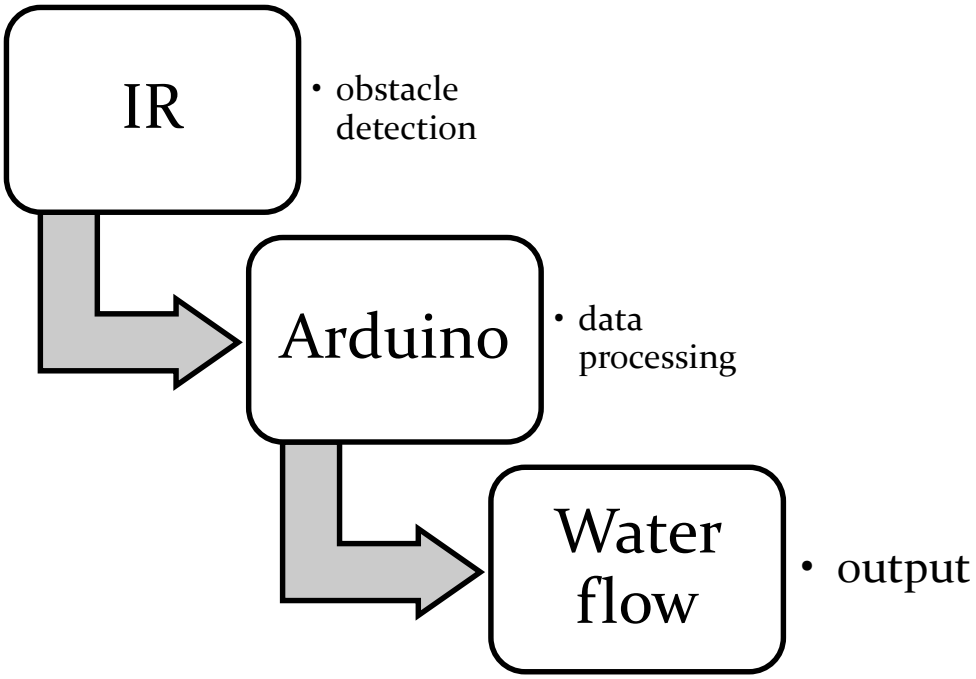


Fig 3.1 working principle

3.3. Circuit Diagrams

Basic Circuit for this module consists of 1 IR receiver and 4 IR transmitters. We used the built-in LED at digital pin 13 of Arduino for output.

The Schematic Diagram for Commode is exactly the same but the control algorithms are different.

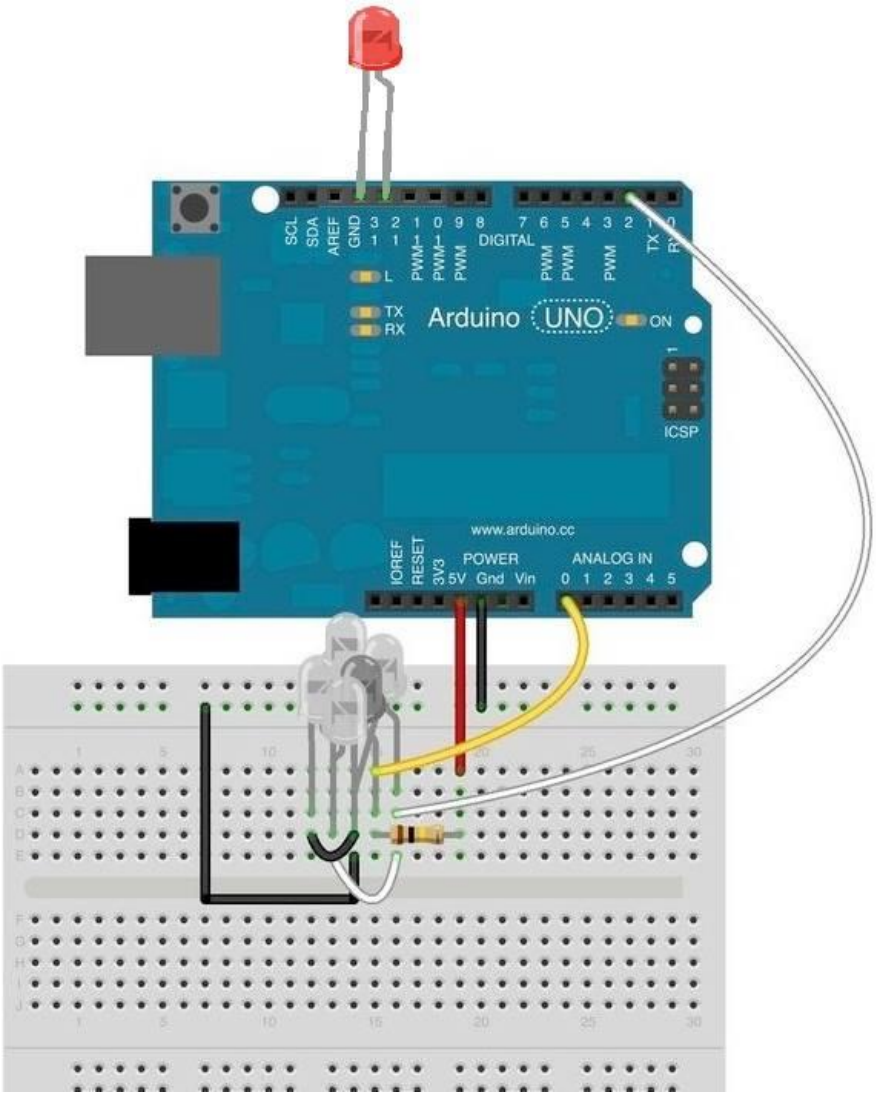


Figure 3.1: Circuit Setup for Bathroom Module (Basin and Commode)

Here we used 4 IR LED to ensure maximum range and to centralize the coverage zone around the receiver. A 330k resistor is used with the receiver for collecting the threshold. Within a certain limit, the larger is this resistor, the more range can be ensured from this setup.

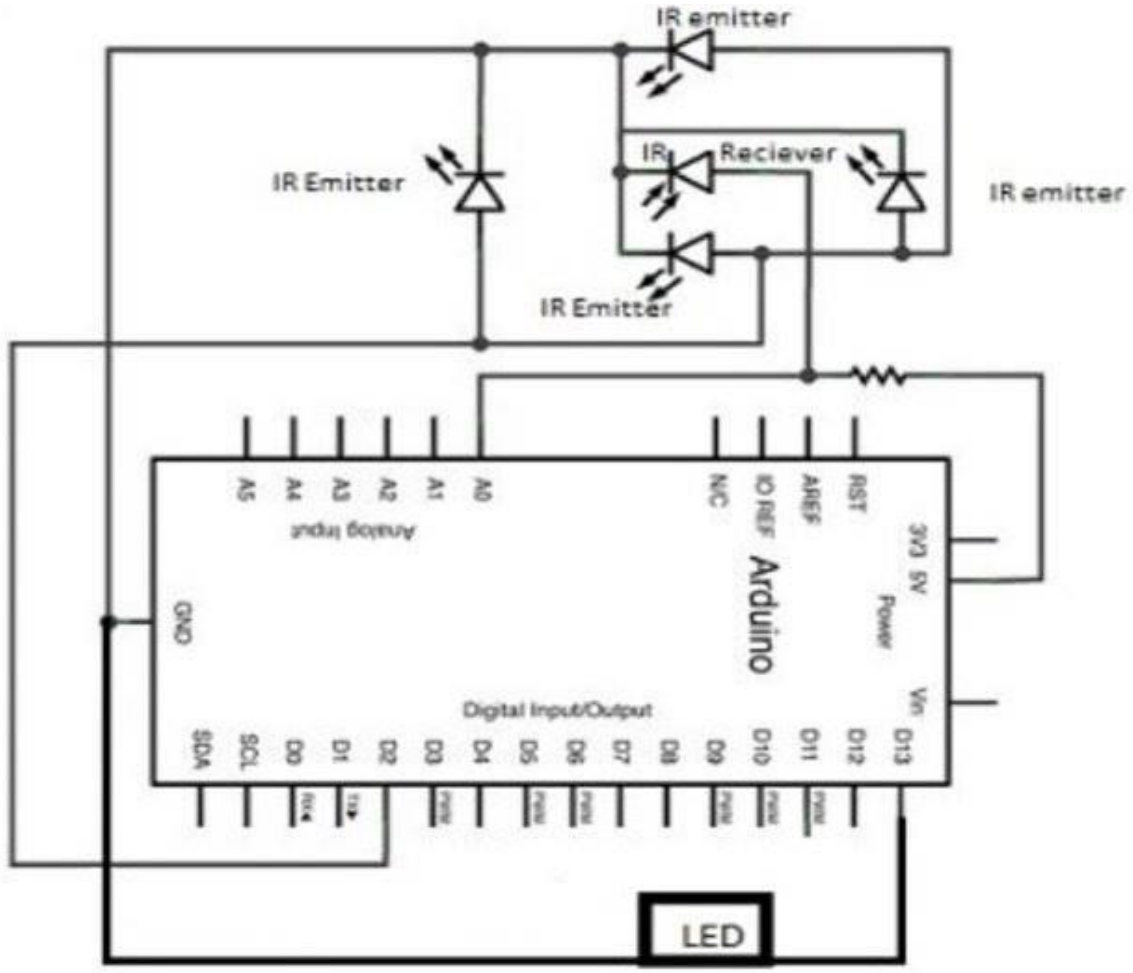
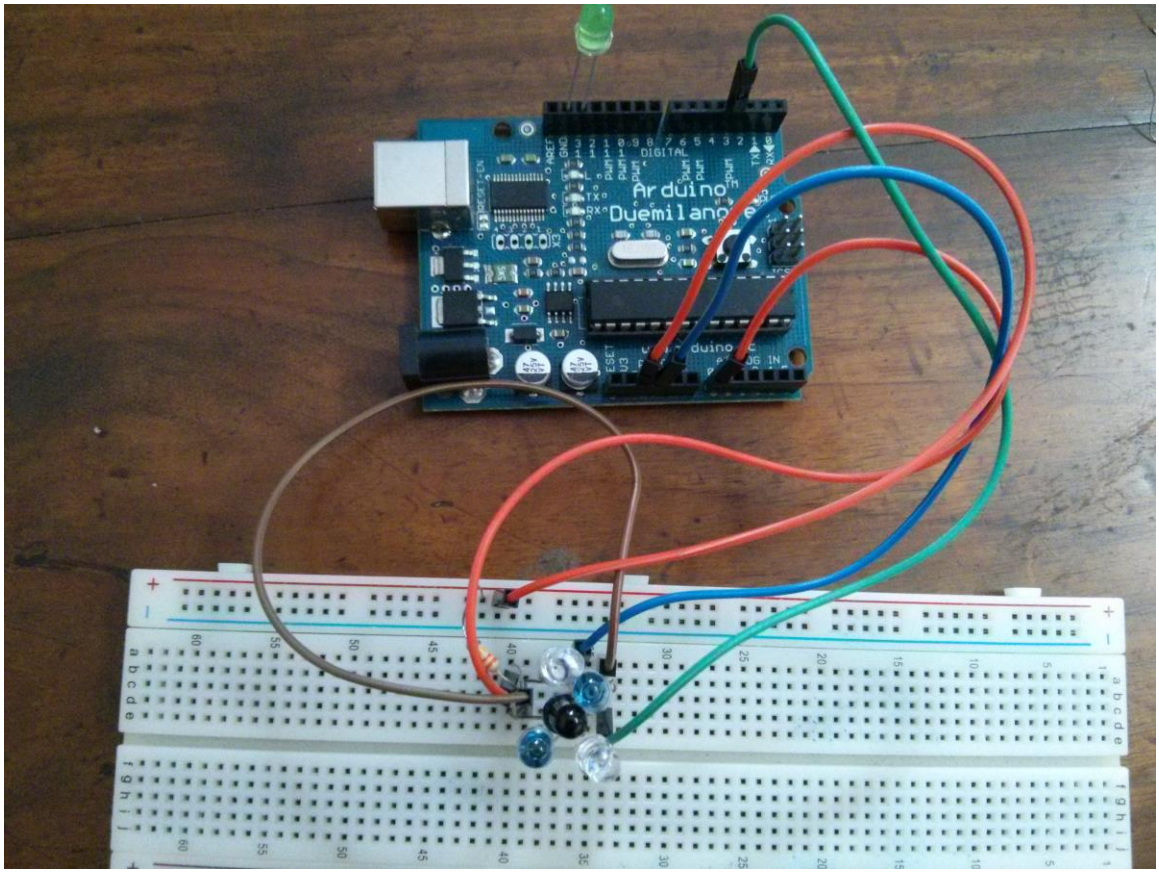


Figure 3.2: Schematic Diagram for Bathroom Module (Basin and Commode)

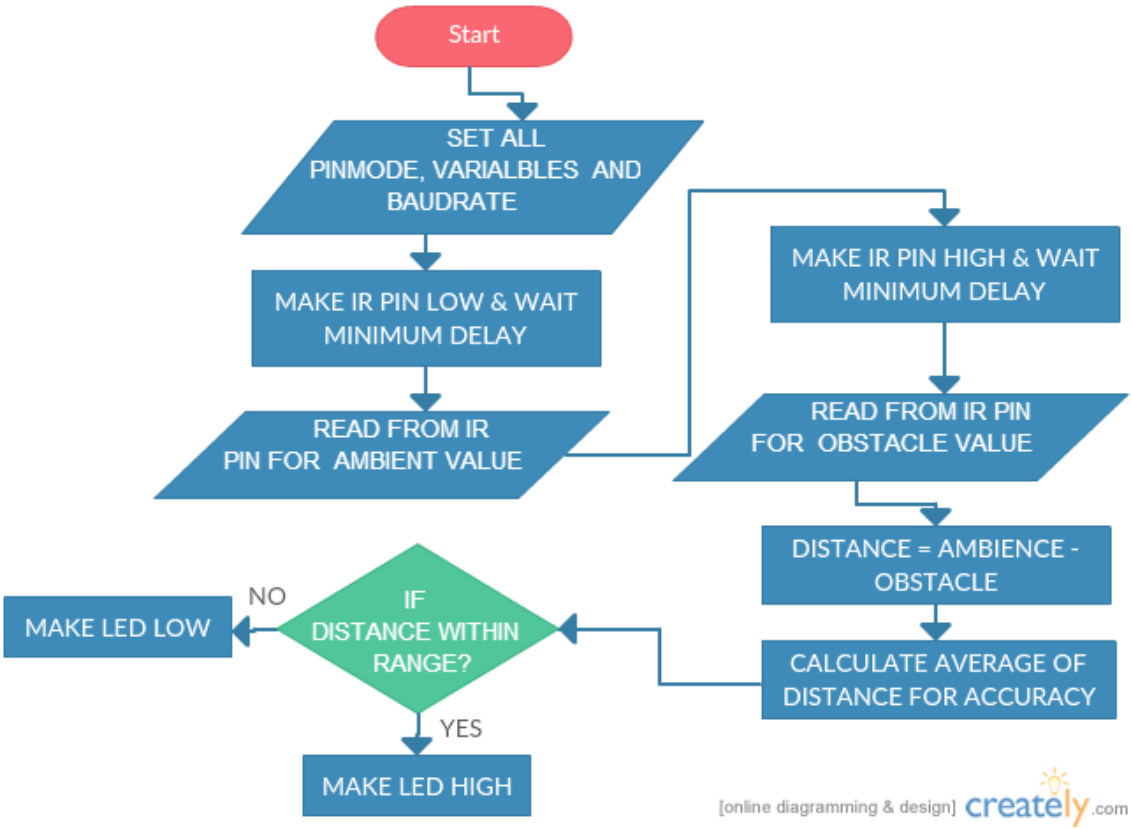
This figure here shows the inner workings of the circuit.

3.4. Hardware

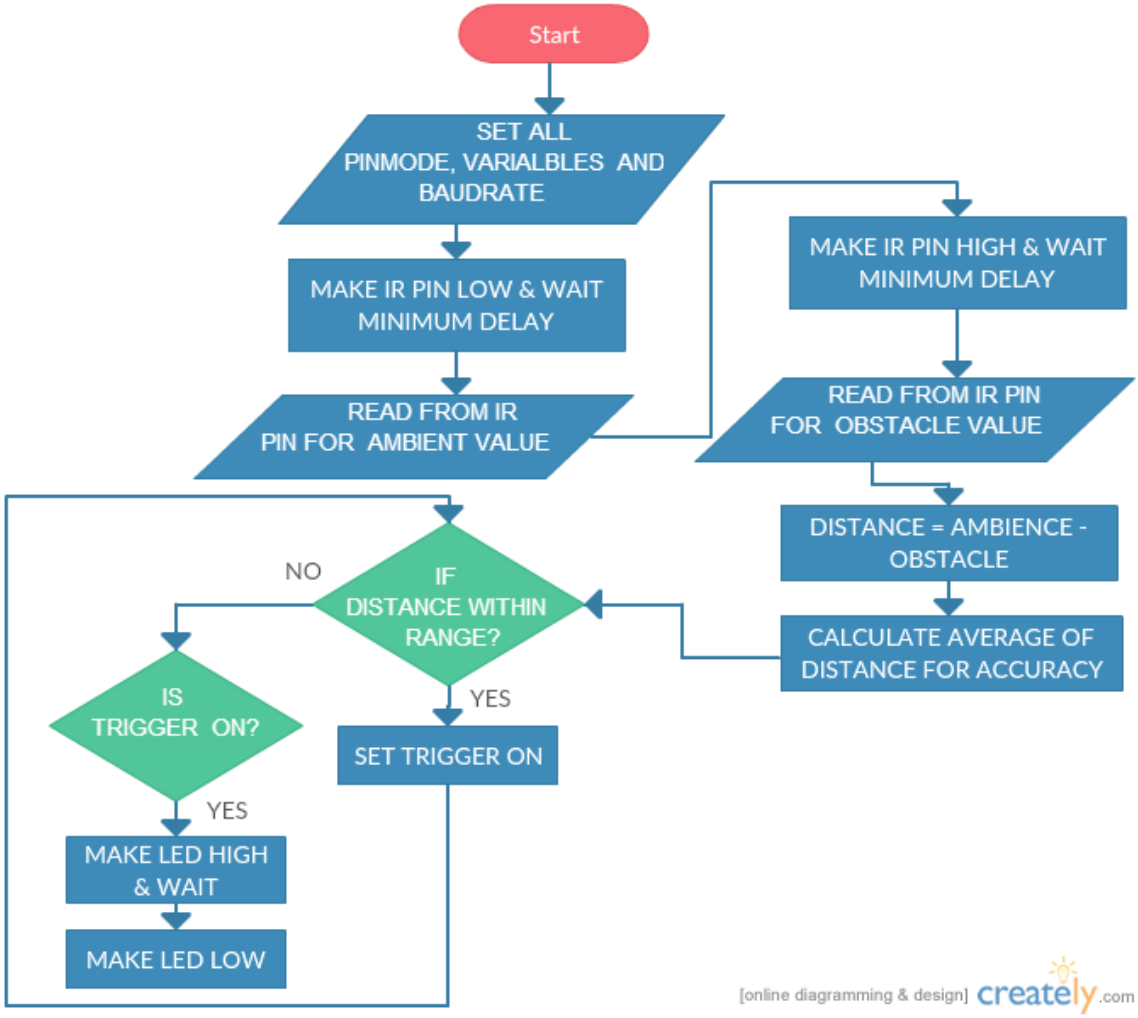


3.5. Control Algorithm

3.5.1. Basin



3.5.2. Commode


Start
SET ALL PINMODE, VARIALBLES AND BAUDRATE
MAKE IR PIN LOW & WAIT MINIMUM DELAY
READ FROM IR PIN FOR AMBIENT VALUE
MAKE IR PIN HIGH & WAIT MINIMUM DELAY
READ FROM IR PIN FOR OBSTACLE VALUE
DISTANCE = AMBIENCE - OBSTACLE
CALCULATE AVERAGE OF DISTANCE FOR ACCURACY
IF DISTANCE WITHIN RANGE?
NO
YES
SET TRIGGER ON
IS TRIGGER ON?
YES
MAKE LED HIGH & WAIT
MAKE LED LOW
[online diagramming & design] creately.com

CHAPTER FOUR

4. Kitchen Module

4.1. Introduction

As mentioned earlier, the leading cause of home fire in the United States of America is due to kitchen appliances[5]. To make it more safe and less prone to fire related accidents, we worked on the kitchen module.

It happens too often that people leave the kitchen in the middle of a cooking that takes a long time, to go do other works or just simply to take a break. Sometimes, they forget that there is something on the stove that might be burning and may cause a house fire[5].

In other occasions, many forget to turn off the stove after a cook. Even when they do turn it off, it may not be properly done. This leads to the house being filled with gas. It could be a match lighting or an electronic spark in other kitchen appliances that would result in a combustion, which of course, in turn again results in a house fire[5].

If the cook could be notified that his/her cooking is almost or near completed. The first scenario could be avoided. If the cook could be notified about the gas leak, again the second scenario can be avoided. To avoid both these scenarios, we developed our kitchen module.

The two scenarios consequently leads the module to divide this module is divided into two parts:

I. *Temperature Sensing:* Notifies the cook about a rise in temperature through a buzzer.
II. *Gas Sensing:* Notifies the cook about a gas leak through a buzzer.

These component parts of the module will surely minimize house fire occurances to a much lower percentage.

4.2. Theory

4.2.1. Temperature Sensing

The temperature sensing part of the kitchen module uses the Grove Temperature and Humidity sensor SEN11301p. This sensor is more commonly known as DHT11 sensor. It has a temperature range of 0 to 50°C with an accuracy of ±2°C[21]. It is used for a cheap price and ensures he high reliability and excellent long-term stability[21].

The Arduino has to initiate data transmission by issuing a “Start” signal. The Arduino pin must be configured as output for this purpose Next, the sensor responds to the Arduino “Start“ signal by pulling the line low followed by a logic high signal. Once detecting the response signal from the sensor, the Arduino should be ready to receive data from the sensor. The sensor then sends 40 bits of data continuously in the data line[11]. Hence, the buzzer buzzes.

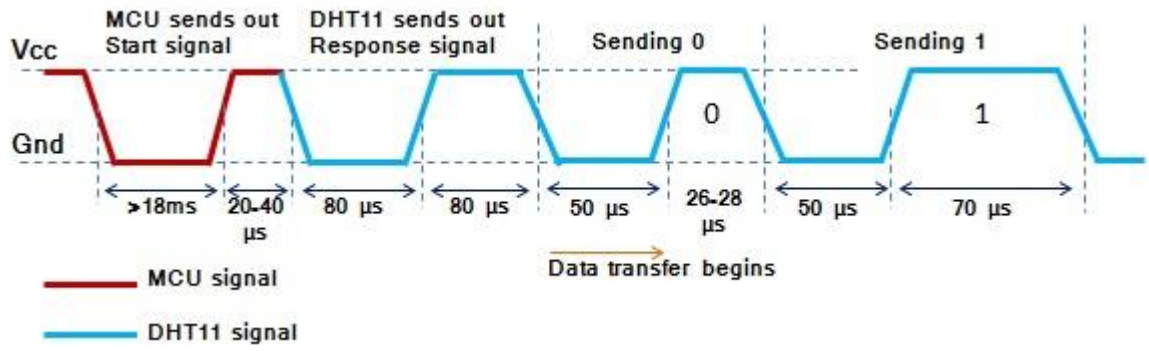


Figure 4.1: Start, Response and Data signals of DHT11[21]

The DHT11 sensor requires an external pull-up resistor to be connected between its V_{cc} and the data line so that during inane conditions, the data line is always pulled high. After finishing the data transmission and releasing the data line, the DHT11 sensor goes to the low-power consumption mode until a new “Start” signal arrives from the Arduino[11].

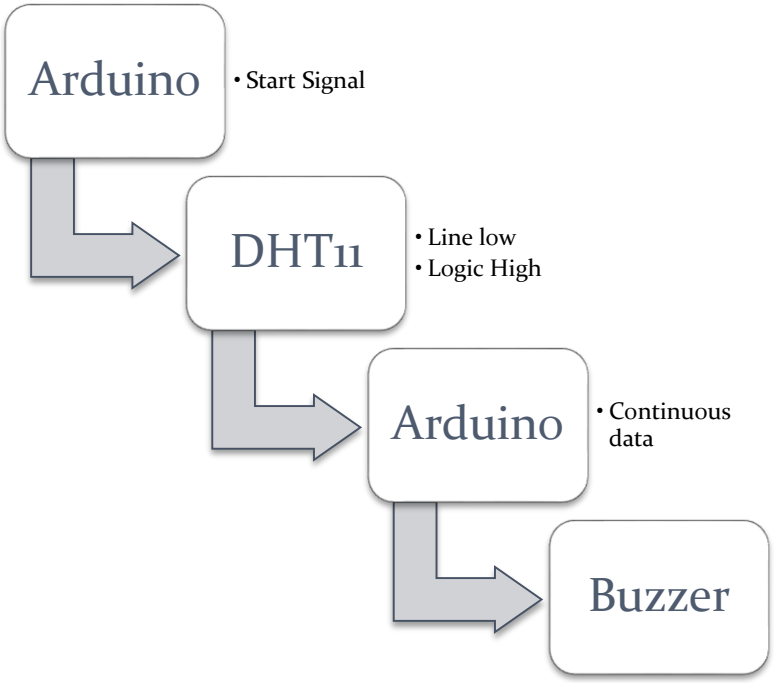


Figure 4.1: Working Principle

4.2.2. Gas Sensing:

The gas sensing part of the kitchen module uses MQ-2 gas sensor. It can detect a wide range of gases including methane, LPG and smoke[14]. LPG and methane are most commonly used in cooktops or stoves. Thus makes MQ-2 the perfect candidate for gas sensing in the kitchen. It uses Tin Dioxide as the sensitive layer which is protected by a plastic crust and stainless still net[14].

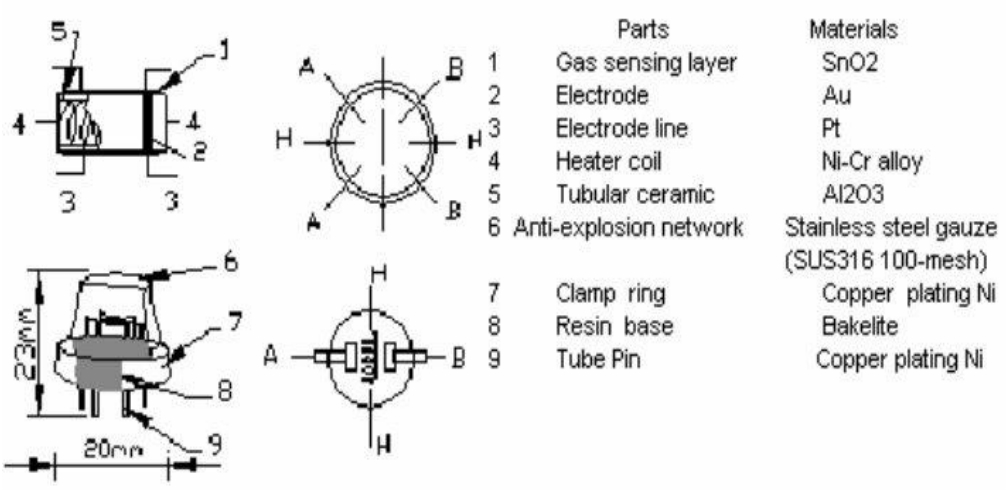


Figure 4.3: Structure and configuration of MQ-2 gas sensor[14]

The MQ-2 gas sensor works similar to the DHT11 sensor. Thus, the buzzer buzzes when the signal sent to it is high.

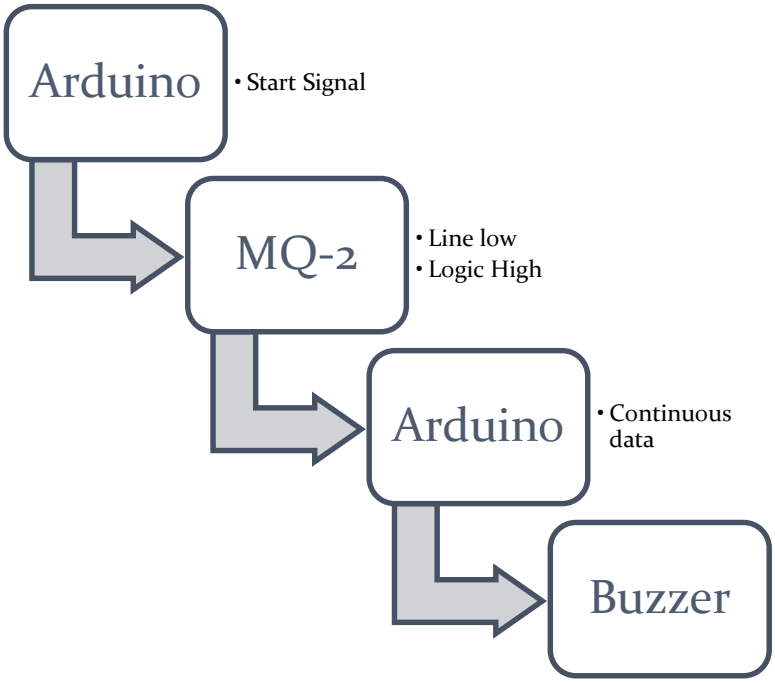


Figure 4.4: Working Principle

4.3. Circuit Diagrams

The basic circuit diagram for both the component parts are simple. They require an Arduino board connected to the respective sensors with a resistor and a buzzer.

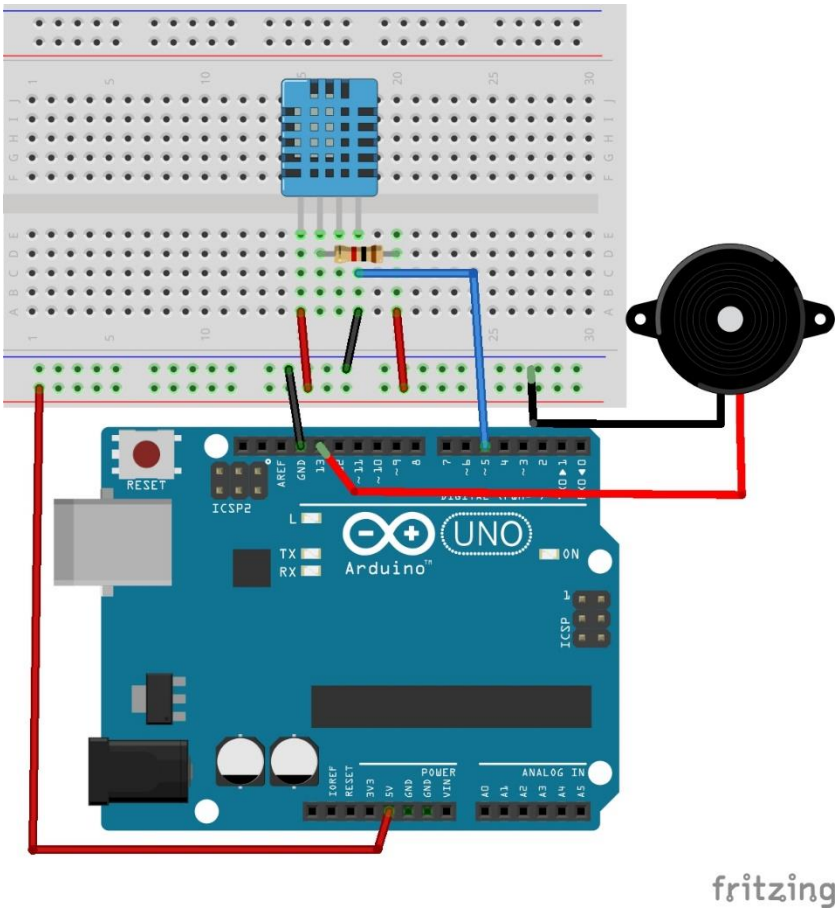


Figure 4.5: Circuit Setup for Temperature Sensing

The 1KΩ resistor is used to pull-up the data line during inert conditions.

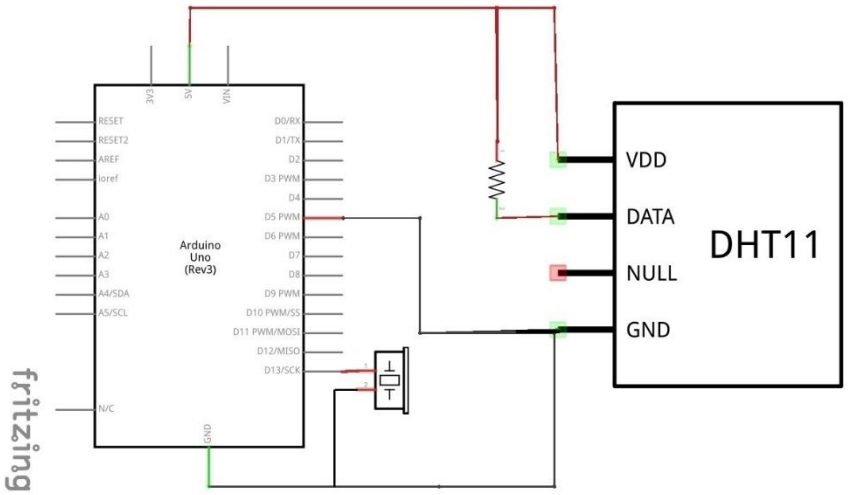


Figure 4.6: Schematic Diagram for Temperature Sensing

The schematic diagram shows the inner workings of the circuit.

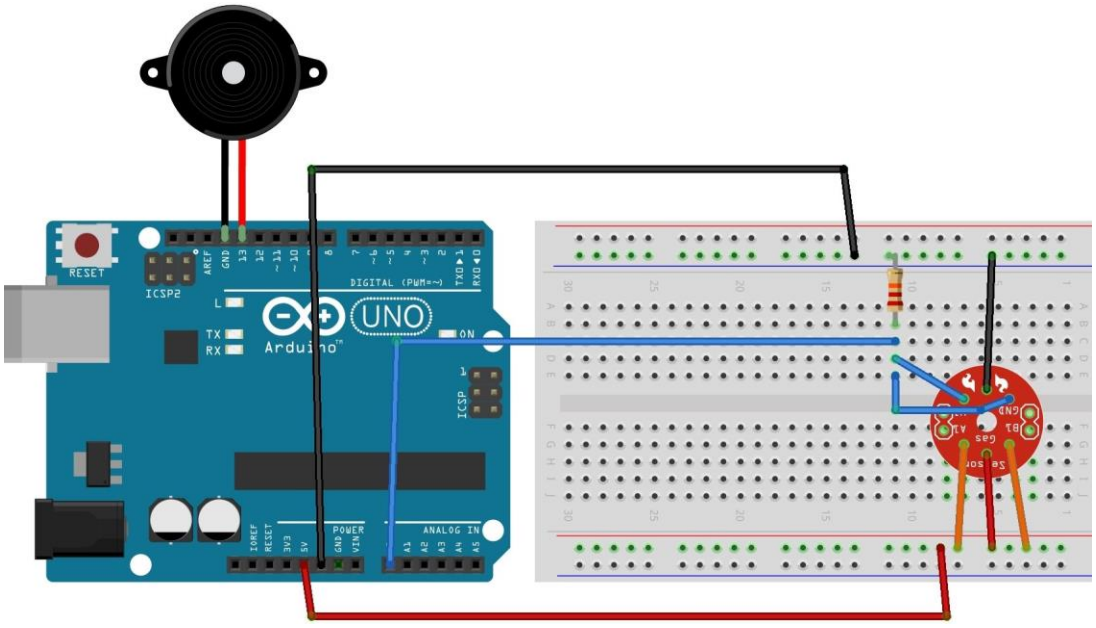


Figure 4.7: Circuit Setup for Gas Sensing

The 22KΩ resistor is used to pull-up the data line during inert conditions.

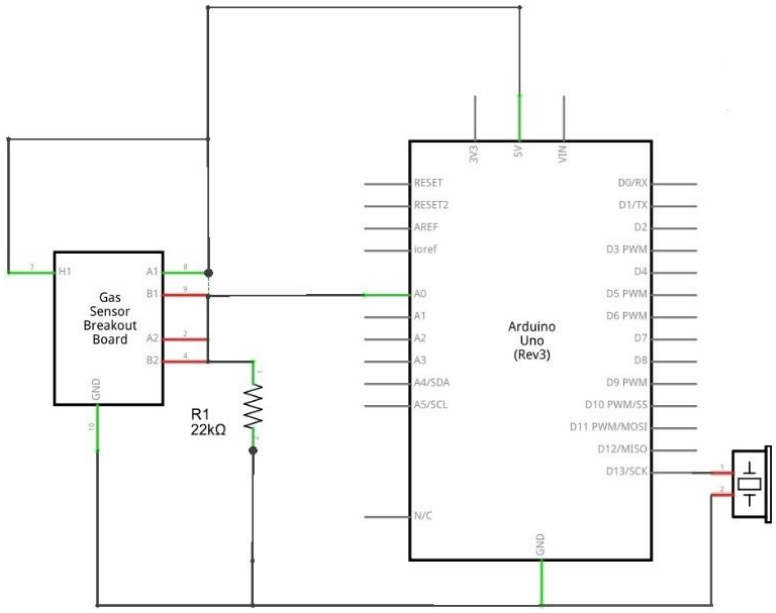
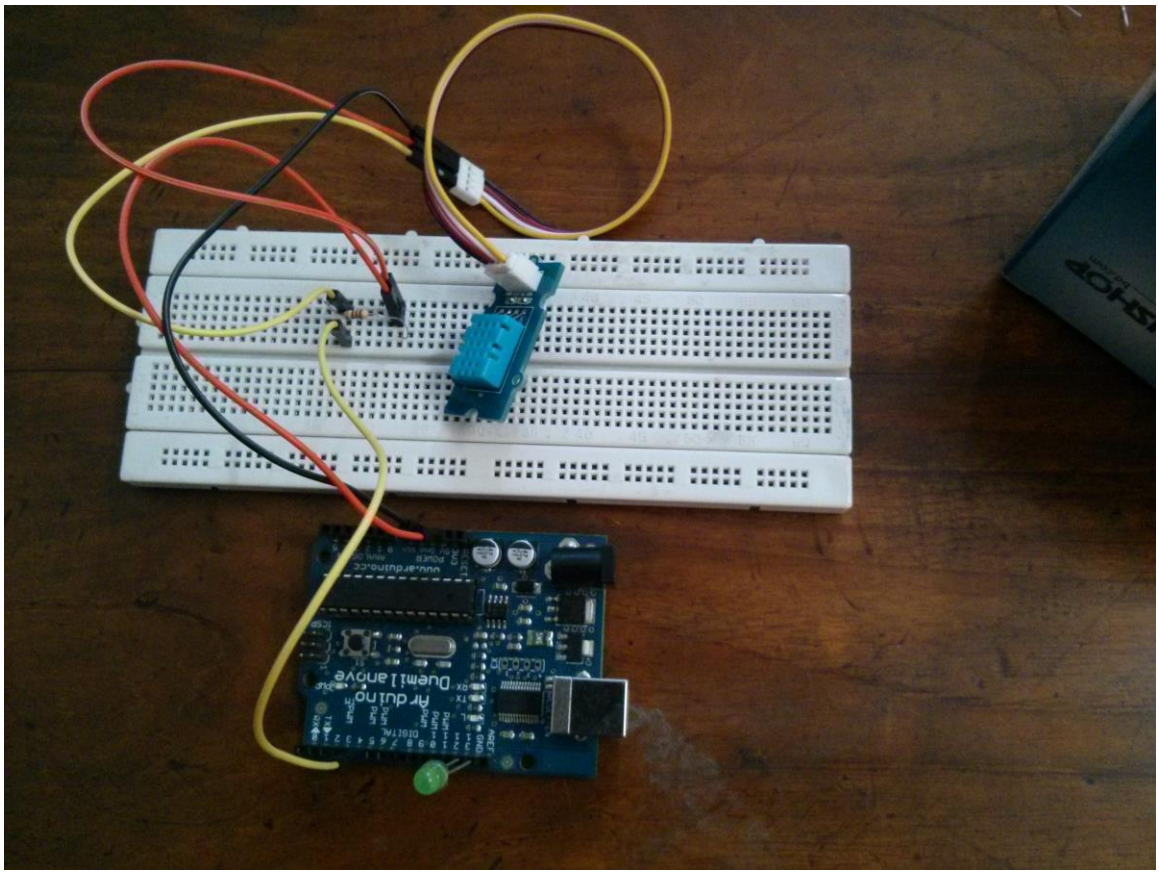


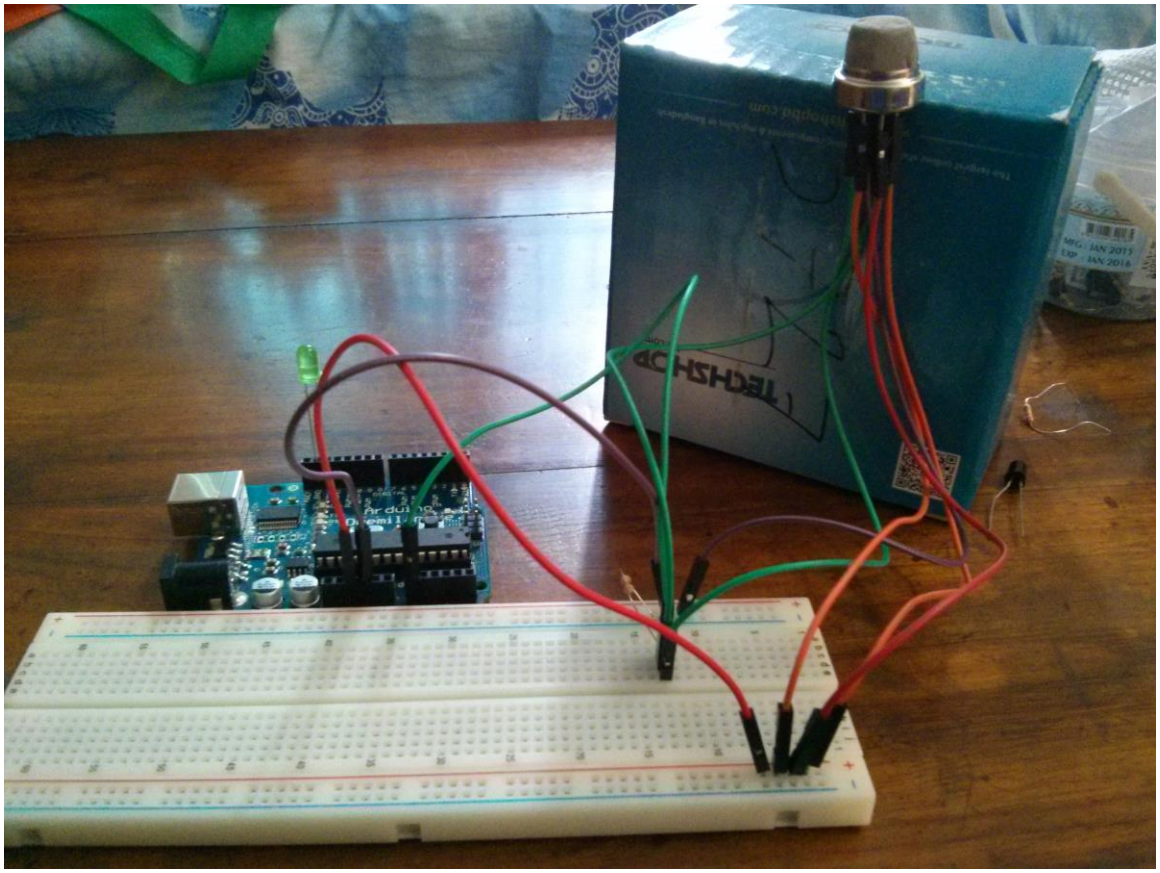
Figure 4.8: Schematic Diagram for Gas Sensing

4.4. Hardware

4.4.1. Temperature Sensing

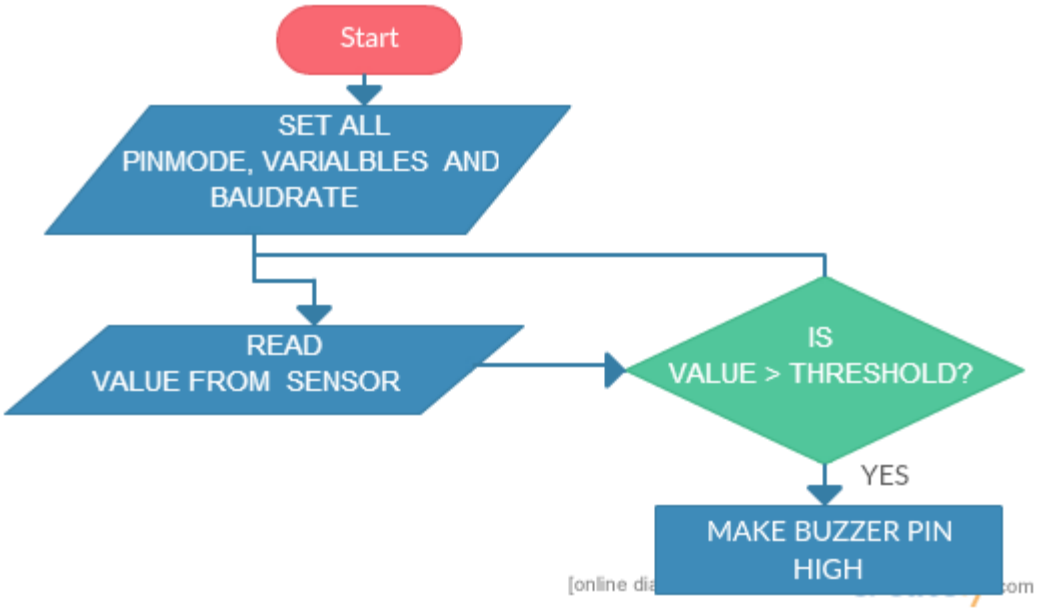


4.4.2. Gas sensing



4.5. Control Algorithm

Both the component parts follow the same basic idea for their control.



CHAPTER FIVE

5. Living Room Module

5.1. Introduction

Have you ever lost your remote or did that ever happen that you can't find your remote just before your favorite show is about to start? What surely happened in this lazy era that we live in is that you for once at least, have wanted to control everything around you with just your voice. In today's age where everything is just a click/tap away, we aimed at developing a system where we can control the IR devices (AC, TV, DVD etc.) with voice command. This system is an addition to the ongoing conquest of making everyday life easier for everyone.

Voice controlled IR remote is an extension to the project of making alternative/extra IR remote. This project is divided into two phases. Phase one is a desktop app which uses the Windows speech recognition and phase two is a mobile app which uses the Google speech recognition. We have successfully completed both phases along with virtual keypad app which works if the speech recognition is unavailable for no internet connection.

Phase One: We used Microsoft visual studio to develop the desktop app and used serial communication for communicating with arduino. We used the built-in speech recognition software of windows for configuring the voice command.

Phase Two: We used MIT App inventor to develop the mobile app and Bluetooth module to communicate with the arduino. We used the built-in Google speech recognition for configuring the voice command.

5.2. Theory:

In our project we have used Arduino as our microcontroller, which will intelligently control the devices or in this case the TV. We used the theory of infra-red (IR) reception and transmission.

In general, the basic building block of any IR transmitter is modulation of the information signal with carrier signal, because the receiver modules that we use are made for a particular carrier frequency. It means when we choose a particular IR receiver or the device that we intend to control, we need to transmit the modulated wave with the same carrier frequency of that module/ device.

When we press a button on the IR light is pulsed on and off at a particular frequency. Carrier frequencies between 30kHz and 60kHz are commonly used in consumer electronics. We used for 38 kHz IR signals.

We created our own library by following this principle for decoding and then emulating the IR Remote.

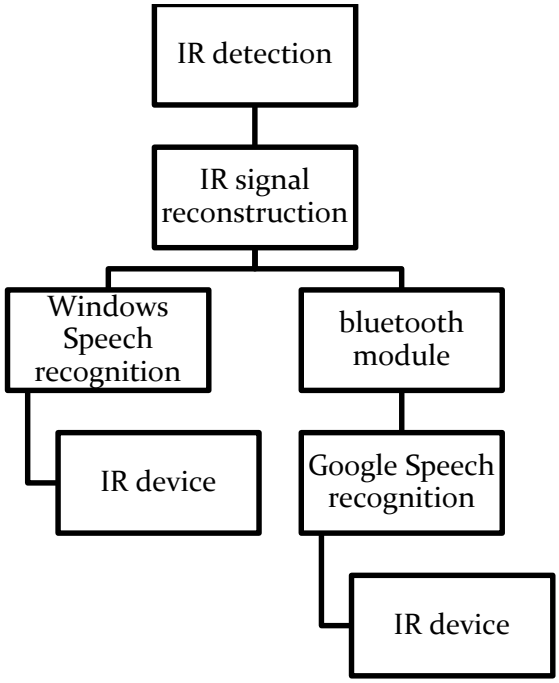


Fig 4.1 Working principle

5.3. Circuit Diagrams:

Basic requirements for this circuit is, regular IR remote control that works on your device, IR receiver, IR LED 940nm, Arduino, some jumper wires, Bluetooth module (HC-05).

We connected the arduino to an IR sensor to retrieve the pulses that the remote sent. After this is done, we uploaded the code to Arduino and have it output the on/off cycle for each button on our remote.

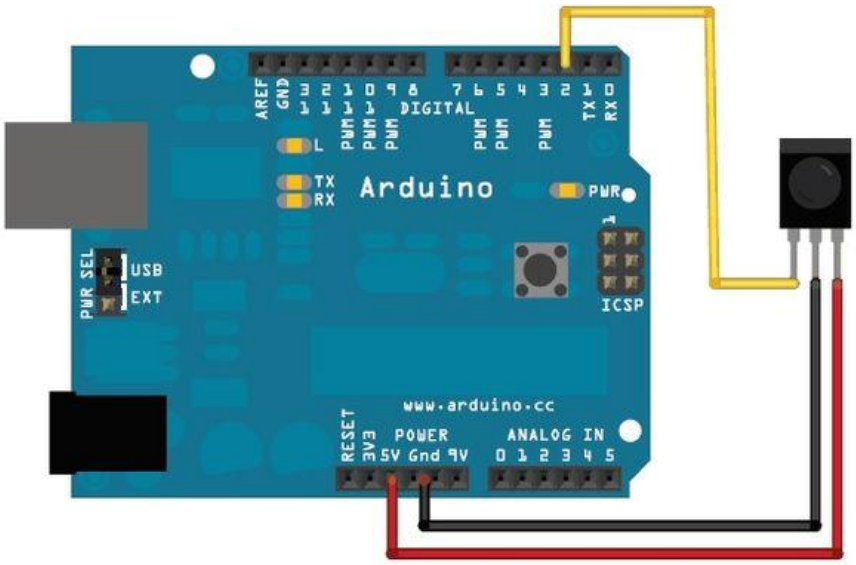


Figure 5.1: Circuit Setup for IR code retrieval

After we have got all the pulses for the required buttons from the remote we proceeded to this step. To emulate the codes, we created a Arduino library.The library consists of two main functions that turn the IR LED either on or off for whatever the correct length is.

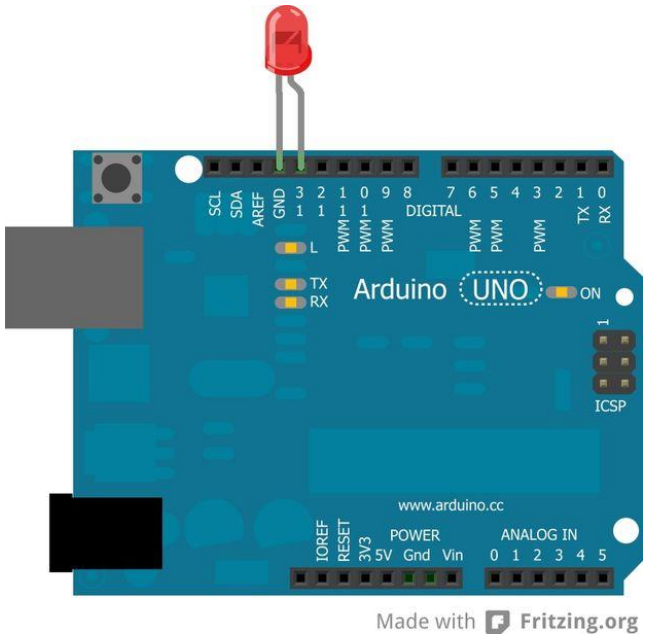


Figure 5.2: Circuit Setup for IR Code Emulation

We used MIT App inventor to develop the mobile app and Bluetooth module to communicate with the arduino. We used the built-in Google speech recognition for configuring the voice command.

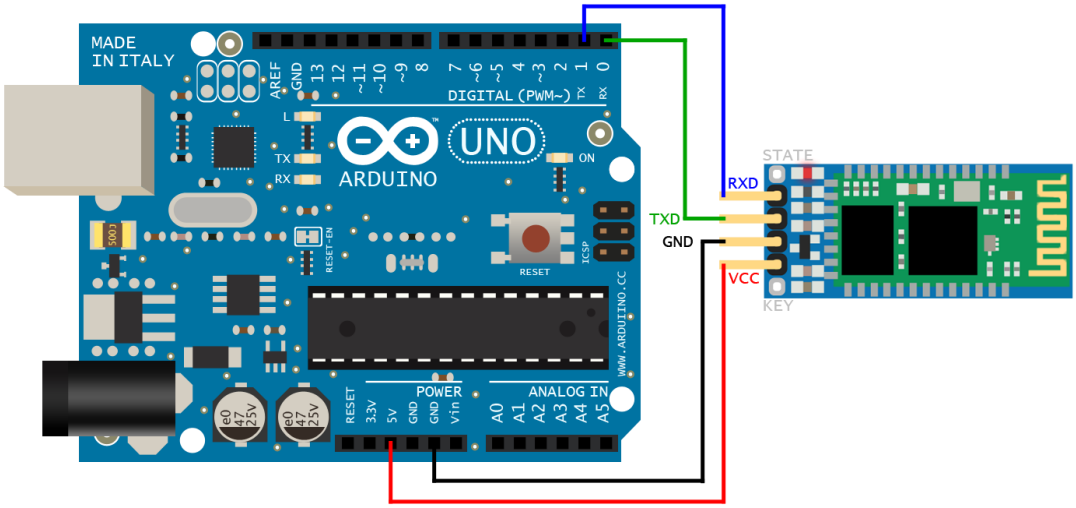
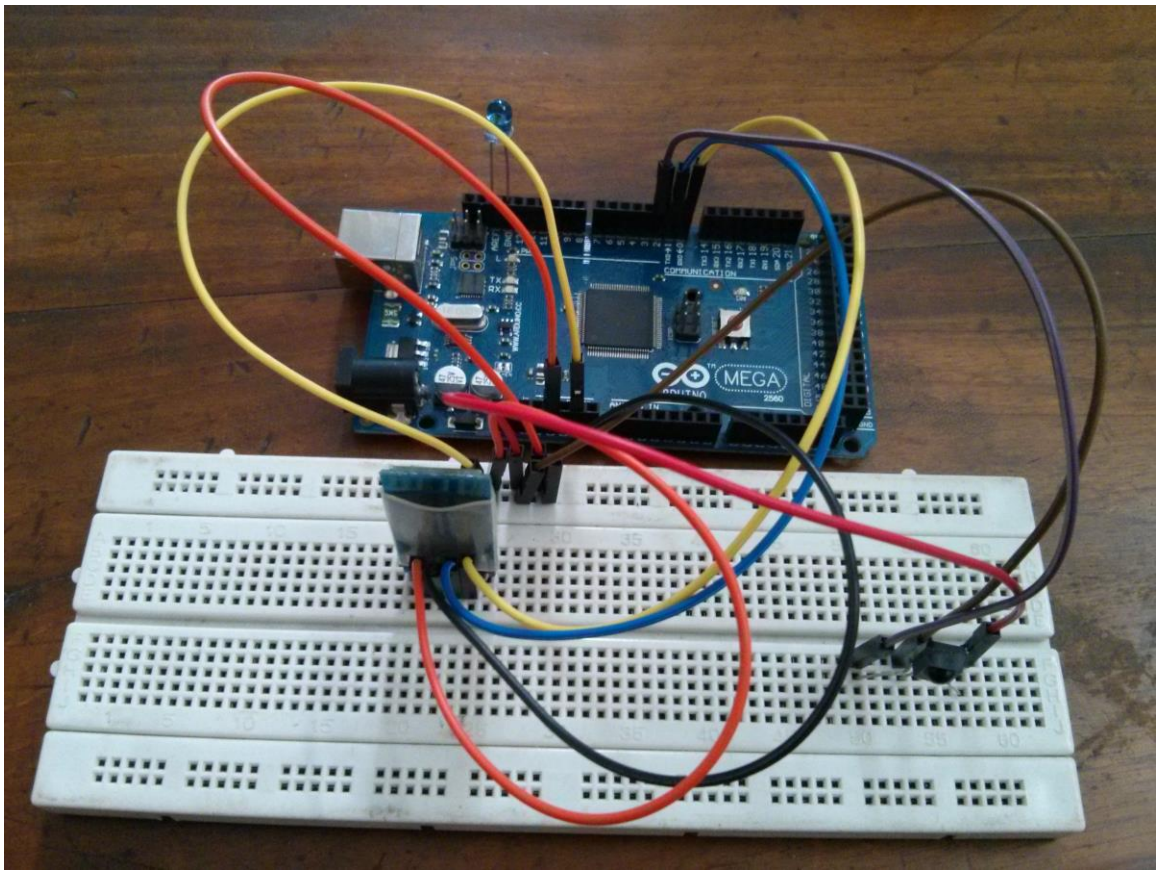
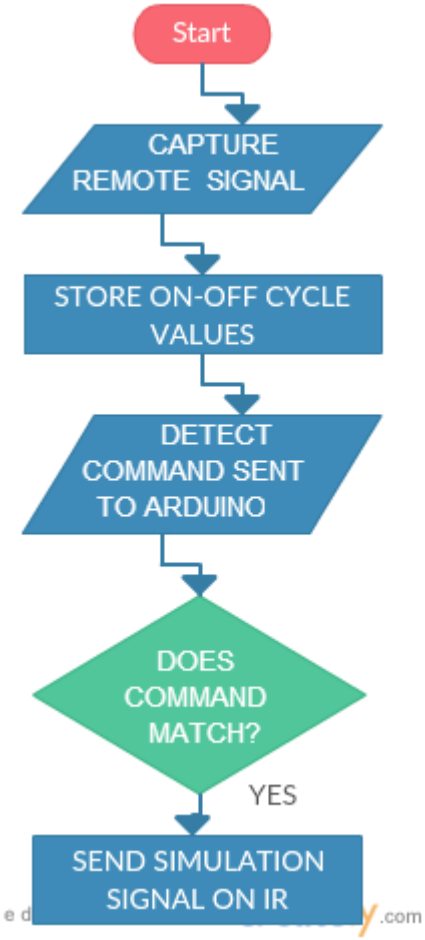


Figure 5.3: Circuit setup for Bluetooth module with Arduino

5.4. Hardware



5.5. Control Algorithm



CHAPTER SIX

6. Discussion and Future Implementation

6.1. Discussion

6.1.1. Bedroom module

The price of electricity per unit (1kWh) in Bangladesh is 5.19 taka for an average household. And this price is increasing gradually. The average fluorescent tube light uses 40 Wh and the average ceiling fan uses 75 Wh. For our research we observed an average household in Dhaka city. In that household there are 3 bedrooms, 2 bathrooms, 1 kitchen and 1 living room. Our findings are accumulated in the table below,

Here hours wasted means the number of hours when there was not anyone present inside the room but the appliance was on.

Room	No. of lights	No. of Fans	Hours wasted (6AM - 6PM)		Hours wasted (6PM-6AM)		Total units wasted	Wastage percentage
			light	fan	light	fan		
Bedroom	6	3	3	7	6	1.5	1.025	35.71%
Bathroom	2	0	6	n/a	8	n/a	0.63	21.95%
Kitchen	1	0	2	n/a	4	n/a	0.27	9.41%
Living space	3	2	3	4	8	2	0.945	32.93%
Total:	12	5	14	11	26	3.5	2.87	100%

From the above table, we can see that on average one household wastes 2.87 units of energy where so many people go without electricity. We are well behind the total electricity demands; we do not have the luxury to waste nonrenewable energies. If we do not feel that much generous then we can think about our utility bill. If we waste 2.87 units per day then it is costing us 14.9 taka daily, which makes it 446.86 taka monthly and 5362.31 taka yearly.

There are a lot of home automation systems in the market but they usually use PIR motion sensor or sensor because they have better accuracy and they are more stable. We used IR because we were opting for the cheapest solution and IR consumes less power than other modules. As for accuracy, IR is not reliable and the range is poor as we do not have access to industry quality IR. Moreover, a digital pin of Arduino offers 40 mA which is much too low to draw an IR. If we power the IR through an npn transistor, it will increase the range sufficiently to work.

6.1.2. Bathroom module

Water tariff in Bangladesh is one of the lowest in the whole world about 6.99 taka per thousand liters and in the rural areas it is free! A few months back a German delegate of engineers visited for their research in our country, they were shocked when they heard we do not have to pay for water in the rural areas. Water is so scarce in their country and our country is not far behind. The water level is decreasing every year; we have to dig a little further every year. In spite of facing water scarcity every year, the amount of water we waste everyday will shock everyone. We observed a typical household in Dhaka city for this. Our findings are accumulated in the table below. The below calculations are based on the fact that it takes about 30 seconds to fill a bottle of water,

Necessity	Required time	Water required	Wasted
Washing hands	30 sec	20 sec	10 sec
Shaving	8 min	3 min	5 min
Brushing teeth	3 min	1.5 min	1.5 min
Showering	20 min	17 min	3 min
Washing in general	20 min	10 min	10 min
Total	3090 sec	1910 sec	1180 sec

From the above table we find that on average household waste water for 1180 seconds daily. In that time they waste roughly 39 liters of water and this is just

one household, if we think about how many households live in a building and how many building there is in a city, the amount will shock you.

We have all faced the problem of dirty washroom in educational institutions, offices basically anywhere there is a public washroom. In a third world country like ours this is a very critical issue but apparently no one cares. Our module addresses this issue in the cheapest possible way so that money doesn't come between sanitation. Though we have used Arduino as microcontroller but the basic principle can be used with any PIC microcontroller which will decrease the cost substantially.

6.1.3. Kitchen Module

6.1.3.1. Temperature sensing

As DHT11 uses one wire protocol, the communication between the sensor and Arduino is not possible through a direct interface with any of its peripherals. The protocol must be implemented in the firmware of the Arduino with precise timing required by the sensor[11]. This posed a slight problem for us- the response time was delayed during many of the trials. We needed to set the exact threshold value to get a better response time.

The detailed specifications and threshold values of DHT11 are given in the following:

Parameters	Conditions	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25℃		±4%RH	
	0-50℃			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0℃	30%RH		90%RH
	25℃	20%RH		90%RH
	50℃	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25℃, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1℃	1℃	1℃
		8 Bit	8 Bit	8 Bit
Repeatability			±1℃	
Accuracy		±1℃		±2℃
Measurement Range		0℃		50℃
Response Time (Seconds)	1/e(63%)	6 S		30 S

6.1.3.2. Gas Sensing

The MQ-2 gas sensor has a wide range of gases that it can detect. Thus, it needs to be calibrated for the gas we need it to sense. For this, a known concentration of the gas is needed. For the calibration the following graph is consulted to:

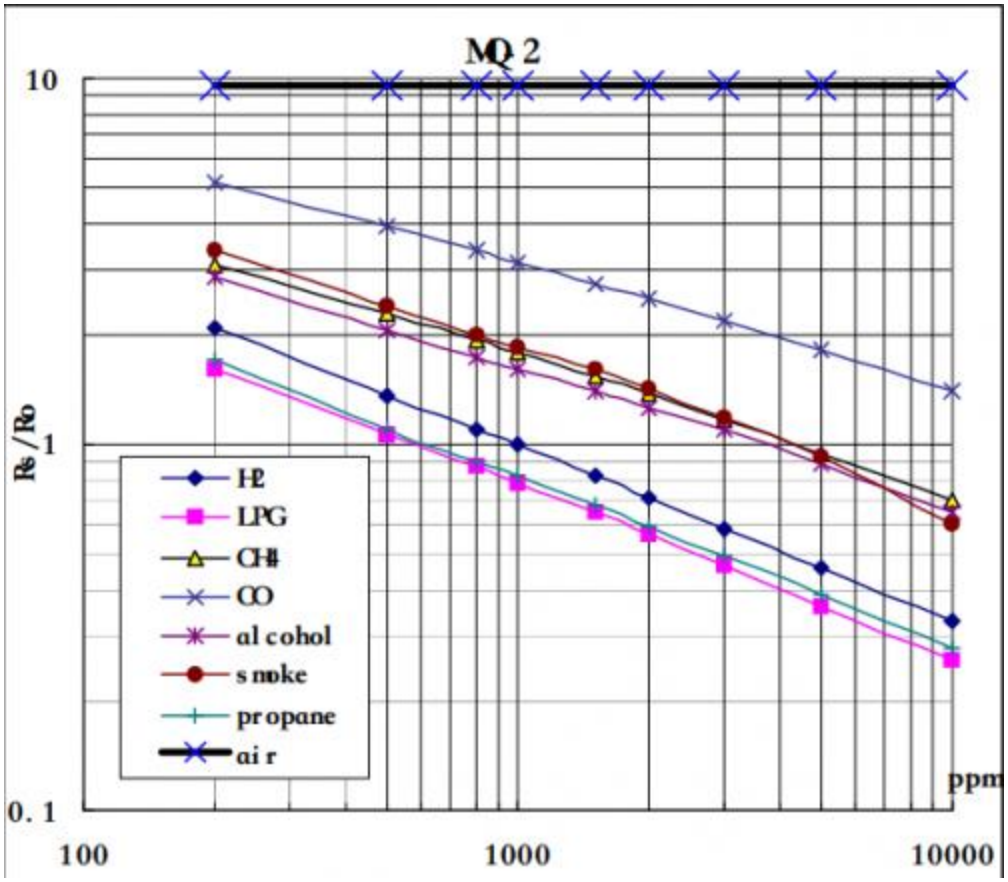


Figure : Typical sensitivity characteristics of Fig.2 shows the typical temperature and humidity the MQ-2

According to the figure, the minimum concentration we can test is 100ppm and the maximum is 10000ppm, in other word, we can get a concentration of gas between 0.01% and 1%. However, we can't provide a formula because the relation between ratio and concentration is nonlinear[22].

6.1.4. Living room module

This is the part where we attempt to make life easy but the implications are much higher. We hacked IR remote which was the toughest part, but the basic principle can be used in all our modules. For people with physical disabilities the voice command can bring some form of control in their lives. This module doesn't essentially save any resources; it has more of a social effect. It improves standard of living for every human being whether he/she is disable or not. Our future plan for this module has a far more social impact. In this fast pacing world parents are forced to leave their child at home unsupervised for work. As a result a lot of children are taking the wrong information from television. Our future work will enable parents to monitor their children even when they are not at home. They will also be able to control the television accordingly.

We worked with two types of speech recognition. The response time is nonexistent as they both work pretty fast but the Google speech recognition works way better than the windows 7 one. The windows 7 speech recognition requires an accent to catch the appropriate whereas the Google Speech recognition works as long as the pronunciation is correct. We also used Bluetooth module HC-05 for communication purposes. This module was easy enough to use but the response time is a bit delayed. Since this module is making life easy the cost is a bit high. This module needs internet connection to work at all times.

6.2. Future Implementation

In the future, we intend to incorporate internet connection to all our modules. That way, we can force turn off lights and fans remotely, incase the IR sensors are not working. We can send notifications on the users' cell phone when there is a gas leak so that they can remotely turn off the stove as well.

The living room module may have the best implementation in the future. Along with android phone, we may be able to implement the voice control using Apple platform. Along with TV, we may be also control other household appliances using voice control.

We may also include parental control where the user can get notification on their phone via the internet, if their children are watching TV in their absence. They may also be able to turn it off and use password so that their children could not access the TV before finishing their homework.

The future of home automation is very incandescent. It will continue to grow for as long as technology grows.

6.3. Conclusion

Home automation makes life easier. Not only it helps save energy, it also helps save time. You do not need to worry about whether you have turned off the switches after you have left home. You also donot need to face awkward toilet situations. In short, you easily save precious time and experience more daily productivity.

The most beneficial impact the system will have is on your monthly utility bill. No longer will you be spending money for household appliances left on in your family's absence. You will also save on gas costs, as you will never need to stop by the house in order to turn something off or on. This is certainly convenient. You will have complete control to make sure costs are low without exerting any additional effort.

Thus, this project includes modules that helps save energy, power water and gas. When fully implemented, it will this will be a cheap solution to many household problems.

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