CSE360 Theory Project

Project Title: "Automation at BRACU Residential Campus"

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Introduction: We are living on the era of Internet of Things. Our life style has been changing continuously. Now a days we have to handle lots of tasks at a time comparing with people from our previous generations. People who participated in industrial revolution ruled the world. There is no doubt for our upcoming days those who can bring the revolution by enhancing the advancement of Machine Learning, Artificial Intelligence will rule the future world. Before reaching the ultimate goal the elementary steps that we are already started to use is vast automation in almost every sectors. We need to do lots of task more efficiently, securely, faster and most importantly it should be cost effective. So, keeping this things on our mind we are planning to automate some task in our Residential Campus till now that has been done manually.

Here, we are mentioning some sub task that we need to achieve through this project:

- **Automated Attendance:** In our residential campus attendance counting is required for two fact. One is as usual for class evaluation and the other fact is the dorm tutor took this attendance to see who were not present within the first 10 to 15minutes of the class. By taking this information dorm tutor go back to their dorm and search for the student if he is sleeping or for what reason he is not attending the class. So, for this task first of all dorm tutor has to go all the classroom and takes the id if missing student. The he goes back to the dorm and find the particular student. At the first place this is a dull work. Moreover, it is also time consuming. So, we will make this sub system that will take attendance automatically so that class teacher can have full of his class time and don't need to call the attendance manually. At the same time dorm tutor will also get the information of the missing student sitting in dorm.
- **Automated Boundary Lights:** We didn't achieve unlimited renewal energy resources yet. To use this limited resource we must use this efficiently. Apart from the dorm's lights we don't need the outer space lights and boundary lights when there is enough sun light. So, here our target is to make this automated. When there is enough sun light the boundary lights will be turned off and if it is dark at certain level the lights will turn on automatically.
- **Laser Security in Boundary:** If any one tries to cross the boundary wall or tries to enter inside the campus over the wall it will alarm the security room. Basically, the idea is to ensure the security of the students as well has keep them protected from any unwanted invasion from outside. Not only students but also the respected faculty members live inside the campus. We are planning to make a defense mechanism that will alarm the security room if there are any trespassers. Not just students going outside jumping over the boundary but also protecting them from people from outside responsible for theft or any casualty inside the campus.
- **RFID Identification in Main Gate:** By this we are planning the lessen the workload of the procedure of counting the attendance of students going in and out, especially during the Fridays when they are allowed to go outside for the Jumma Prayer. So for the convenience we have planned to make an automated attendance system on the gate as well, just like the attendance in classes. Here Students will just punch out their respective ID cards and their information will be registered along with time of day they

went out and got in. So all this can make the process much easier and efficient without handling physical paperwork or man power.

- **Automated Electrical Appliances:** The idea of saving electric energy becomes a top priority in a place the Residential campus because it is hard to maintain and requires a huge task force. We plan to make all the rooms in the campus totally automated and just to be monitored from a specific control room. There will definitely be a manual override for the system proposed. The idea is to turn off all the electrical appliances in a given room if there is no presence of human being. We plan to achieve that with a PIR sensor in every room attached with a micro controller. Since devices like air conditioner eat up a huge portion of the electricity bills if not the power consumption supplied to the campus, we have planned to minimize that to a decent amount so there is minimal wastage of energy which ultimately adds up to saving electricity bills in the process. Our goal is not only focus on the air conditioner but the all the electric appliances possible on entirety of the campus.
- **Monitoring Movement of students at night:** We all know there are restrictions of student roaming around the dorm at late hours if not the campus. And some of them take a step forward and hide the vision of the CCTV cameras and can go to another room or whereabouts the dorm in different places. A simple solution to monitor this one could be a sonar sensor attached to the top of every room. As soon as the door opens or someone gets out their identity will be compromised no matter how clever they are trying to avoid the circumstances. That system will only be activated at late hours so there's no ringing siren all over the dorm at 2PM on broad daylight.

Application Area: The application area we are considering to focus on is basically embedded system prior to home automation. Because our proposed system adds up to a number of things and it ultimately exceeds the boundaries of home automation or industrial automation per say.

As we are trying to focus on security system as well as monitoring system we are bound to use some sort of embedded system for our proposed model to function properly. Not only that, the embedded system will hold together the entirety of the project and give us feedback and respond to us with output when asked for. As we include a number of devices that already tolls up to a long list of things starting from a sensor as simple as LDR to sophisticated devices like PIR sensors we are bound to breach the barriers of the term home automation and focus on Embedded System to express the functionality of our application area clearly.

Technology and Tools: There are an abundance of tools lying around us that can majorly impact the efficiency in our day to day life. A sensor as simple as LDR, which is only designed the evaluate the intensity of light can lead us to a natural energy saving process just by connecting it to a development board such as Arduino, EPS or even a Raspberry Pi for higher workloads.

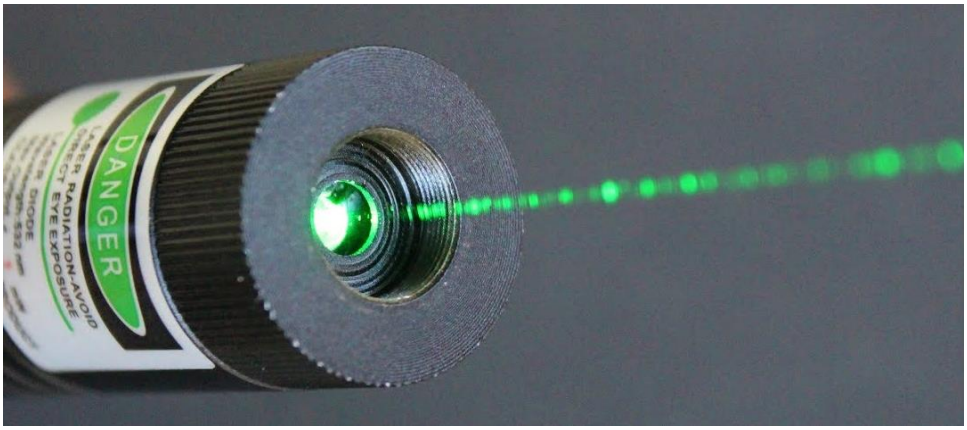
The tools we are planning to integrate are mentioned below.

- **Development Board Arduino**: We are all familiar with the most common development board on the market that goes by the name Arduino. It is really simple to integrate that board with multiple devices and it can store as well as process data at a pretty high rate

compared to its small size. We are using Arduino for cost efficiency as well as trying to keep the aftermath simple and clean. We could integrate something like and ESP8266 or a Raspberry Pi B+ to explore the outcome through internet but that is something we are planning to implement in near future. Arduino comes in different size and shapes as per requirements. Strategically we are planning to implement the use of Arduino Uno and Arduino Mega for most of the cases and maybe a few Arduino Nano where the efficiency needs to be swapped off with size.

- **Light Dependent Resistor, LDR Sensor** : We might have also heard of LED's and LDR's as they are the first bunch of sensors we get introduced to while learning a project based on embedded system. It will help us giving a value depending on the intensity of light which we can use to manipulate our electrical appliances as per requirement.

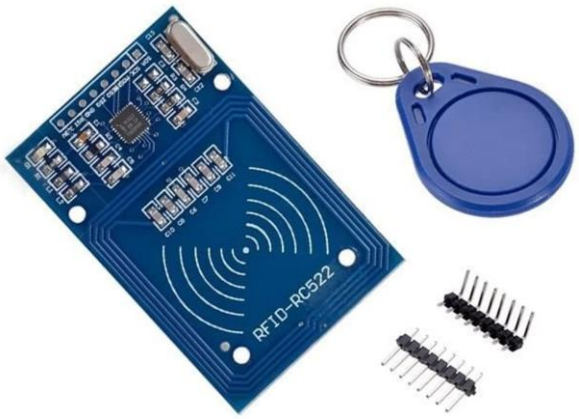
- **Laser Light**: It is basically nothing special than an ordinary light. This is just going the be used for the purpose of giving our LDR sensor a specific value. If there is a change in the value of the LDR we have to assume that the security has been breached.



- **Sonar Sensor**: The name itself is pretty self-explanatory. The sonar sensor works on the basis of input and output generated by sound. It has two outgrowths namely one pings for echo more commonly known as Sender and the other side a receiver which responds to the echo and calculates the distance measured by taking time into account.

- **Passive Infrared Sensor, PIR Sensor:** Moving towards a bit more sophisticated sensors such as PIR sensor we can yield great value. This sensor even works on no lighting conditions generally speaking IR rays being invisible to the human eye. This is more widely used in the fields of home automation as well as industrial automation for detecting presence of human. It takes heat and light on account to generate values and that data is ultimately used to come to a conclusion whether there is presence of human life in that room or not.

- **Radio Frequency Identification, RFID:** RFID is one of the most popularly used programmable chips in the market. It is very simple and very efficient considering its price point. We observe this sort of technology in high standard hotels which have card keys for accessing the rooms. Basically a specific RFID sensor can generate a specific frequency which is registered to the database with respect to that particular device. This if we hand out RFID registered identity cards to each individual student they can just register the card when they leave the campus and register it back when they return. In the process there workload can be minimized to many folds.



Language: There are different types of language which are compatible with different development boards. For example for Raspberry Pi the most commonly used language is Python 3 or above. Since we are using Arduino in our case we will be using its own language which is more commonly known as Modified C. We will try to implement the circuitry mostly with Arduino and keep it as simple as possible.

Working Mechanism of Sensors: The sensors we are going to be using are pretty basic. Just by using sensors as simple as LDR and Sonar we can achieve a lot of things if our approach is efficient.

Here is a brief description of the working mechanism of sensors.

- **LDR Sensor:** Basically we plan to power a bunch of LDR sensors in specific corners of the campus. We do not need an entire field of LDR sensors just to achieve the value of regular sunlight. We might just put them up on 4 corners of the campus along the boundaries. They all will be sequentially connected to the power system of the street lights or flood lights per say. The mechanism is pretty basic. If the value the LDR is receiving goes down below a certain extent it will send signal to the Arduino and the Arduino will channel the date to the main control room ultimately turning on the lights of the campus on the process.
- **Sonar Sensor:** This works on the basis of sound response it gets from its own echo. We will use this type of sensors on top of the doorframe. It as a max range of 20 meters which is pretty decent for the goal we are aiming to achieve. The sensor will be connected to an Arduino on top of the doorframe. As soon as someone comes out of

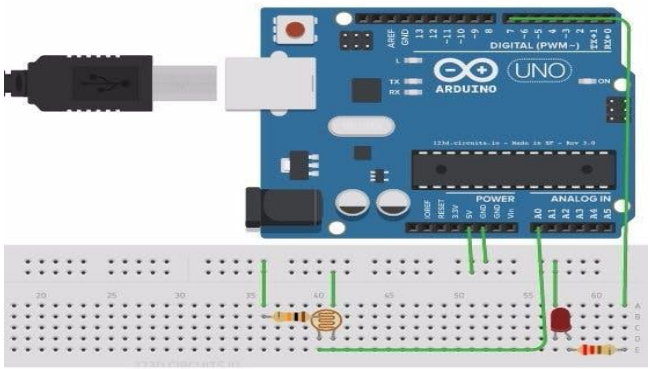
the room the echo will be received by the receiver because the transmitter is always pinging in search of a response. We can set an interval for sending the signal in search of a response. We plan to execute this mission in that order. The module name of the sensor is HC-SR04.

- **PIR Sensor:** The working mechanism gets a bit more complicated for here onwards. PIR is a sophisticated sensors which works on the basis of infrared days. Basically it can detect the infrared light radiated by a warm object. It consists of pyro electric **sensors** which can detect changes in their temperature of the surroundings (due to incident infrared radiation) into electric signal. When infrared light strikes a crystal, it generates an electrical charge. Thus it can detect the presence of a living body inside a room which can be used to turn on and off the electrical appliances as per need, ultimately resulting in efficient utilization of energy. The module name of the sensor is HC-SR501.
- **RFID Sensor:** This is by far the last and most complicated sensor we are planning to implement. Although there are many more complicated sensors out there this one takes the crown of being at the top from our perspective of the goal we are trying to achieve through the project. RFID works on the principle of radio frequency. RFID or Radio Frequency Identification System is a technology based identification system which helps identifying objects just through the tags attached to them, without requiring any light of sight between the tags and the tag reader. All that is needed is radio communication between the tag and the reader. The model name of the sensor we are going to use is RFID-RC522.

Connection with IC: The IC or Integrated Circuit we are going to use is none other than Atmega328 which is more popularly known as the Arduino IC. It is integrated on the circuitry of Arduino. Some of the older versions of Arduino still have the compact IC fitted on top of the development board while newer ones are more clean and compact reducing the IC into a smaller chip which resembles the figure of a card chip or processor.

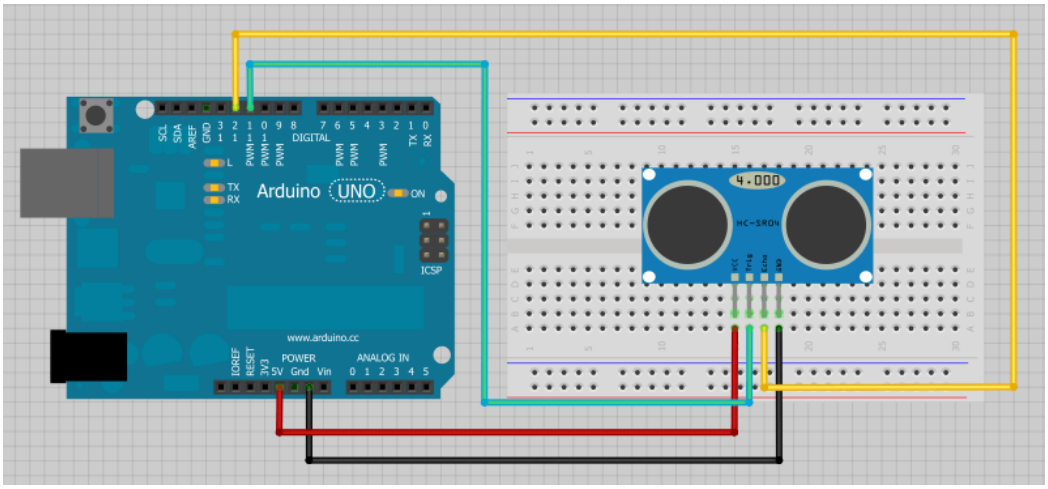
The connection of the IC with different sensors are given below.

- **Connection with LDR:** The connection with LDR is the simplest among them all. Its what we have learned on the first class of physics that is connecting the positive and negative ends. We connect the two ends of LDR to 3.3v or 5v pin for input voltage and to the ground respectively. Finally we connect the input voltage pin to another analog or digital pin on the Arduino to send or receive a signal or data from the sensor.



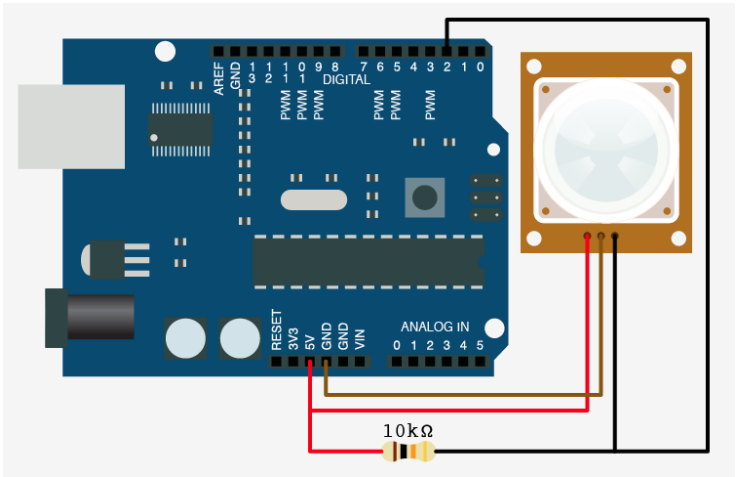
Here, we can see the pin A0 is used to receive data from the sensor, 5v pin to power the sensor and the GND pin to complete the entire circuitry respectively.

- **Connection with Sonar:** The ultrasonic sensor HC-SR04 has 4 pins on the module itself namely VCC, Trig, Echo and Gnd. The VCC and GND are pretty self-explanatory. The additional pins Trig and Echo are to be used for fetching data to the Arduino for processing.



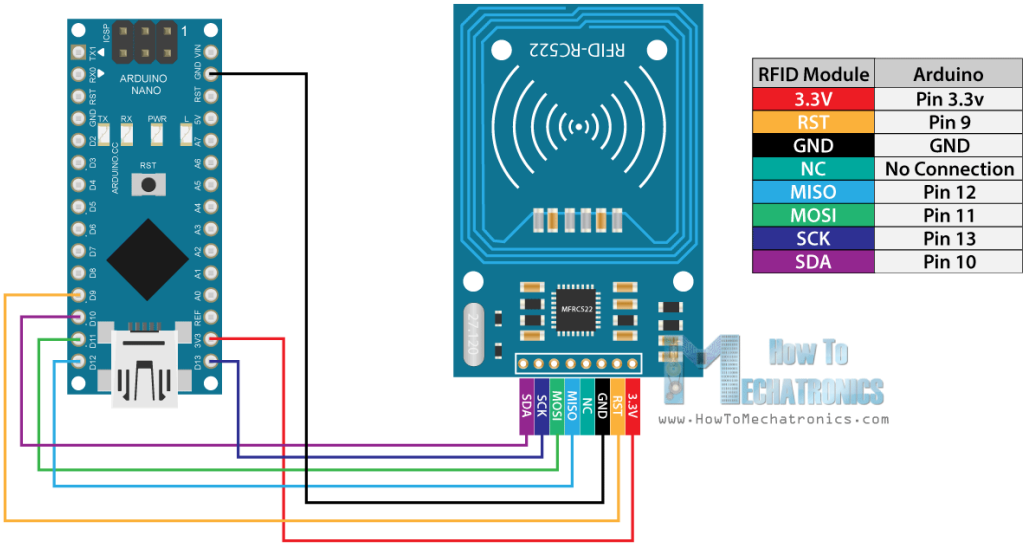
Here, we can see the pins 1 and 2 are connected to the pins Trig and Echo to receive data.

- **Connection with PIR Sensor:** The PIR sensor is comparatively simpler than that of Sonar sensor and takes less effort. It needs to be connected to the input 5v power supply and ground to complete the circuit.



And just needs to be connected to one pin for receiving the data in the processor to make results out of it.

- **Connection with RFID Sensor:** RFID is by the most complicated connection we are going to have to set up. The process is a bit tricky.



RFID Module	Arduino
3.3V	Pin 3.3v
RST	Pin 9
GND	GND
NC	No Connection
MISO	Pin 12
MOSI	Pin 11
SCK	Pin 13
SDA	Pin 10

But following the above diagram we can easily set up the connections with a development board. The RFID sensor being small we are trying to keep the entire model as compact as possible. That's why we plan to shift towards Arduino NANO for this project. The ground , power pins are pretty self-explanatory. We are going to set up the input and output pins by the above mentioned manner to receive and channel the data to utilize it efficiently. The students just need to swipe their ID cards above this module and their attendance will be registered. The best part about this module is it does not require any medium or presence of light. As RF itself is an electromagnetic wave so it does not need the presence of light to operate. Just need to have the power to operate. Power can be generated by a 9v battery as well. So if there is backup power supply for modules like these the students can register their attendance even if there is a scarcity of electricity in the campus for the time being.

Data flow from Sensors through I/O Devices: The process of data flow comes on two phases. Some of them are pretty simple like an LDR sensor while the other one can become as complicated as the RFID sensor per say. The data receiving in the LDR sensor is pretty basic. Assume we set up a value of 9000 intensity with respect to the voltage supplied. If the reading of the LDR sensor comes anything below that or starts falling the Arduino will get the signal and will light up the entire campus considering the fact of daylight hours coming to an end. For Sonar sensor we can give a range of values like up to 20 cm. If there is an obstacle between 20 cm of the trigger end of the sensor the echo will be received in the receiver end and the data will be channeled through for to Arduino for processing. In terms of PIR sensor we really don't have to set up many parameters because it has a default system of considering the entire area of the room taking into account. Since it can sense the IR rays coming from a from a heated body it does not need much calculating. We can just connect it to the Arduino and set up the signal pin to receive data. When a person enters the room the logic will be ||TRUE|| for the data signal and when this response is rendered to Arduino it will automatically turn on the lights in the room.

Code: We do not plan to go to the bottom of this explaining all the code for every single sensor but here we are showcasing a few.

Code for Sonar Sensor:

```
// defines pins numbers
const int trigPin = 9;
const int echoPin = 10;
// defines variables
long duration;
int distance;
void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
Serial.begin(9600); // Starts the serial communication
}
void loop() {
// Clears the trigPin
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
// Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH);
// Calculating the distance
distance= duration*0.034/2;
// Prints the distance on the Serial Monitor
Serial.print("Distance: ");
Serial.println(distance);
}
```

Done compiling.

Code for LDR Sensor:

```
*/
//This Code is written for Arduino Uno

int v = 0;
void setup()

{
  pinMode(A0, INPUT); //Signal for LDR
  pinMode(8, OUTPUT); //Signal for LED
  digitalWrite(8, HIGH);
  Serial.begin(9600);
}

void loop()

{
  v = analogRead(A0);
  if (v < 700) {
    digitalWrite(8, HIGH);
    Serial.println(v);
  } else if (v > 750) {
    digitalWrite(8, LOW);
    Serial.println(v);
  }
}
```

```
Done compiling.
```

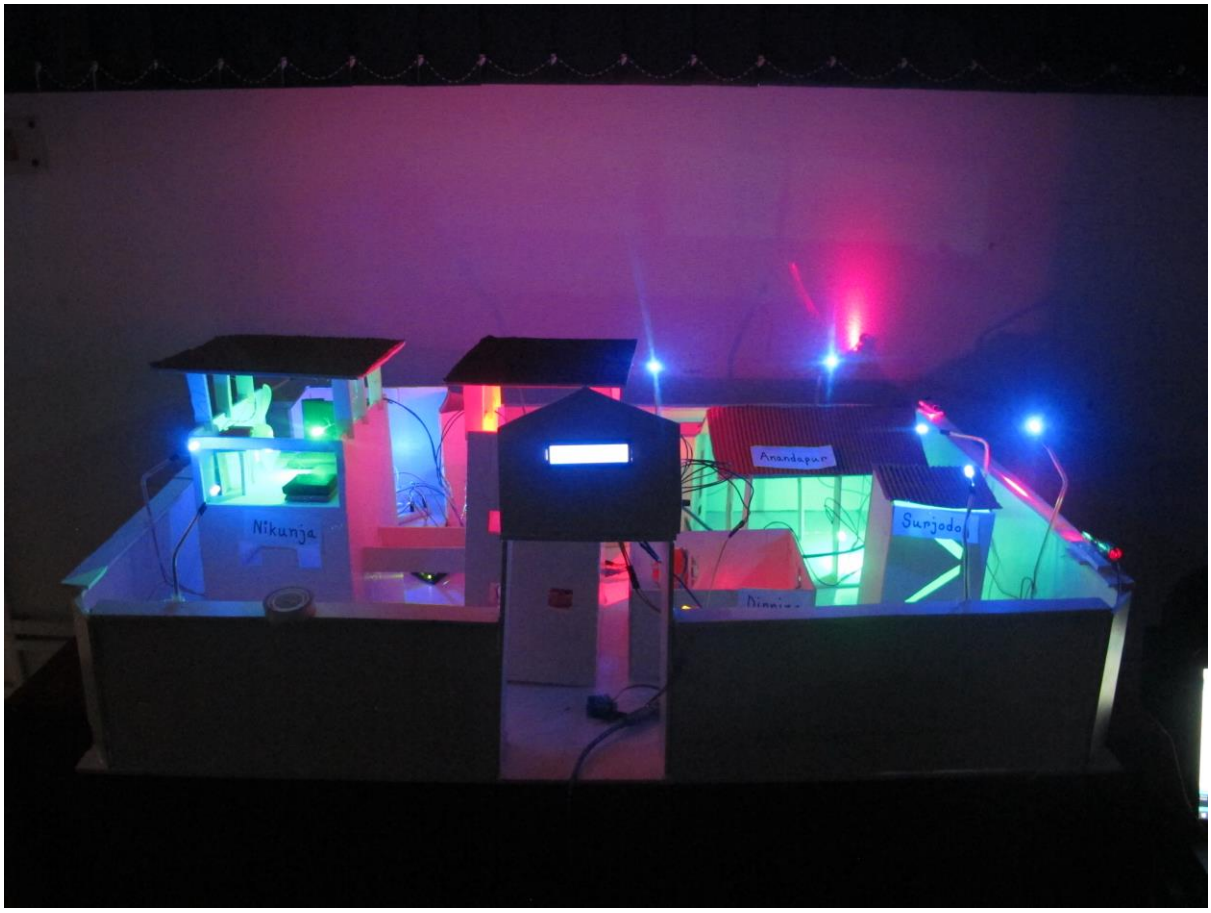
Estimated Cost Analysis: There is a cost for every project to be executed. Ours are not different but we have tried to make a as efficient as possible to make a considerable positive outcome. The idea of using the LDR sensor is very simple. If we put up just 4 LDR sensors on 4 corners of the campus at a higher altitude we will have enough data to handle the automated street light portion. When the active daylight hours are off the lights will go on. So we don't need an extra caretaker for this cause and the portion of his salary can be invested in another project. In a similar way if we consider using the PIR sensor to detect the presence of human being in a room in and the electric appliances can be switched on and off automatically taking the presence into account we believe the efficiency can be increased to a different level.

Just take this simple example in consideration. Assume there is electricity waster of 1000 kW for keeping the air conditioners on after the students leave the classroom. Lets assume the

electric bill of 1000 kW is 1 lac BDT(Totally an hypothetical). Now if we implement 250 PIR sensors in every room of the building and circulate them centrally we are going to have to spend around 25k BDT considering the price of one module is 88 BDT more or less. Now if we use 25k in total for a month and we save electric bills of 1 Lac BDT we are making an economic efficiency of 75 thousand taka every month and that can be very profitable for the university which they can invest in other sectors to improve where needed.

So just to give out a rough figure there will be minimalistic costing for LDR sensors which we can even exclude taking into consideration. We need around 200-250 PIR sensors for the entire academic building and the other administrative buildings which have air conditioners fitted to them as that is the prime reason of increasing electric inefficiency in terms of expenses. So we will have to spend around 25,000 for PIR sensors . The price of an RFID sensor is not more than 100 BDT. So if there are 1000 students in the campus per semester we will have to spend 1 lac BDT for the RFID sensors. But this is not a heavy expense considering the amount of manual labor we will have off our shoulders. We don't have to keep 10/20 people just to take attendance once at the dorm every night just to confirm if a student is present in his respective dorm or not. And if the project is successful we can implement it on Mohakhali campus as well for which the ultimate annual expense of the product will go even lower and the efficiency will go higher. And finally to control all these sensors and utilize the data we will have to buy some development boards namely Arduino. An Arduino Uno costs around 300 BDT while a MEGA has ten folds of its capacity and costs around 700 BDT. So if we buy 100 MEGA 30 Uno and 20 Arduino Nano I think it we will be more than better off. So 70000 BDT for Mega, around 9000 BDT for Uno and 6000 for NANO and wiring we can pack up with 85000 BDT with completing all the programmable boards.

So the final estimation for the project comes around 2,10,000 BDT for the entirety of the project around the whole campus and the efficiency only increases from now on and onwards. On the first month of use of the project can lead us to and electric bill efficiency of 75000 BDT which is almost $1/3^{rd}$ of the expense of the entire project. So by the end of one semester the university will have saved up the cost of the entire project and still keep gaining from it for the future months to come.



This is the prototype of our Project

Conclusion: As we are live in an era where there is scarcity of resources and no infinite power supply of any form we must make efficient utilization of whatever we have. In this sense saving up for the electricity bills and the wastage of electricity cannot be neglected at any circumstance. And with the help of technology we can ease out the hassle of maintaining every operation manually where we can do it more efficiently with the help of microcontrollers and sensors.

There is a famous quote saying "Efficiency *is cleaver laziness"*. And Masaru Enatsu says "*Why it yourself when Robots do it better*". So we will focus on efficient manpower and utilize it only where needed on the other hand use embedded system technology and sensors to ease out the hassle of maintaining ten folds of lines maintaining ques just to go in and out of the campus as well as dorms replacing a human being. As we know "To err is human" that quote does not necessarily work for electronic devices until and unless there is a malfunction in its core system. So replacing these hard hold tasks with automation can be extremely beneficial for the authority physically as well as economically and ultimately helping out students in the process. So we hope our project will look forward to greater good and may be implemented one day so we can be proud of the hours we have put in generating the thought process.