D.K.T.E. Society's Textile and Engineering Institute, Ichalkaranji.

(An Autonomous Institute, Affiliated to Shivaji University, Kolhapur)

Department of Information Technology

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DKTE

Promoting Excellence in
Teaching, Learning & Research

A PROJECT REPORT ON

Automatic Switching System of Electric Appliances using Deep Learning

Under the Guidance Of

Prof. D. M. Kulkarni

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DEPARTMENT OF INFORMATION TECHNOLOGY

DKTE SOCIETY'S TEXTILE AND ENGINEERING INSTITUTE, ICHALKARANJI

(AN AUTONOMOUS INSTITUTE)

YEAR 2019-2020

DEPARTMENT OF INFORMATION TECHNOLOGY

CERTIFICATE

This is to certify that the project report entitled "Automatic Switching System of Electric Appliances using Deep Learning" is a record of project work carried out in this college by,

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In partial fulfillment of the requirement for the degree of BACHELOR OF TECHNOLOGY in INFORMATION TECHNOLOGY of SHIVAJI UNIVERSITY, KOLHAPUR. This project report is a record of their own work carried out under my supervision and guidance during the academic year 2019 - 2020.

Prof. D. M. Kulkarni   Prof. (Dr.) D. V. Kodavade
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[Director]

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Also, we would like to take the opportunity to thank our head of department Dr. D. V. Kodavade for his co-operation in preparing this project report.

We feel gratified to record our cordial thanks to other staff members of the Information Technology Department for their support, help, and assistance which they extended as and when required.

Thank you,

Anjuman Patwekar	(16UIT11001XX)
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Abstract

Nowadays without electricity we cannot imagine our daily life because electricity has become a necessity for all, without which day-to-day life chores & daily activities become stand still. Also, the wastage of electricity has become a routine thing for us, and the problem has become frequent at homes, schools, and colleges and even in industries. Sometimes we notice fans and lights keep on working even in the absence of people. This often happens in homes, offices and public places due to utter negligence of the inmates. It is easy to integrate with lighting system such as automatic lighting system. Automatic Room Lights using Arduino and PIR Sensor, where the lights in the room will automatically turn ON and OFF by detecting the presence of a human. Such Automatic Room Lights can be implemented in your garages, staircases, bathrooms, etc. where we do not need continuous light but only when we are present.

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Introduction

a) **Problem Definition**

In this project, we will see the Automatic Room Lights using Arduino and PIR Sensor, where the lights in the room will automatically turn ON and OFF by detecting the presence of a human.

Also, we will see the Android app that will handle on/off of lights and fan which will also handle the intensity and speed of appliances respectively.

b) **Need for the project with motivating example**

It is easy to integrate with lighting system such as automatic lighting system. It is used for energy consumption or energy management by automatic control of brightness level in mobile phones and auto ON/OFF of room lights based on ambient light intensity. LDR (i.e. photoresistor) based light sensors are available in different shapes and sizes. Light sensors need small voltage and power for its operation. Photoresistors are lower in cost, bi-directional and offer moderate response time. Photodiodes offer quick response time, lower in cost and provide digital output. Phototransistors are very fast and provide immediate output compare to photoresistors. Phototransistors generate high current compare to photodiodes. The optional smart phone application takes care of the fact that the user may also wish to control his home appliances without sensors being triggered.

c) **Objectives of the project**

- System where lights switch on as soon as a human enters in the room.
- To develop a system that responds only to human motion.
- To develop a smartphone application that takes care of the fact that the user may also wish to control his home electric appliances.
- Brightness of light and speed of fan can also be controlled using app.
- App keeps a record of Light consumption on daily basis.
- If there are different smart rooms in a house app can switch access from one room to another.
- There is minimum delay for the switching system (in microseconds)
- To avail a low-cost system with minimum requirements.

### d) Scope & limitations of the project

- In our system we are taking decision based on Human presence but we can also interface LDR (Light Dependent Resistor) Sensor and Temperature sensor for better working of the system. This system can be also interfaced with the Bluetooth module so we can control the whole system from the mobile itself. Applications of our device are listed below 1. It can be used in college and schools (Turn of lights and fans when no one is there) 2. It can be used for home security purpose also we can fit at the main door of the house.

- LEDs are currently more expensive, price per lumen, on an initial capital cost basis, than more conventional lighting technologies. The most common design of a heat sink is a metal device with many fins, which conducts the heat away from the LED.

- The existing infra-red (IR) or Bluetooth remote controls present in the market are in general appliance specific and the same cannot be used interchangeably.

- Electrical appliances connected through Bluetooth making use of Bluetooth enabled smartphones cannot be managed from a distant location.

- Thus, functions such as being able to turn on an air-conditioner while returning home cannot be done with such systems.

- The difficulty faced by current home security/surveillance systems in providing information pertaining to the situation to users while being away from home is tried to overcome in this project.

e) Timeline for project

We have used the classic life cycle paradigm also called the "Waterfall Model" for Software Engineering which is a sequential approach to software development that begins at the system level and progresses through analysis, design, coding, testing, and maintenance. We had completed software requirement analysis by the mid of September 2019 which encompasses both system and software requirement gathering. By the end of November 2019, we had completed project planning and design. On the basis of the design prepared in the previous stage, by the end of March 2020, we completed the coding stage.

After completion of the coding stage the important part in the software development which is testing phase was carried out in the first week of April 2020. Various criteria of testing were taken into account which includes unit testing, integration testing, validation testing, and system testing. First, each and every module of the project was tested under the unit testing. After the unit testing, integration testing was carried out by integrating all modules tested in unit testing. After Integration testing the product system was cross-checked with the design.

Fig. Timeline of Project
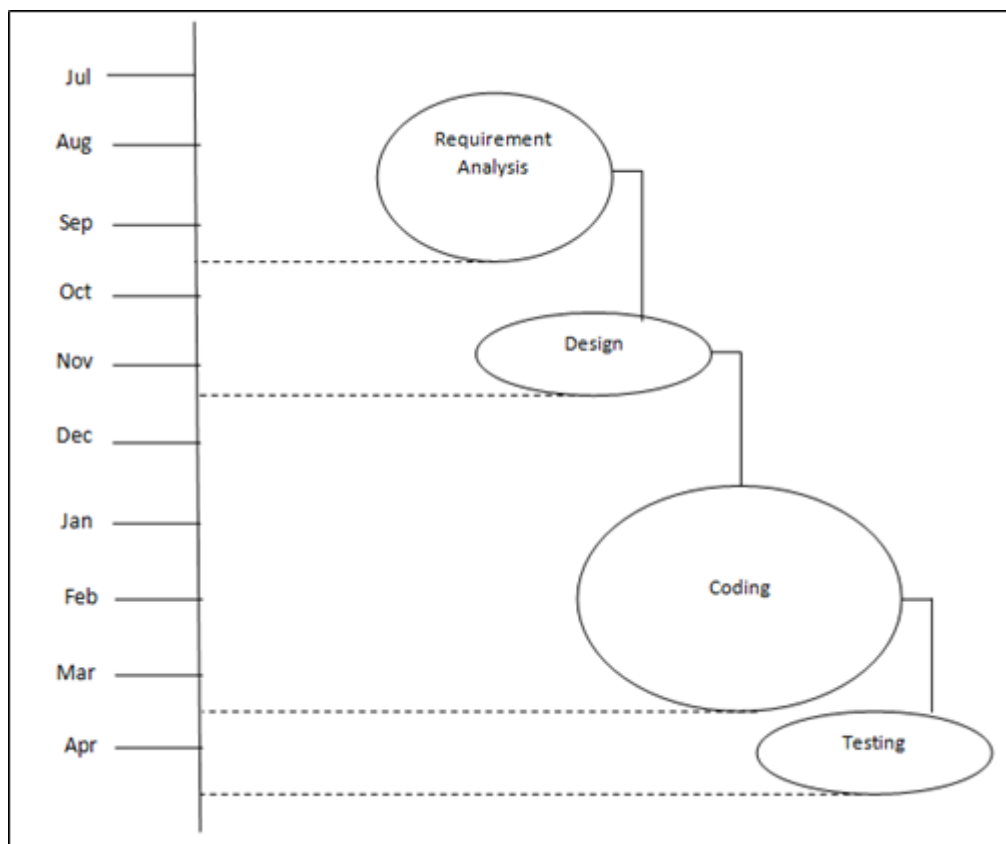
Literature Review

a. Technology review

In recent years the people are looking forward for the automation in their day to day life. And even now the people are eager to save energy consumed in day to day life People are becoming lazy to switch off the lights while leaving the room. So, the large amount of energy is wasted if the light is ON in the absence of human being. Generally, in public and private sector companies, offices most of the people are not interested to switch OFF the consumer electronic appliances like fan, light etc., if they are not present. As more and more consumer electronic and home appliances are used, the size of them is becoming large; power consumption in home area tends to grow. Moreover, useless power consumption occurs in the absence of human being in public and private sectors. Using the automation in switching the home lighting system large energy will be saved which will in turn save the money of the owner of the house. Now the people are looking forward for automation in all simple tasks they need to do. The people are trying to reduce human efforts. The automatic switching of home lighting system actually reduces the human efforts. By the use of automatic switching the person will not have given attention towards turning OFF the lights while leaving the room, this system also helps to reduce the power wasted when the lights, fans and other electric appliance are ON in the absence of any person. The components used are IR sensor for detection of human being.

ARDUINO UNO

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world.

PIR Sensor

PIR sensors are more complicated than many of the other sensors (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works. The PIR sensor itself has two slots in it each slot is made of a special material that is sensitive to IR. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room

or walls or outdoors. When a warm body like a human or animal comes in the vicinity of the sensor, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.

Bluetooth Module (HC 05/06)

HC 05/06 works on serial communication. The Android app is designed to send serial data to the Arduino Bluetooth module when a button is pressed on the app. The Arduino Bluetooth module at the other end receives the data and sends it to the Arduino through the TX pin of the Bluetooth module (connected to RX pin of Arduino).

b. Literature review (Critical appraisal of earlier work in the same area)

Vaishnavi S. Gunge, Pratibha S. Yalagi "Smart Home Automation: A Literature Review" International Journal of Computer Applications, National Seminar on Recent Trends in Data Mining (RTDM 2016)

[1] Home automation is becoming popular due to its numerous benefits. Home automation refers to the control of home appliances and domestic features by local networking or by remote control. Artificial Intelligence provides us the framework to go real time decision and automation for Internet of Things (IOT).

[2] The work deals with discussion about different intelligent home automation system and technology from various features standpoint. The work focuses on the concept of home automation where the monitoring and control operations are facilitating through smart devices installed in residential buildings.

[3] Heterogeneous home automation systems and technologies considered in review with central controller based (Arduino), web based, email based, Bluetooth-based mobile-based, SMS based, ZigBee based, Dual Tone Multi Frequency-based, cloud-based and the Internet with performance.

Requirement Analysis

Functional Requirements

- Modular/ Component Requirements

    System analysis uses various types of information systems to support many processors needed to carry out their business function. Each of these information systems has a particular purpose, and each have a life of its own. This "life of its own "concept is called the System Development Life Cycle.

System Requirements

- Hardware Requirements

    1. Micro Controller: Arduino

    2. Sensors: PIR sensor

    3. Regulated Power Supply: 230AC-5V

    4. Module: 5V Relay Module

    5. Display: LED

    7. Bluetooth module

    6. Android smartphone

- Software Requirements

    1. IDE: Android eclipse, Arduino

    2. Coding Language: Java

System Design

a) Architectural Design
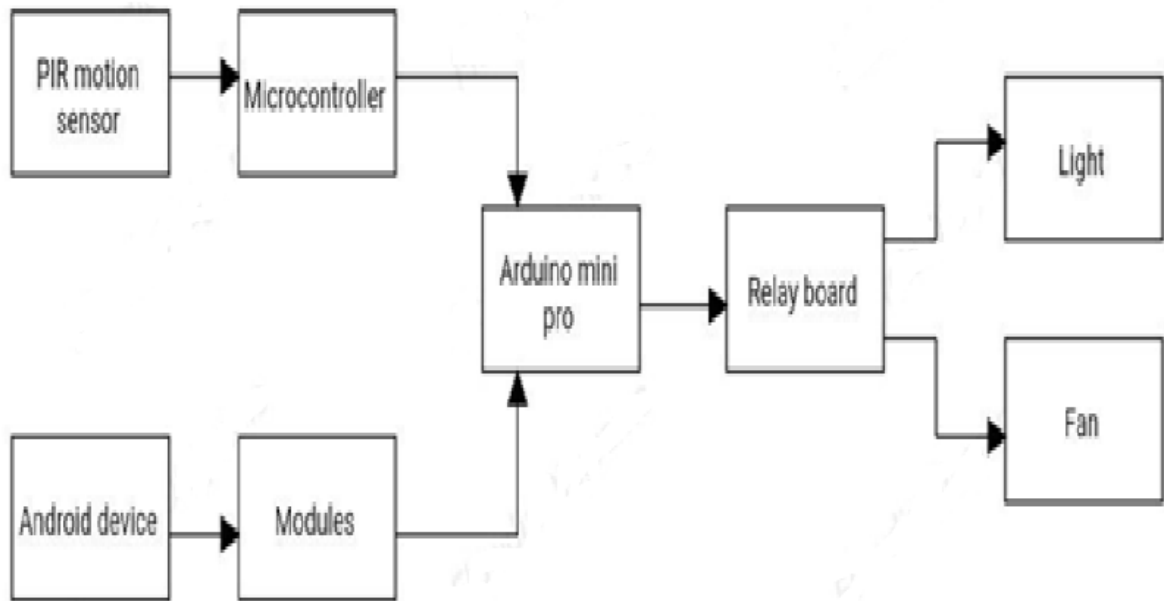
Fig No.1: Architectural Design

b)   Block Diagram
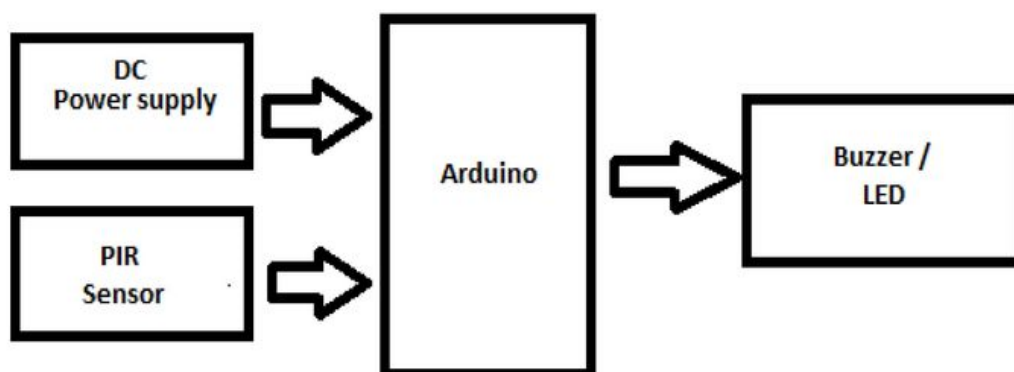
Fig No.2: Block Diagram

c) Circuit Diagram
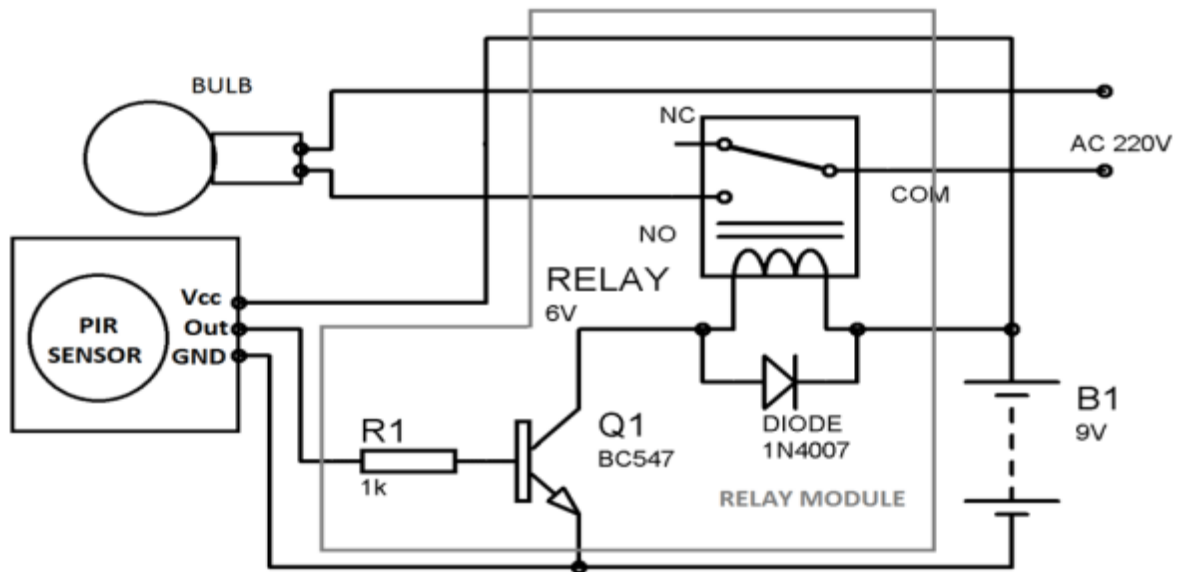
Fig No.3: Circuit Diagram.

Components

Arduino UNO

PIR Sensor

LED

Fan

100Ω Resistor (1/4 Watt)

Connecting Wires

Breadboard

Power Supply

5V Relay

d) System Modeling

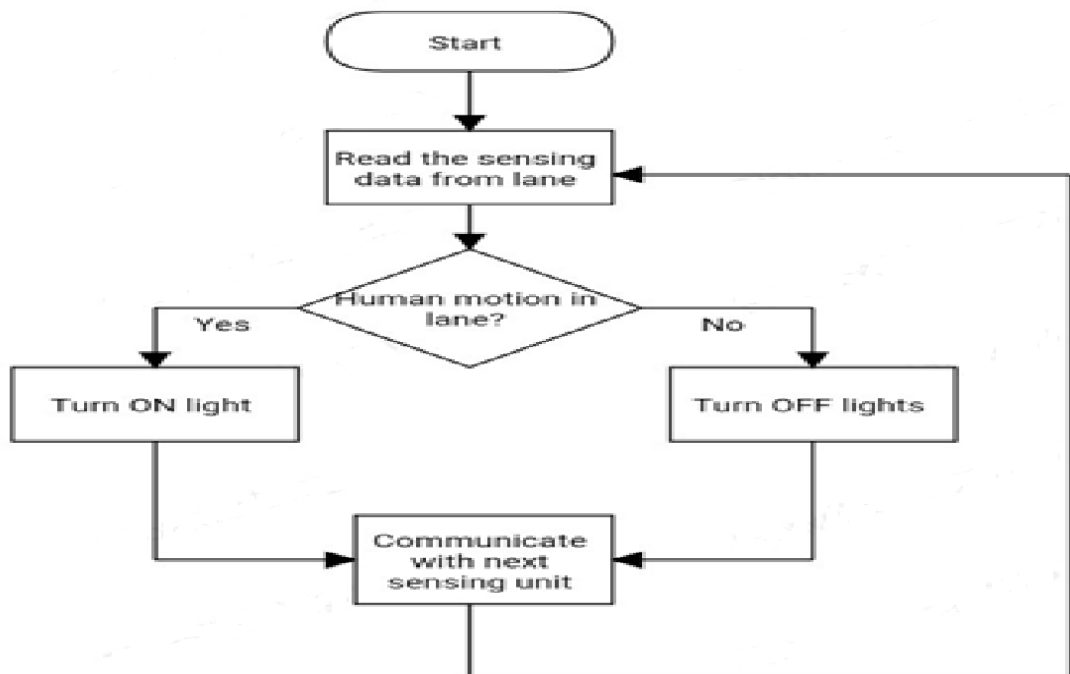- **Flowchart**
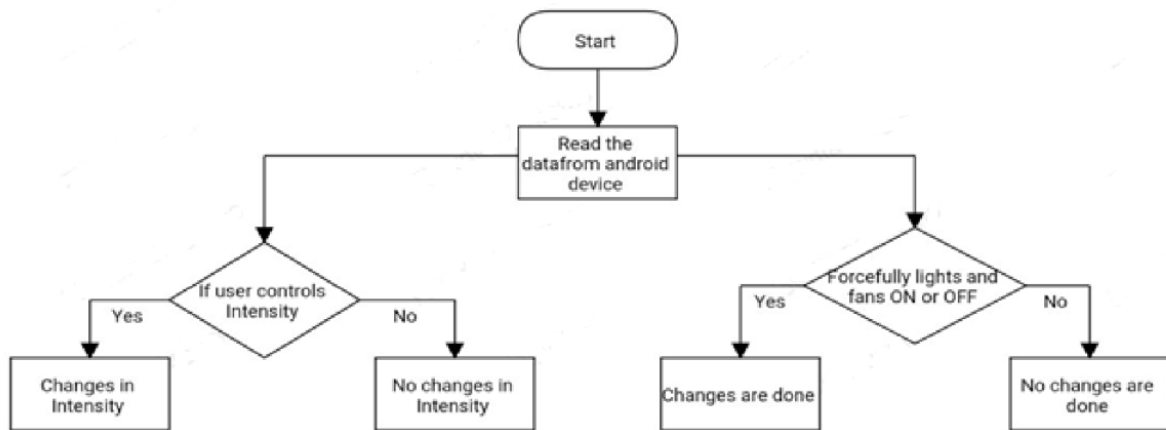
Fig No.4: Flow chart for Android application

Fig No.5: Flow chart for Human detection

- **Data Flow Diagram (Deep Android Malware Detection)**

- DFD Level_0
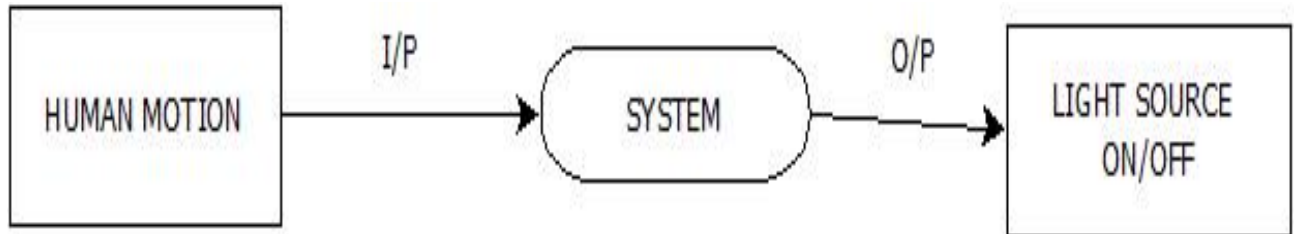
Fig No.6: DFD level 0

- DFD Level_1
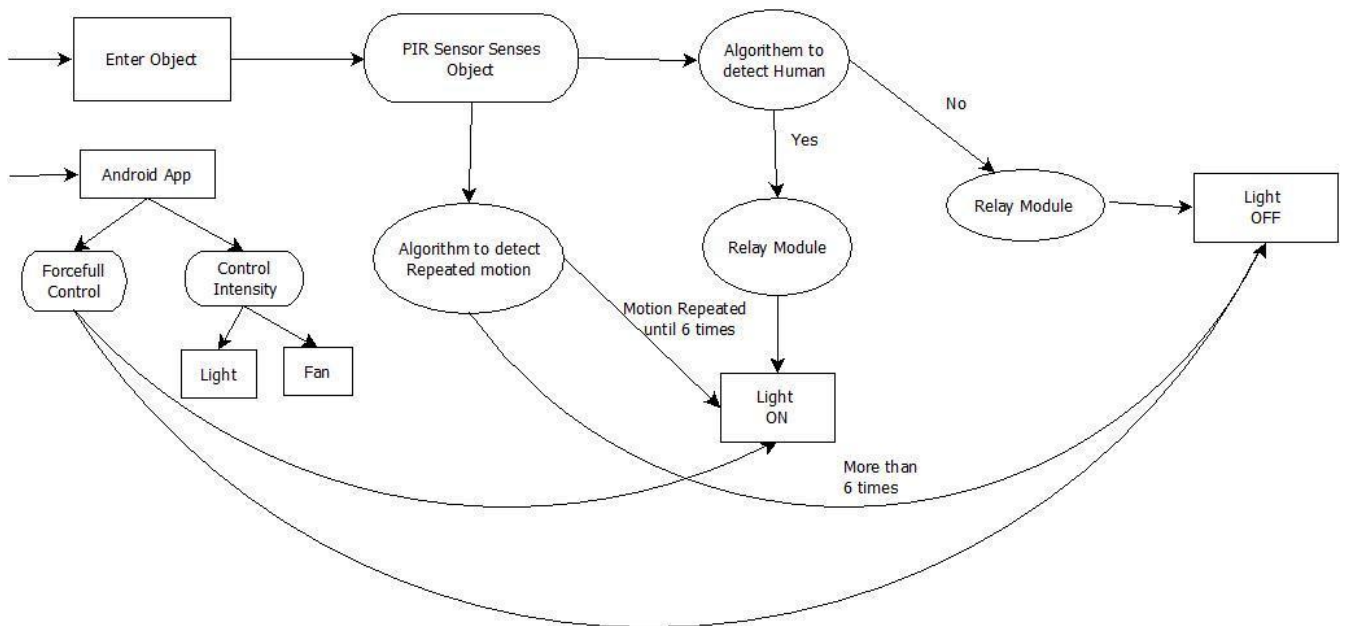
Fig No.7: DFD level 1

- **Use Case Diagram**
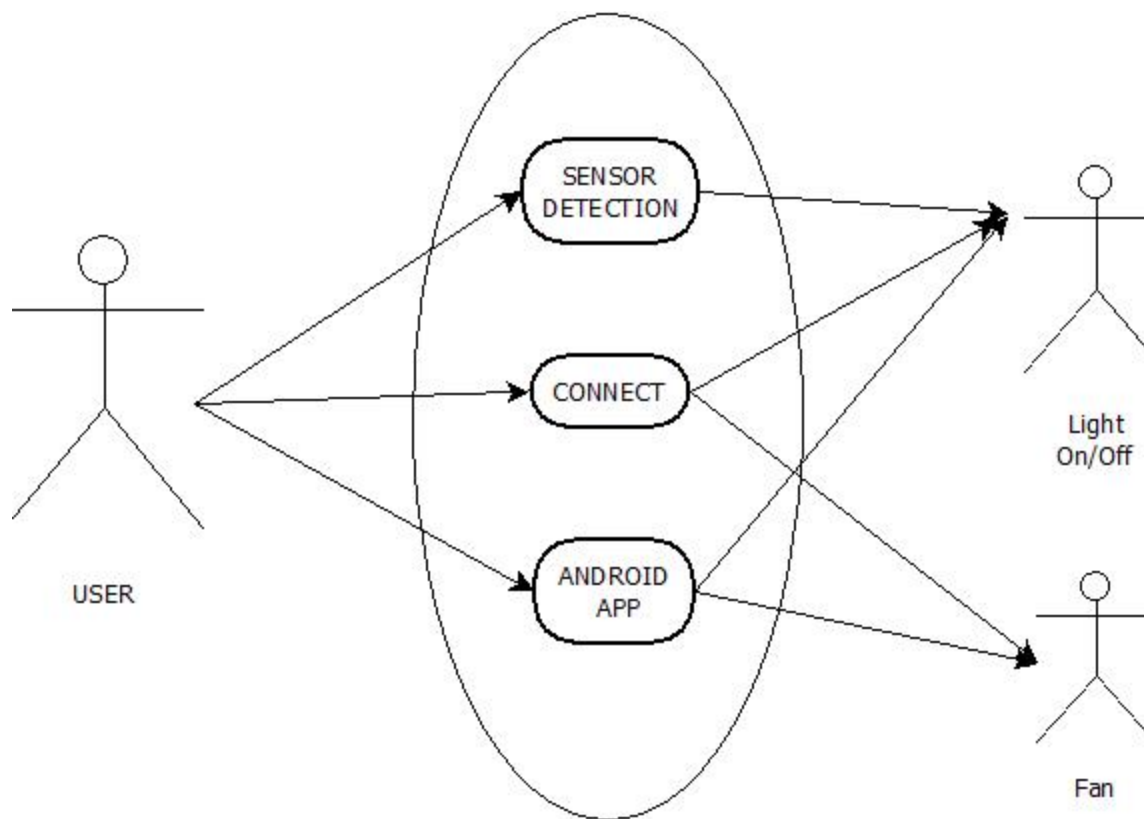
Fig No.8: Use case Diagram

Implementation

a) Setup

The motion sensor is connected to a digital in-out pin of Texas board. The board is powered up by external 12V battery or 12V adapter. The home appliances are connected to mains through relay which in turn is connected to another digital pin of the board. The board is programmed to have access to the Bluetooth. The voice call feature of the mobile phone should be enabled.

b) Working of PIR motion sensor

Human Beings emits thermal energy of wavelength around 9-10 micro-meter every day. Pyroelectric or Passive Infrared Sensor (PIR) is an electronic device which is designed to detect this IR wavelength when a human being is in its proximity. To have a wide range for detection a simple lens is used. Sensors may also be calibrated in such a way so as to ignore domestic pets by setting a higher sensitivity threshold, or by ensuring that the floor of the room remains out of focus.

The PIR motion sensor is ideal to detect movement. PIR stand for "Passive Infrared". Basically, the PIR motion sensor measures infrared light from objects in its field of view.

So, it can detect motion based on changes in infrared light in the environment. It is ideal to detect if a human has moved in or out of the sensor range.
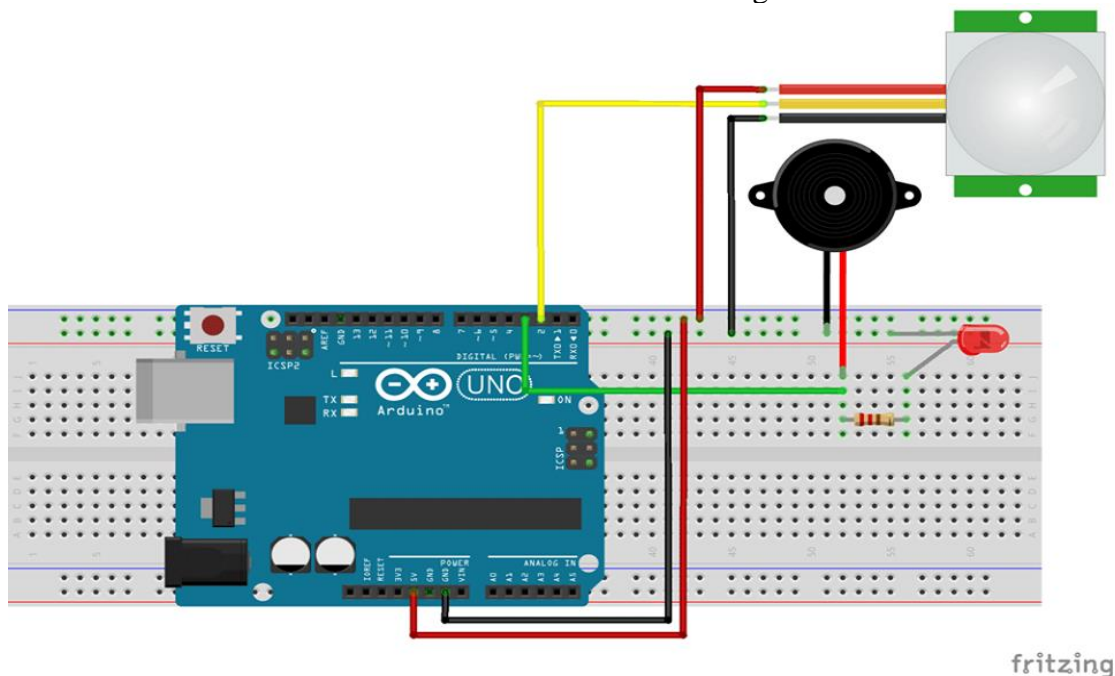

Fig No. 9: Motion Detector

c) Working of prototype

The prototype can be used in the following two ways:
1) As a smart security system
2) As a smart home automation system

d) Interface an Android smartphone with an Arduino via Bluetooth to control an LED from your phone.

There are three main parts to this project. An Android smartphone, a Bluetooth transceiver, and an Arduino.
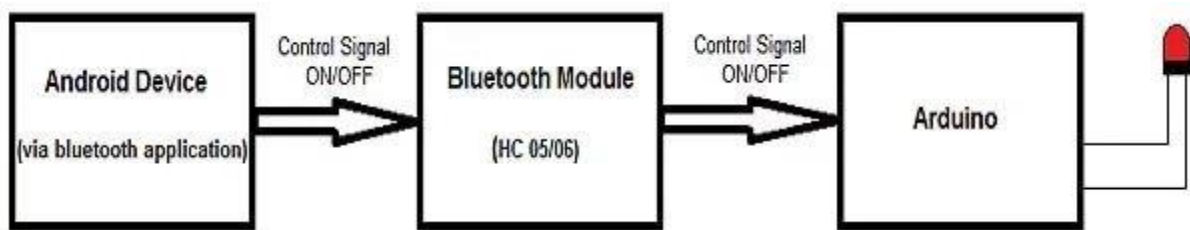

Fig No. 10: Basic flow for Bluetooth module connection

HC 05/06 works on serial communication. The Android app is designed to send serial data to the Arduino Bluetooth module when a button is pressed on the app. The Arduino Bluetooth module at the other end receives the data and sends it to the Arduino through the TX pin of the Bluetooth module (connected to RX pin of Arduino). The code uploaded to the Arduino checks the received data and compares it. If the received data is 1, the LED turns ON. The LED turns OFF when the received data is 0. You can open the serial monitor and watch the received data while connecting.
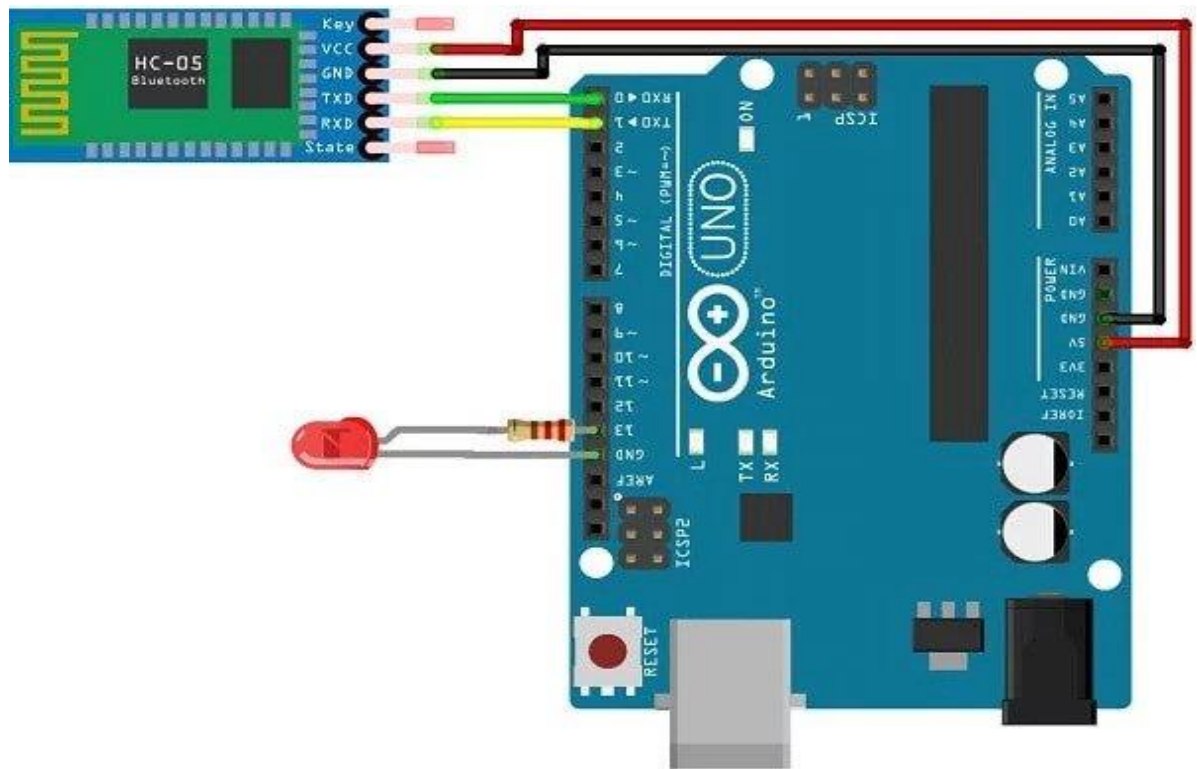
Connecting the Arduino Bluetooth Hardware

Fig No. 11: Connections for Bluetooth module

This circuit is simple and small. There are only four connections to be made between the Arduino and Bluetooth module!

Arduino Pins | Bluetooth Pins
RX (Pin 0) ————> TX
TX (Pin 1) ————> RX
5V ————> VCC
GND ————> GND

Connect an LED positive to pin 13 of the Arduino through a resistance (valued between 220Ω–1KΩ). Connect its negative to GND, and you're done with the circuit!
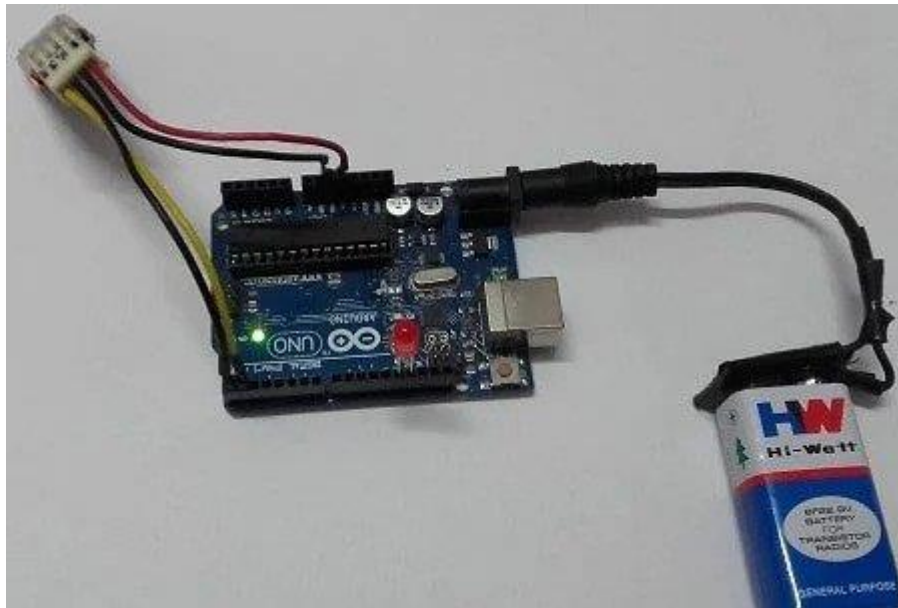

Fig No. 12: Basic checking of Bluetooth connection.

You can connect the Bluetooth module to the Arduino using a set of jumper wires and a connector.

(Note: Don't connect RX to RX and TX to TX on the Bluetooth and Arduino. You will receive no data. Here, TX means transmit and RX means receive.)

e) About the Android Studio:
- Android studio is one of the most commonly used software used for android app development which includes designing and programming.
- Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development.
- Android Studio supports all the same programming languages of IntelliJ (and CLion) e.g. Java, C++, and more with extensions, such as Go; and Android Studio 3.0 or later supports Kotlin and all Java 7 language features and a subset of Java 8 language features that vary by platform version." External projects backport some Java 9 features.
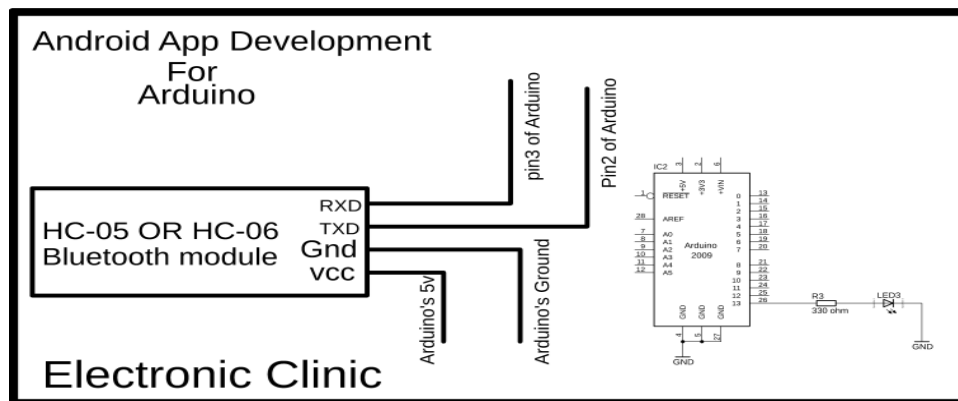
Circuit Diagram:

Fig No. 13: Circuit Diagram

This is a very basic circuit diagram.
An LED is connected with Pin number 13 of the Arduino through 330-ohm resistor. This is a 2.5v LED and that's why I connected this current limiting resistor. If you have a 5v LED then there is no need to connect this resistor. In Video you will see I am not using this resistor as the led I am using is 5v. The main reason I added 2.5v LED in the circuit diagram is that this led is very commonly available. It really doesn't matter if you use a 2.5v LED or a 5v led or even if you add a relay to control a 220 Vac bulb, it will have no effect on the programming.
On the left side, you can see a Bluetooth module, you can use HC-05 or HC-06 Bluetooth Module. If you are using a Bluetooth for the first time then you can watch my getting started tutorial on the Bluetooth module available in the related projects section. The Bluetooth module Tx and Rx pins are connected with the Arduino's pin number 2 and pin number 3. Pin number and pin number 3 will be used as the Serial Port, which will be defined in the programming. While the VCC and GND are connected with the Arduino's 5v and GND.

f) CNN Algorithm

- In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural networks, most commonly applied to analyzing visual imagery. They are also known as shift invariant or space invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics. They have applications in image and video recognition, recommender systems, image classification, medical image analysis, natural language processing, and financial time series.
- The name "convolutional neural network" indicates that the network employs a mathematical operation called convolution. Convolution is a specialized kind of linear operation. Convolutional networks are simply neural networks that use convolution in place of general matrix multiplication in at least one of their layers.
- Object detection accuracy has been increased by employing deep learning-based Faster region convolutional neural network (Faster R-CNN) algorithm. Object association is

carried out by using appearance and improved motion features. Evaluation results show that we have enhanced the performance of current state-of-the-art work by reducing identity switches and fragmentation.

- In our project we are using it to detect human being which will lead to on the lights of the room only if the human being is detected. If any other object enters other than human being then the lights will stay off. For eg. If a cat, dog or any robot enters in the room the algorithm is such trained that it will keep recognize that it is not a human and will not allow the further action to take place.
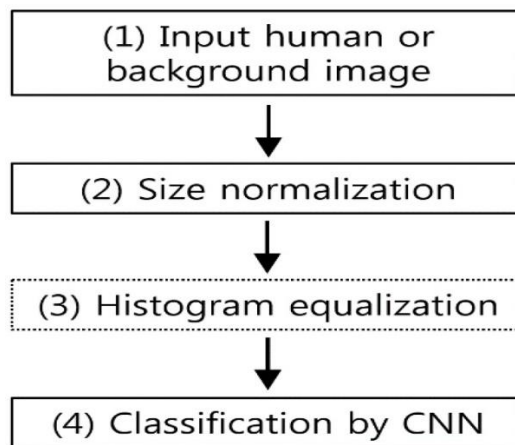
Fig No. 14: Flowchart of proposed method

- There are two stages of Faster R-CNN.
1. In the first stage, region proposal network (RPN) generates the anchors on the regions present in the image where there might be a high possibility of the presence of an object. This process is further divided into three steps:
   a.) First step involves the process of feature extraction by using convolution neural network. Convolution feature maps are generated at the end of last layer.
   b.) In second step, a sliding window approach is used on these feature maps to generate anchor boxes. These anchor boxes are further refined in the next step to indicate the presence of objects.
   c.) Finally, in the third step, generated anchors are refined using a smaller network which calculates the loss function to select top anchors containing objects.

   - For region proposal network, prerequisite step is extraction of convolution features that are extracted using backbone network.
   - RPN is trained to propose regions of interest (ROIs) on feature maps which are obtained from input image. These RoIs are enclosed in bounding boxes. RPN outputs different scales of bounding boxes, on feature maps. These bounding boxes contain high probability of presence of objects.
2. Now comes the second stage of Faster R-CNN, which is a classification of ROIs obtained from RPN network. To bring the ROIs in feedable format for the classifier, a ROI-pooling method is used which uses the pooling mechanism to shape all RoIs in

the same scales. Its purpose is to perform max pooling on inputs of nonuniform sizes to obtain fix-sized feature maps for each RoI.

- ROI classification and regression

Now same-sized feature maps or RoIs obtained from RoI-pooling are further proceeded for classification and regression purpose. This step runs two stages in parallel. Bounding box classification and regression loss are calculated based on the optimization of the loss function. Classification head results in the class score for each individual category, and regression head resizes the bounding box values (x,y,w,h)xywh to cover complete object. Overall performance and accuracy of Faster R-CNN is better than all the traditional object detectors. A diagram for Faster R-CNN is given below.
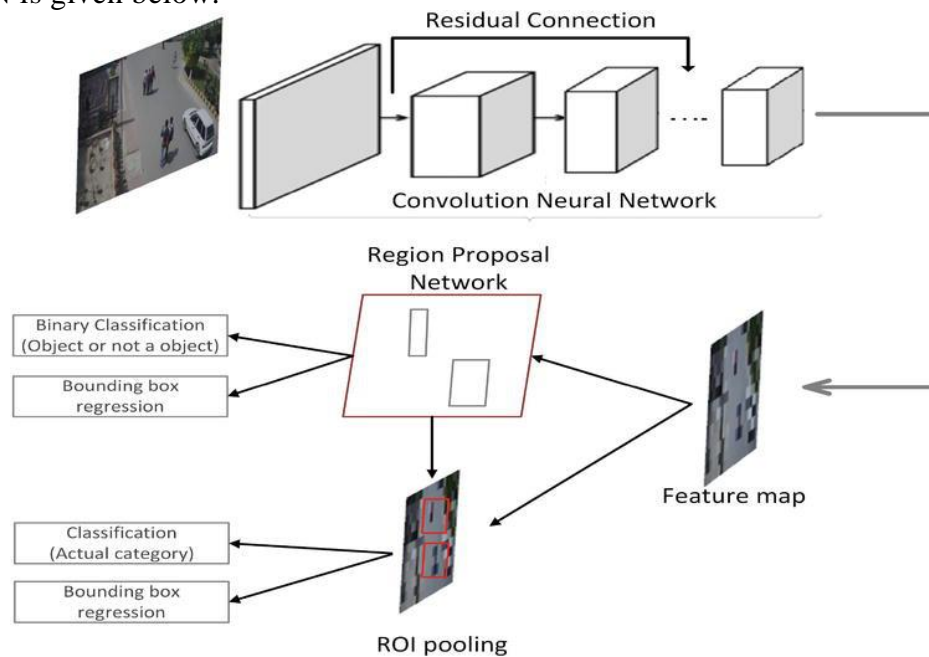
Fig No. 15: Complete framework diagram of Faster R-CNN.

We have trained Faster R-CNN on 4000 annotated images of human heads, shoulders, and complete bodies which improved detection accuracy efficiently having only few numbers of miss rate.

g) MQTT

MQTT is the standard messaging and data exchange protocol for the Internet of Things (IoT). The MQTT protocol provides a scalable and cost-efficient way to connect devices over the Internet. You can use MQTT to deliver data over the Internet in near real-time with predefined guarantees of delivery. Connecting millions of IoT devices to your business infrastructure, sending instant updates, and moving data efficiently is where MQTT truly excels.
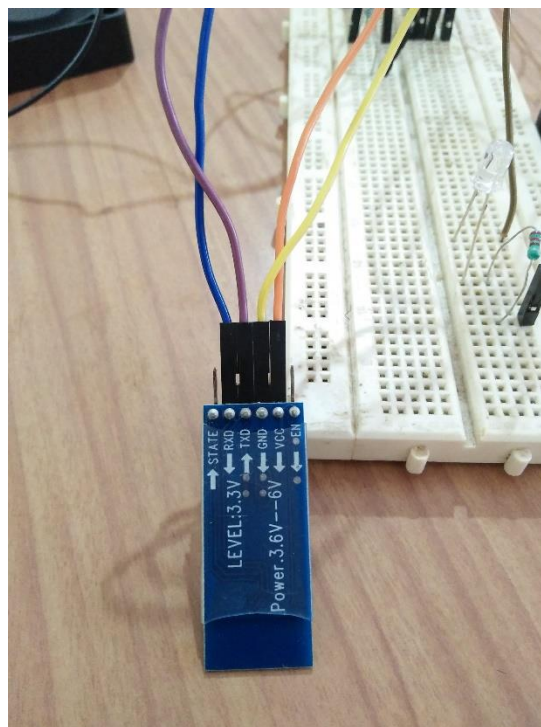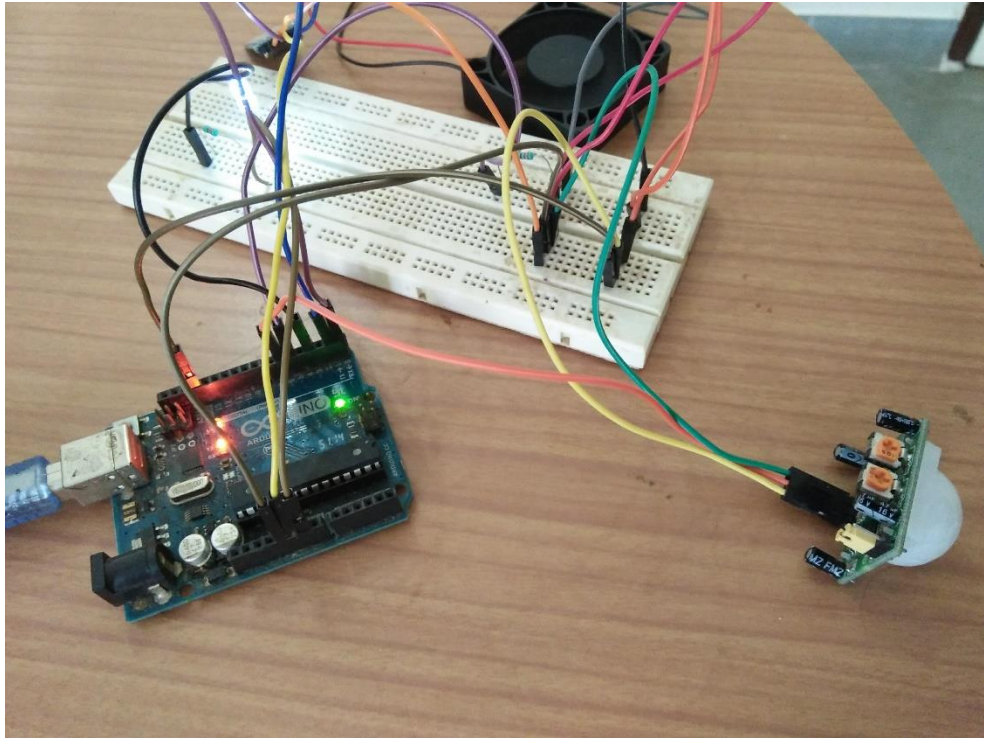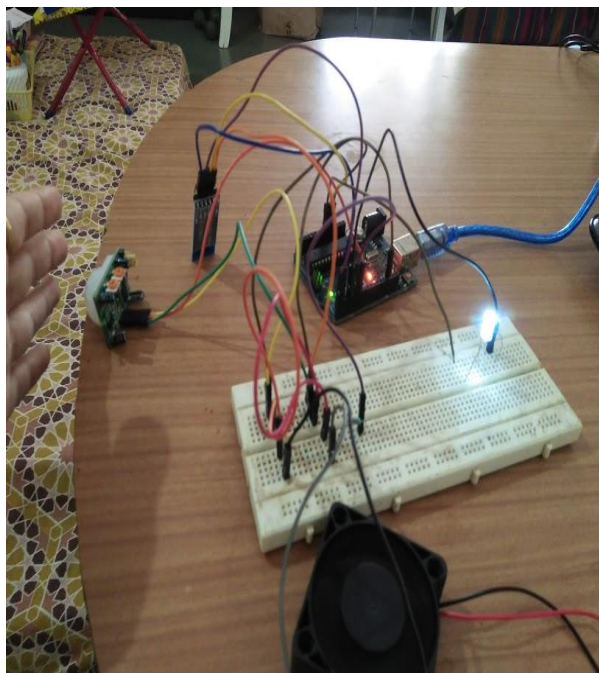
Snapshots of System
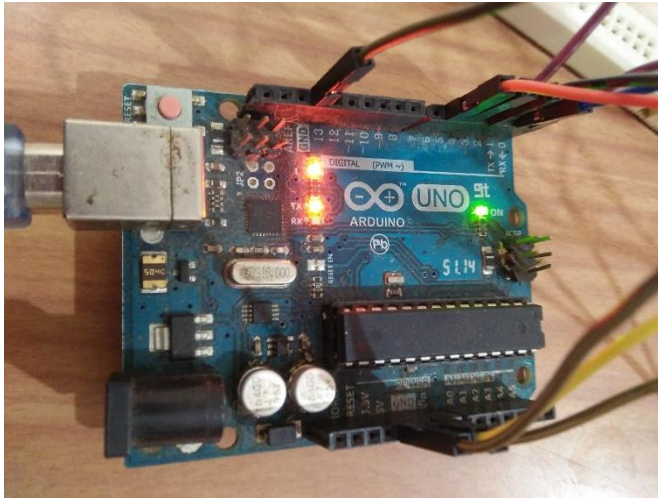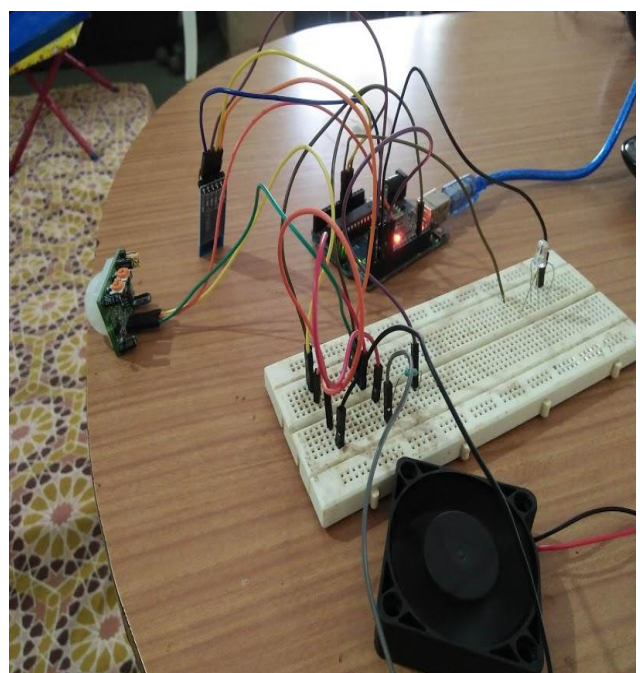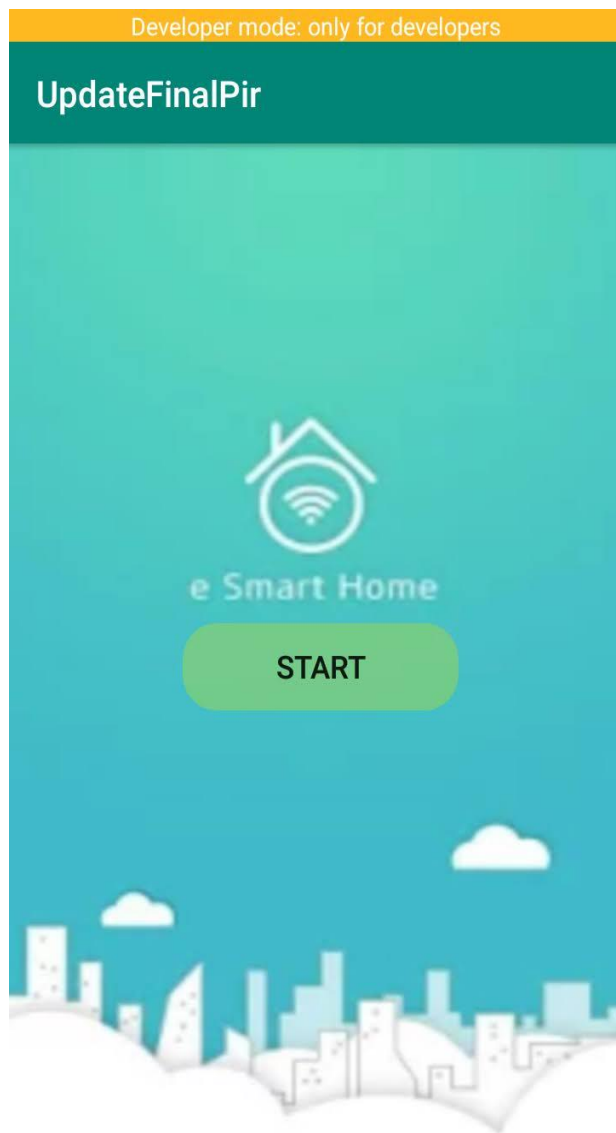

Arduino UNO

PIR Sensor

Bluetooth Module

Hardware connections
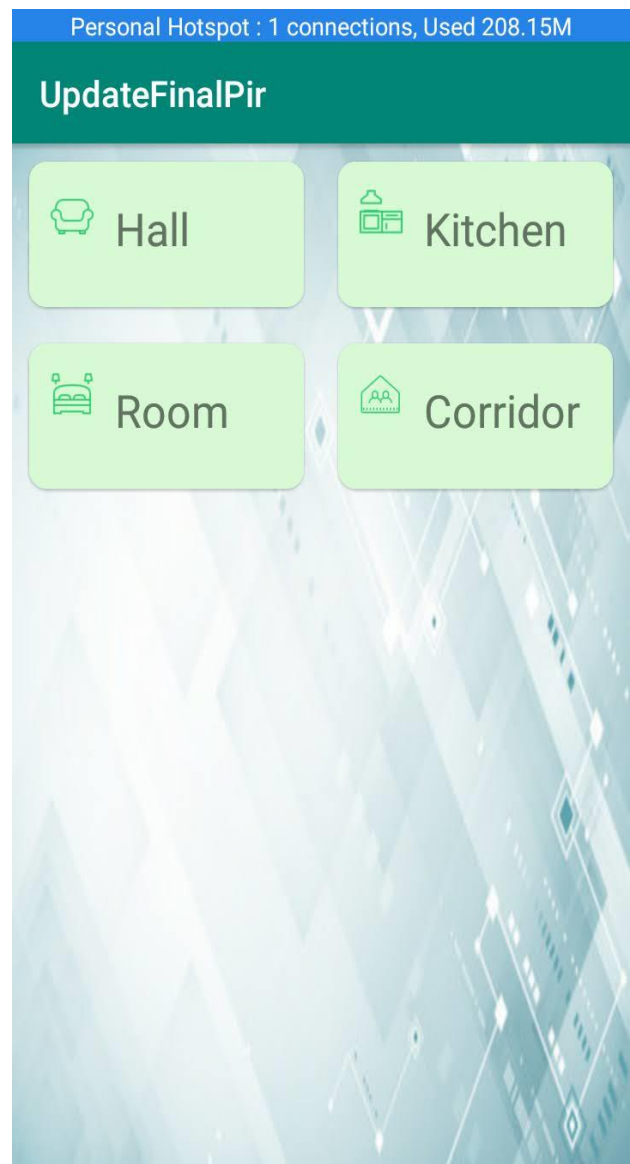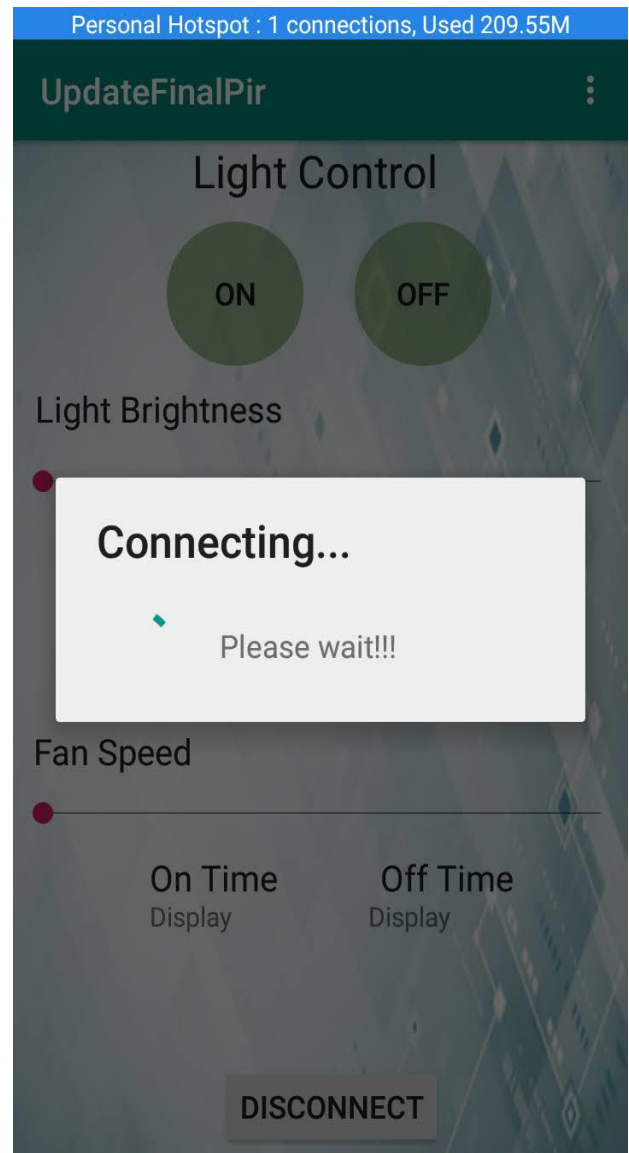

Motion detected hence light is on

Motion not detected hence light is off

UpdateFinalPir

UpdateFinalPir

e Smart Home

START

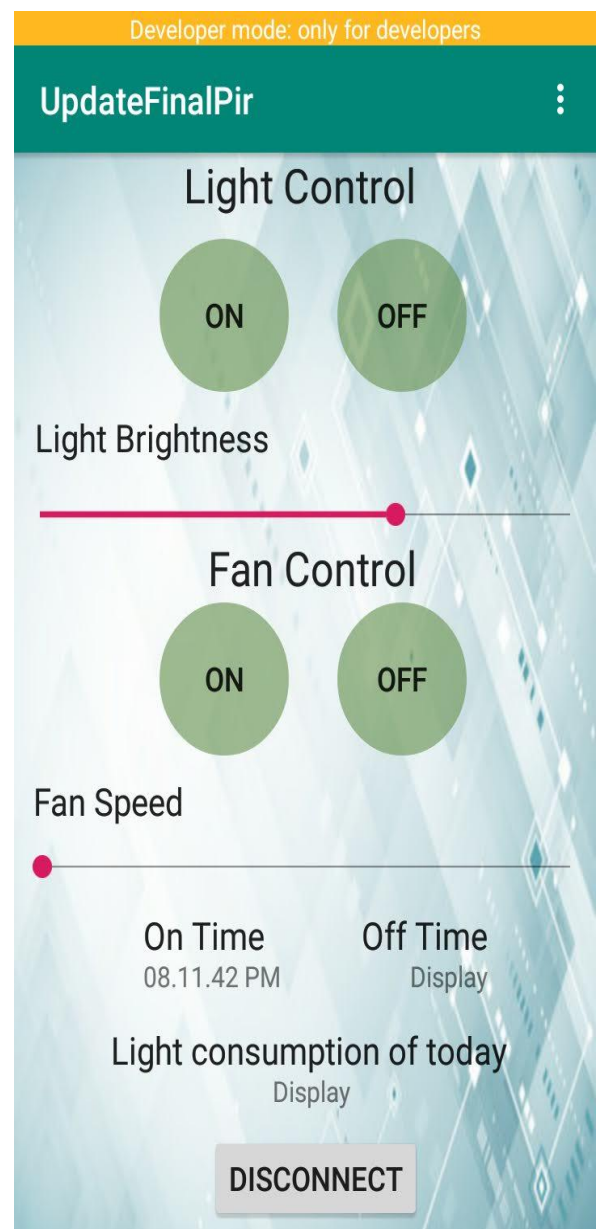Hall   Kitchen

Room   Corridor

Starts the application

Here we can choose the room we are entering

Connecting to Bluetooth

1. Turning on and off lights as well as fan.
2. Handling the intensity of light and speed of fan through the slider provided.
3. Also, the light consumption details will be provided.

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