CSE360: Computer Interfacing

Project Title: Smart Home Security System

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Section: 01

Group No: 3

Group Information

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Introduction

In our technologically advanced age, securing our homes is more important than ever. Smart technologies and the IoT have led to new home security methods. Our Smart Home Security System is next. The Arduino Nano microcontroller, I2C 20x4 LCD Display, PIR Sensor, Flame Sensor, MQ-2 Gas Sensor, Bluetooth Module (HC-05), Buzzer, and Jumper Wires are used in our project. The breadboard integrates these components. We created a highly efficient and flexible security system using this extensive setup, giving you full control over home security. Our system's primary processing unit, the Arduino Nano, coordinates sensors. The I2C 20x4 LCD Display displays critical system status and events in real-time. Infrared PIR sensors detect movements within their range and activate the alarm system. The MQ-2 Gas Sensor enhances safety by identifying dangerous gases. The inbuilt Buzzer alerts people to unauthorized entry or gas leaks with a loud sound. Our solution is designed to seamlessly integrate with your smartphone using the HC-05 Bluetooth Module. This feature lets customers remotely monitor and operate the security system using a mobile app, making it more convenient and accessible. This project intends to provide homeowners with a reliable, simple, and technologically sophisticated security system that improves their home security. By proactively protecting loved ones and things, the Smart Home Security System provides a feeling of security wherever.

Application Area:

The Smart Home Security System, which has been developed utilizing the Arduino Nano microcontroller and a diverse array of sensors and actuators, demonstrates adaptability across a multitude of scenarios. The advanced functionalities of this product are designed to meet the specific requirements of homeowners, rendering it an optimal solution for the subsequent application domains:

1. The system's main application domain is within residential environments. Individuals who own residential properties have the option to install a technologically advanced security system, which enables them to effectively monitor their primary residences, rental apartments, or vacation homes. The PIR sensor is capable of detecting any movement within its surrounding area, thereby providing prompt notifications in the event of possible intrusions. In addition, the gas sensor serves the purpose of detecting noxious gases, thereby offering an augmented level of protection against potential dangers such as gas leakage, safeguarding the welfare of the occupants.

2. The Smart Home Security System proves to be of great value for individuals who possess vacation homes or own properties situated in remote locations. The utilization of the Bluetooth module enables individuals to remotely observe the security condition of their assets, receive notifications on their mobile devices, and promptly respond to any instances of unauthorized actions.

3. The security system is equally suitable for small businesses and office environments. The implementation of security measures aids entrepreneurs and business owners in safeguarding their premises outside of operational hours, thereby discouraging potential intrusions and guaranteeing the protection of valuable assets and equipment.

4. Gas Leak Detection in Workspaces: In addition to residential environments, the gas leak detection capability of the MQ-2 Gas Sensor holds significant value in commercial and industrial contexts. This technology has the potential to be utilized in various settings such as workshops, laboratories, and factories, to mitigate the occurrence of potential accidents resulting from gas leaks. By doing so, it serves the purpose of safeguarding both valuable assets and the well-being of the individuals involved.

In addition to the above-mentioned applications of our project, it should be noted that due to the modular nature of the project inclusion of other sensors can highly broaden the scope of applications associated with the project.

Project Details

Technological Tools & Sensors:

- **Arduino Nano:**

The way Arduino works is exceptionally straightforward. It primarily depends on three elements: inputs, which give the controller data from sensors and switches. You can input almost anything, including on/off signals, variable voltage signals, and communications with other controllers.

Figure 1: Arduino Nano

- **I2C 20x4 LCD Display:**

A 20x4 LCD is an essential and widely used component that is used in numerous gadgets and circuits. A 20x4 LCD can display 20 characters over its 4 lines. A 5x7 grid of pixels compose each character. Two registers make up the LCD. They are:
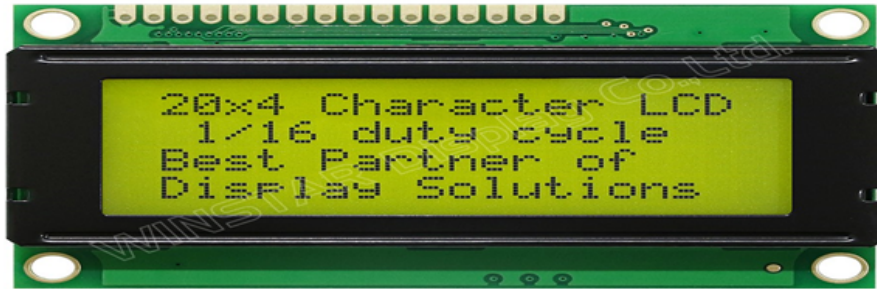
1. The Command Register,
2. The Data Register.

Figure 2: 20x4 LCD Display

- **PIR Sensor:**

PIR-based motion detectors frequently use PIR sensors. Systems for safety and security typically use it. Since a live thing's body emits heat energy in the form of infrared radiation when it is exposed to the sensor, the sensor will be able to detect movement.

Figure 3: PIR Sensor

- **Flame Sensor:**

A flame sensor is a type of detector created to identify and react to the appearance of a fire or flame. This sensor can guarantee protection from potential fire threats. The flame sensor's sensing technique, which enables it to react more quickly and accurately, makes it more efficient at detecting flames than other heat or smoke sensors.
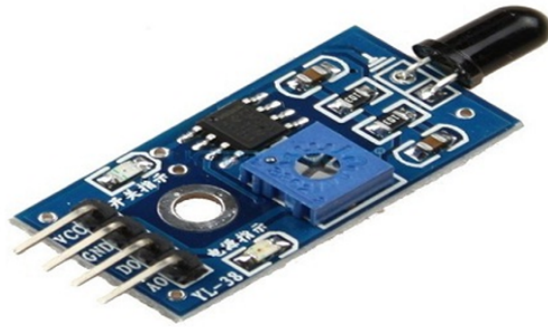

Figure 4: Flame Sensor

- **MQ-2 Gas Sensor:**

MQ gas sensors are a collection of sensors that can recognize a wide range of gases, including alcohol, smoke, methane, and hydrogen. The MQ-2 type of MQ gas sensor has a flammable gas detection range of 300 to 10,000 parts per million (ppm). MQ-2 is often used in household gas leak alarms due to its high sensitivity to smoke and propane.

Figure 5: MQ-2 Gas Sensor

- **Jumper Wire:**

Jumper wires are frequently used in electrical circuits to connect two terminals. They come in a range of lengths. There are three types of jumper wires, which are:

1. Female To Male,
2. Male To Male,
3. Female To Female.

Figure 6: Jumper Wire

- **Buzzer:**

A buzzer is an electrical device that transforms an audio signal into sound; it can be mechanical, electromechanical, or piezoelectric in construction. It is often used in a variety of devices, including clocks, alarms, and rail systems, and as a technique to validate human input like a mouse click or keyboard stroke.

Figure 7: Buzzer

- **Large Breadboard:**

It is standard practice for designers to quickly add, remove, or alter components while building temporary circuits on a breadboard. In a word, it is a plastic board with rows of linked sockets that are used to build electrical circuits.
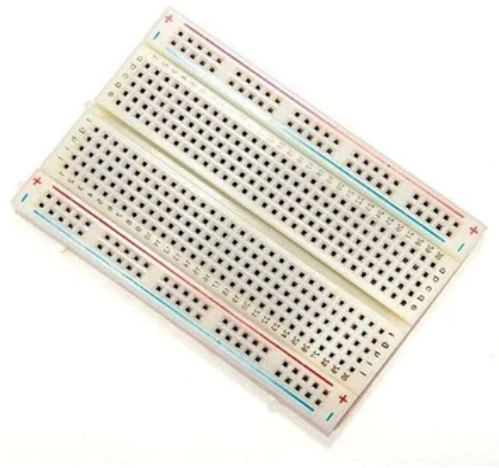

Figure 8: Large Breadboard

- **HC-05 Bluetooth Module:**

A well-known Bluetooth module for wireless electrical device connectivity is the HC-05. It uses the Bluetooth 2.0 protocol and provides a quick and affordable way to enable Bluetooth connectivity for a variety of tasks. Due to its simplicity of use and dependable performance, the module is frequently used in robotics, IoT, and hobbyist applications.

Figure 9: HC-05 Bluetooth Module

Working Mechanism of Sensors & Module:

In this project, we will be using three sensors and one module. They are,

1. PIR Motion Sensor,
2. MQ-2 Gas Sensor,
3. Flame Sensor,
4. HC-05 Bluetooth Module.

A brief overview of the mechanism of these sensors and modules is given below:

- **Working Mechanism of PIR Sensor:**

A passive infrared (PIR) sensor is a type of motion detector that can detect the presence of moving objects by monitoring changes in the heat energy emitted by those objects. The PIR sensor uses a Fresnel lens to enable its two slots to detect changes in the amount of infrared radiation reaching each slot. Normally, both slots detect the same amount of radiation from the environment. However, when a person or animal passes by, the first slot is temporarily blocked, resulting in a positive differential change between the two slots. When the body leaves the sensor's range, the opposite occurs, and a negative differential change is detected. This change in radiation triggers the sensor to send a signal to a connected device to activate an alarm or perform another action.

Features of PIR sensor:

- Detection Range: Upto 30 feet
- Field of View: 110-180 Degrees
- Response Time: Within a fraction of second
- Power Consumption: Very low

- **Working Mechanism of MQ-2 Gas Sensor:**

The MQ2 gas sensor can detect gases like LPG, methane, ethanol, and carbon monoxide in the air. It works by using electricity and has a special part that changes its resistance when it touches gas. This change in resistance creates an output voltage, which can be used to measure the concentration of the gas in the air. The sensor heats up to become more sensitive to gas, and the higher the concentration of gas, the higher the voltage values it produces

- **Working Mechanism of Flame Sensor:**

  A flame sensor is an electrical device that can detect flames or fire by using special light called infrared radiation. It has a lens that focuses this light onto a sensing element, like a photodiode or a phototransistor. When the sensor sees a flame, it sends the infrared light to the sensing element, which changes the electrical current passing through it and activates the sensor's output signal. This signal can then trigger a buzzer. The flame sensor can work with different wavelengths of light, typically between 700 and 1100 nm. It operates in temperatures ranging from -25° to 85° Celsius.

- **Working Mechanism of HC-05 Bluetooth Module:**

  The HC-05 Bluetooth module works as a transceiver, enabling wireless data transmission between devices using Bluetooth technology. Upon initialization, it enters pairing mode, allowing other Bluetooth devices to discover and connect with it. Once paired, it establishes a secure connection with the user's device. Data is sent and received transparently between the module and the connected device, acting as a bridge. The module communicates with external devices via serial communication using UART protocol. It supports AT commands for configuration, like setting the device name and communication parameters. Overall, the HC-05 facilitates seamless wireless data transfer by pairing and connecting with other Bluetooth-enabled devices.

Connection with ICs:

The main microcontroller board used in the project is ARDUINO NANO. It is connected to various peripherals using jumper wires. The detailed connections between the Arduino board and peripherals are given below:

- **I2C 20x4 LCD Display:**

  - Connect the SDA pin (Serial Data) of the LCD to Arduino A4 (Analog Pin 4)

  - Connect the SCL pin (Serial Clock) of the LCD to Arduino A5 (Analog Pin 5)

  - Connect the VCC pin of the LCD to Arduino 5V

  - Connect the GND pin of the LCD to Arduino GND

- **PIR Sensor:**

  - Connect the output pin of the PIR Sensor to Arduino pin D6 (pirSensorPin)

  - Connect the VCC pin of the PIR Sensor to Arduino 5V

  - Connect the GND pin of the PIR Sensor to Arduino GND

- **Flame Sensor:**

  - Connect A1 pin of the Flame Sensor to Arduino A1 (analogRead(gasSensorPin))

  - Connect the VCC pin of the Flame Sensor to Arduino 5V

  - Connect the GND pin of the Flame Sensor to Arduino GND

- **MQ-2 Gas Sensor:**

  - Connect A0 pin of MQ-2 Gas Sensor to Arduino A0 (analogRead(flameSensorPin))

  - Connect the VCC pin of the MQ-2 Gas Sensor to Arduino 5V

 - Connect the GND pin of the MQ-2 Gas Sensor to Arduino GND

- **Buzzer:**

  - Connect the positive (anode) pin of the buzzer to Arduino pin D7 (buzzerPin)

  - Connect the negative (cathode) pin of the buzzer to Arduino GND
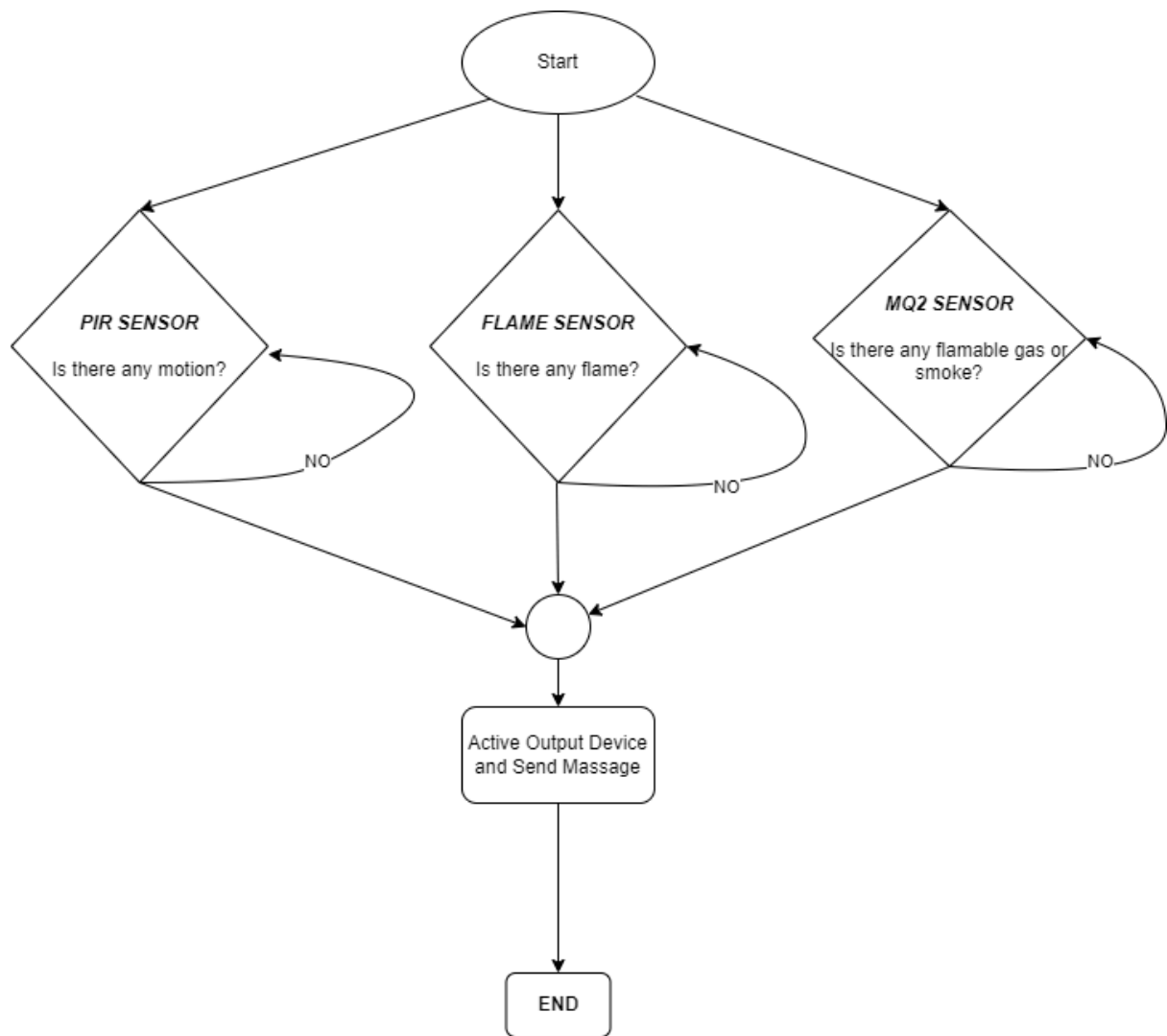

- **HC-05 Bluetooth Module:**

  - Connect the TX pin of the Bluetooth module to Arduino pin D3 (TX)

  - Connect the RX pin of the Bluetooth module to Arduino pin D2 (RX)

  - Connect the VCC pin of the Bluetooth module to Arduino 5V

  - Connect the GND pin of the Bluetooth module to Arduino GND

Circuit Diagram:
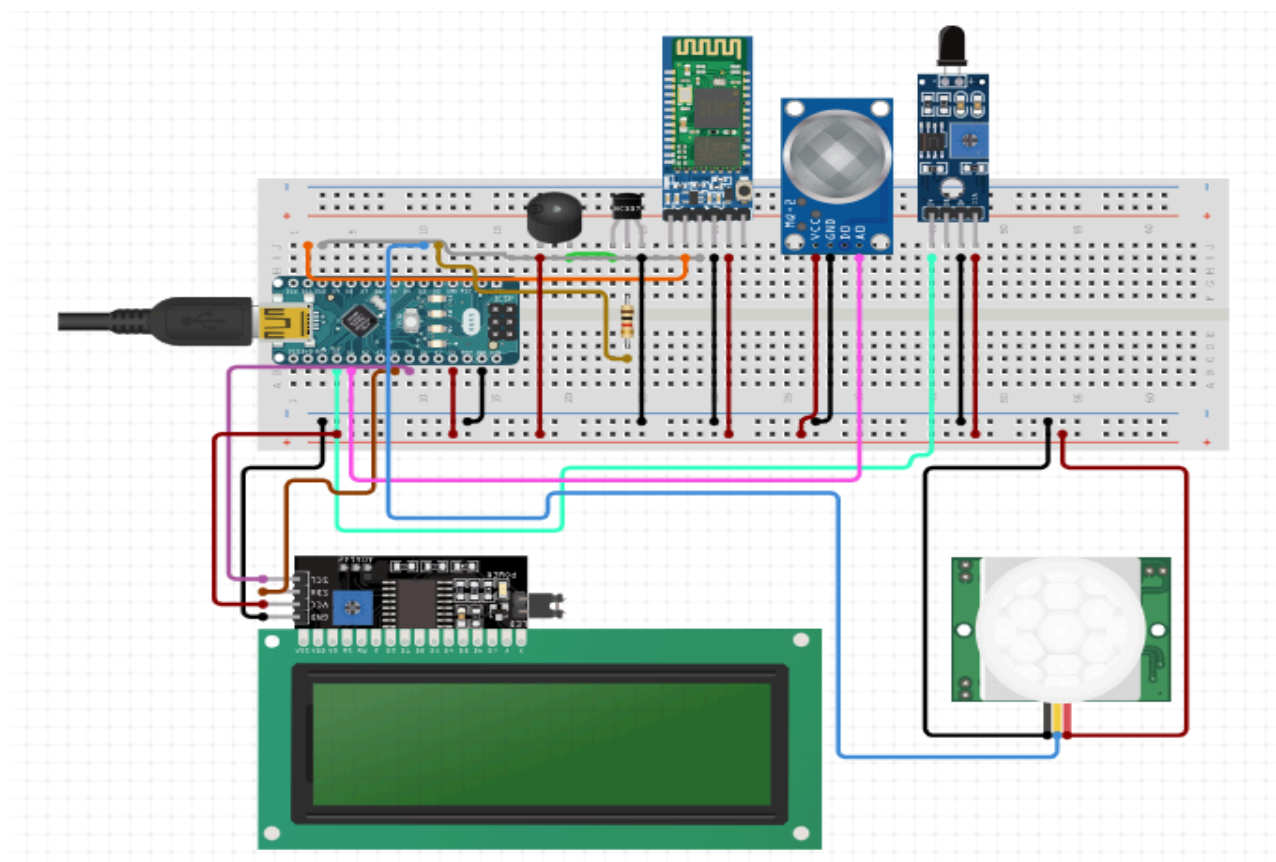
Data Flow from sensors through ICs to I/O devices:

For the PIR Sensor, Whenever it senses any motion in front of it, It will have a value of 650 and give this signal from the OUT pin to the A1 pin of ARDUINO NANO. Then ARDUINO NANO sends the data to the output devices; LCD and Buzzer. LCD will show that the PIR sensor is active, so someone is in the room. Also, Buzzer will make a sound to alert the owner. Also, by using the Bluetooth module an alert message will be sent to the house owners' phone. The MQ-2 gas sensor senses flammable gas and smoke in the air. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane, and Carbon Monoxide concentrations ranging from 200 to 10000 ppm. So, if there is any flammable gas or dense smoke in the air, the MQ-2 sensor activates and sends the signal to ARDUINO NANO by A0 pin. As a result, LCD will show that the gas sensor is activated, also Buzzer will be activated to alert the owner. Here also, an alert message will be sent to the house owners' phones. Now the flame sensor is dependent on infrared light. The IR photodiode will identify IR light from any heated body. This number is then compared to a threshold amount. When the radiation exceeds the threshold value, the sensor will be activated and send the signal to ARDUINO NANO by pin 10. Then ARDUINO NANO will activate the LCD and buzzer. LCD will show that the flame sensor is activated and the buzzer will make a sound to alert the owner and a message will be sent to the owner by using the Bluetooth module.

Work Plan:
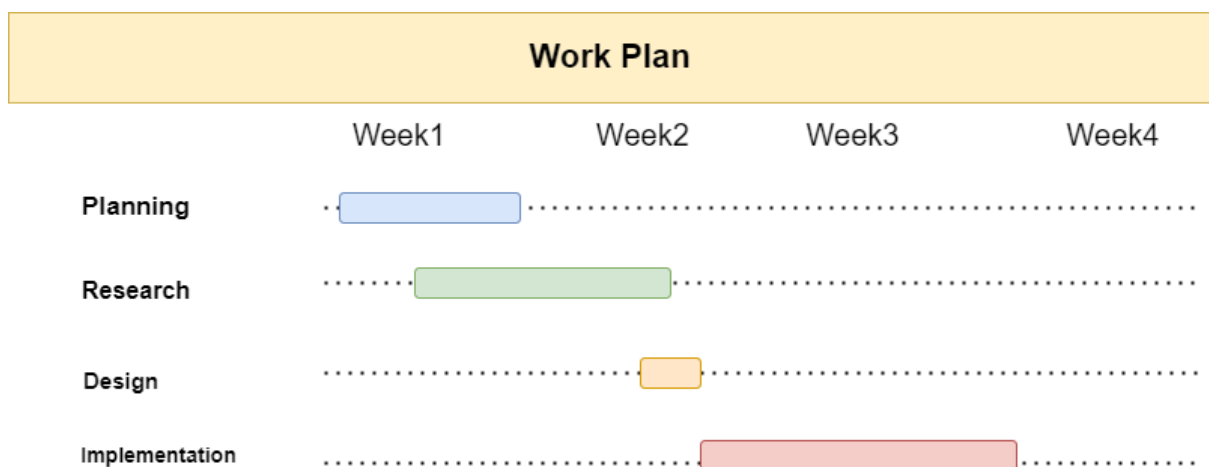
Estimated Cost Analysis

The components we will be using are 1 Arduino Nano, 1 I2C Serial 20x4 LCD Display, 1 Active Buzzer 5V, 1 PIR Sensor, 1 Flame Sensor, 1 MQ-2 Gas Sensor, 1 HC-05 Bluetooth Module, Jumper wire 30 pcs, 1 Large breadboard.

Price List	
Arduino Nano	450 TK
20x4 LCD Display	450 TK
I2C Module	115 TK
Active Buzzer 5V	15 TK
PIR Sensor	80 TK
Flame Sensor	50 TK
MQ-2 Gas Sensor	150 TK
HC-05 Bluetooth Module	320 TK
Jumper Wire-30 pcs	30 TK
Large breadboard	120 TK
Total Amount	1780 TK

Responsibilities of Each Member

Name	ID	Responsibility
Farhan Faruk	20301137	Technology and Tools, Working Mechanism of Sensors, Circuit Diagram.
H.M. Sarwer Alam	20301224	Data flow from sensors through ICs to I/O devices, Data Flow Diagram, Workplan.
Elham Nusrat	18301265	Conclusion and Future Work, Reference.
Maruf Bin Murtaza	23141042	Connection with ICs, Estimated Cost Analysis.
Md Mahibul Haque	20101503	Introduction, Application Area.

Conclusion and Future Work

In conclusion, nothing is more important than living in a secure place. The Smart Home Security System project represents a significant advancement in modern home security. The project's emphasis on user convenience and accessibility is evident in features such as mobile alerts, which empower homeowners to actively participate in safeguarding their premises. The core components of a Smart Home Security System are access limitation tools, activity detectors, surveillance, audible sirens, monitoring service, etc. An intelligent residential security system is essential to provide advanced household protection and monitoring. If an intruder breaks into the house or any sign of gas leakage or fire accident happens, the components of the project, such as the PIR Sensor, Flame Sensor, MQ-2 Gas Sensor, and Bluetooth Module (HC-05) work smoothly to keep the house extremely cautious.

In this future landscape, the Smart Home Security System project will transcend its current capabilities, becoming an indispensable part of our daily lives that safeguards our homes and enriches our living experiences through innovation and intelligence. Additionally, as smart home security systems are designed to enhance safety and prevent accidents, incorporating backup power solutions and cloud storage enhances the reliability and resilience of the system, ensuring uninterrupted protection even during unforeseen circumstances. In essence, the Smart Home Security System project sets a new standard for home protection by amalgamating innovation with practicality.

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