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Open Source Simulation Lab (MCN431L)

Report On

Implementation of Smart Home Automation System

Submitted by
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Submitted in partial fulfillment for the award of degree of

COMPUTER NETWORK ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
2023-24

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CERTIFICATE

Certified that the project work titled **"Implementation of Smart Home Automation System"** carried out by **B A Anirudh Koushik, USN: 1RV23SCN01** and Pavankumar Patil, **USN: 1RV23SCN10** , submitted in partial fulfilment for the award of **Master of Technology** in **Computer Network Engineering** of **RV College of Engineering®, Bengaluru, affiliated to Visvesvaraya Technological University, Belagavi,** during the year **2023-24.** It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirement in respect of project work prescribed for the said degree.

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DECLARATION

We, **B A Anirudh Koushik** and **Pavankumar Patil**, students of second semester M-Tech in **Computer Network Engineering**, **Department of Computer Science and Engineering,** RV College of Engineering®, Bengaluru, declare that the Open Source Simulation Lab Project with title **"Implementation of Smart Home Automation",** has been carried out by us. It has been submitted in partial fulfilment for the award of degree in **Master of Technology** in **Computer Network Engineering** of RV College of Engineering®, Bengaluru, affiliated to Visvesvaraya Technological University, Belagavi, during the academic year **2023-24**. The matter embodied in this report has not been submitted to any other university or institution for the award of any other degree or diploma.

Date of Submission: 18-09-2024 **Signature of the Student**

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ABSTRACT

IOT has become a revolutionary ecosystem which describes the network of physical things, like embedded systems and sensors to exchange data over a wired or a wireless medium. In the last few years IOT based smart home applications have become common since it makes people's life easier. A smart home comprises of internet-connected equipment with cutting-edge technology which residents can control from distance. Smart home technology refers to household appliances like lighting, heating, air conditioning, and entertainment systems having key features like comfort, convenience, safety, energy efficiency. Many heterogeneous devices and sensors installed in smart houses monitor various physical factors, and the produce data which can be useful for applications.

Internet of Things is a network of the physical objects which are embedded using electronics, sensors and programmed using software to establish connectivity and provide communication by exchanging data with user, manufacturer and other IOT devices. Interconnected smart devices have become a ubiquitous part of daily lives. Innovative applications like smart home environments are incorporated into daily life with increasing popularity of IOT, to improve convenience, comfort, energy efficiency, and safety.

The work suggests a smart home model using Arduino Uno as central controller programmed using Arduino IDE. The controller is integrated with sensors like ultrasonic, PIR, LDR, smoke detector sensor which provide crucial data based on which automation and mechanical movements are performed by electrical home appliances. The overview of placement and orientation of sensors and equipment is discussed. Evaluation of the proposed topic is performed in two phases where in the first phase Tinkercad application is used to design and simulate the design and understand the strength and flaws. In the later phase the hardware implementation is performed and analyzed.

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CHAPTER 1

INTRODUCTION OF SMART HOME

Internet of things is a network of physical objects used to send, receive communication information using the internet or any other communication and network technology in between the user, manufacturer and other connected devices, which helps in monitoring, coordinating or controlling process across the internet. IOT has become a revolutionary ecosystem which describes the network of embedded systems and sensors to exchange data over a wired or wireless medium. In the last few years IoT based smart home applications have become common since it makes people's life easier. A smart home comprises of internet-connected equipment with cutting-edge technology which residents can control from distance. Smart home technology refers to household appliances like lighting, heating, air conditioning, and entertainment systems having key features like comfort, convenience, safety, energy efficiency. Ubiquitous technologies like IoT, AI/ML, communication technologies, robotics, image processing are used to implement smart home applications. Many heterogeneous devices and sensors installed in smart houses monitor various physical factors, and the produce data which can be useful for applications. A Smart Home Automation System integrates various sensors and actuators to automate household functions, enhancing convenience, security, and energy efficiency. By using Tinkercad to simulate hardware components such as LDRs (Light Dependent Resistors), PIR (Passive Infrared) sensors, gas sensors, and servo motors, the system automates tasks like controlling lights, fans, door locks, and detecting hazardous gas levels. This system relies on real-time data from these sensors to make intelligent decisions, providing users with a safer and more efficient living environment. A Smart Home Automation System uses modern technology to automate various household tasks, offering enhanced comfort, security, and energy efficiency. This project, developed using Tinkercad for simulation, involves the integration of multiple sensors such as LDR for light control, PIR sensors for motion detection, gas sensors for safety, and servo motors for automated door management. The system operates intelligently, responding to environmental changes by automatically controlling lights, fans, and other appliances, creating a smart, energy-conscious, and safe living environment.

The core idea behind smart home automation is to reduce manual efforts and optimize energy usage by utilizing sensors and actuators that communicate with each other. Various components, such as Light Dependent Resistors (LDR), Passive Infrared (PIR) sensors, gas sensors, and servo motors, are employed to monitor and respond to environmental changes in real-time. These sensors collect data, which is then processed by the system to make informed decisions, such as turning lights on or off, activating fans based on motion detection, or alerting the user in case of a gas leak. The LDR is responsible for detecting the ambient light levels in the home, enabling automatic control of lights. If the light levels drop below a predefined threshold, the system will automatically switch on the lights, and when sufficient light is present, the lights will be turned off, thus conserving energy. This feature not only adds convenience but also helps in reducing electricity consumption by ensuring that lights are used only when necessary. Another crucial component is the PIR sensor, which detects movement within a specific range. This sensor can be used to control fans or other appliances in a room. For example, if the sensor detects human motion, it can turn on the fan, and if no motion is detected for a certain period, the fan will be turned off. This ensures that appliances are operated only when needed, further contributing to energy savings and convenience. The gas sensor is a vital element in ensuring safety within the home. It continuously monitors the environment for harmful gases, such as carbon monoxide or methane, and triggers an alarm if dangerous levels are detected. This early warning system can help prevent accidents and ensure that the home remains safe from potential hazards. In addition to lighting and safety, the system also integrates a servo motor for door automation. The ultrasonic sensor works in conjunction with the servo motor to control the opening and closing of doors. When an object or person is detected within a certain range, the servo motor is activated to open the door automatically, providing a hands-free and efficient way to manage entry and exit in the home. The use of Tinkercad software in this project allows for the simulation of the smart home automation system before it is implemented with actual hardware. Tinkercad is an online platform that enables the design and simulation of electronic circuits, making it an ideal tool for prototyping and testing. Through Tinkercad, the sensors, actuators, and control logic can be visualized and tested, ensuring that the system operates as expected. Once the design is validated in the simulation, it can be translated into physical hardware using components such as Arduino boards, which serve as the central control unit for the automation system.

CHAPTER 2

THEORY AND CONCEPTS OF SMART HOME

2.1 Tinkercad

Tinkercad is a free, web-based 3D design, electronics simulation, and coding platform designed for beginners and hobbyists. Developed by Autodesk, Tinkercad is widely used for creating simple 3D models, simulating circuits, and learning basic coding concepts in a user-friendly environment. Its intuitive drag-and-drop interface allows users to quickly create, simulate, and visualize their projects without the need for extensive technical knowledge or prior experience with advanced design software.

Tinkercad is particularly popular in education, as it introduces users to essential concepts in 3D design, electronics, and coding. It is also a powerful tool for prototyping simple hardware systems such as Arduino projects, allowing users to test and simulate their circuits before building them in the physical world.

Advantages of Tinkercad

1. User-Friendly Interface: Tinkercad's drag-and-drop functionality and simple interface make it easy for beginners to learn 3D modeling, electronics simulation, and coding without needing advanced skills.
2. 3D Design Capabilities: Tinkercad allows users to create and manipulate 3D models, which can be used for 3D printing, gaming, or virtual simulations. This feature makes it useful for designers and engineers to quickly prototype their ideas.
3. Circuit Simulation: Tinkercad includes a powerful electronics simulator where users can build and test virtual circuits using components like LEDs, resistors, motors, and microcontrollers (e.g., Arduino). This allows for error-free prototyping, as users can debug and refine their designs in the simulation environment before physical implementation.
4. Integration with Arduino: The platform offers an integrated environment for working with Arduino, allowing users to code using Arduino's C++-based language, connect virtual components, and run simulations. This is particularly useful for testing Arduino projects without the need for physical hardware.
5. No Installation Required: Tinkercad is completely web-based, so there is no need for installation. This makes it easily accessible on any device with a browser and internet connection, making it convenient for users who want to work on projects from multiple locations.

6. Educational Use: Tinkercad is widely used in classrooms to teach basic concepts of 3D design, electronics, and coding. It offers tutorials, guides, and pre-built projects, making it an excellent educational resource for students and teachers alike.
7. Supports 3D Printing: Tinkercad's 3D models can be exported in formats compatible with 3D printers, allowing users to create and print their designs. This feature is valuable for those interested in manufacturing or product design.
8. Collaboration and Sharing: Projects can easily be shared with others, making it a collaborative platform for group work, whether for educational purposes or collaborative prototyping.
9. Free to Use: Tinkercad is entirely free, making it accessible to everyone, including students, educators, and hobbyists, without the need for expensive software licenses.
10. Cross-Disciplinary: Tinkercad brings together 3D modeling, electronics, and coding in one platform, allowing users to engage with multiple fields and develop interdisciplinary skills.

Applications of Tinkercad

- Education: Tinkercad is widely used in schools and universities to teach 3D modeling, electronics, and coding. It provides a hands-on learning experience that is engaging and intuitive for students of all levels.
- 3D Printing: Users can create simple or complex 3D designs and export them for 3D printing. This is popular for hobbyists and designers who want to bring their ideas to life.
- Electronics Prototyping: Tinkercad's electronics simulator is used for designing and testing circuits, allowing users to experiment with components like resistors, LEDs, and microcontrollers without requiring physical parts.
- Arduino Simulation: Tinkercad is a valuable tool for simulating Arduino projects, especially for those who don't have access to physical components. Users can write code, connect virtual sensors, and test their designs in real-time.
- STEM Projects: Tinkercad is commonly used for STEM (Science, Technology, Engineering, and Mathematics) projects, allowing students and educators to build interactive and creative solutions in a virtual environment.

Tinkercad provides a powerful yet simple platform for learning and prototyping in 3D design, electronics, and coding. Its versatility, accessibility, and integration with hardware like Arduino make it an indispensable tool for educators, hobbyists, and developers alike.

Fig 2.1 Tinkercad Workspace

2.2 Arduino UNO

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P chip. It is known for its simplicity, versatility, and ease of use, making it ideal for both beginners and experienced developers in electronics and embedded systems. The board features 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog input pins, a 16 MHz quartz crystal, a USB connection for power and programming, and a power jack.

Designed to interact with various sensors, actuators, and other electronic components, the Arduino UNO is the central control unit in many DIY projects, including robotics, home automation, and security systems. It can be programmed using the Arduino IDE (Integrated Development Environment) in Arduino C++, which simplifies coding with pre-built libraries for managing components like displays, motors, and keypads.

The Arduino UNO is widely praised for its affordability, broad community support, and extensive documentation, which makes it a popular choice for prototyping and educational purposes. Its robust functionality allows developers to create interactive and automated systems quickly, making it a key tool for hobbyists, students, and professionals alike.

Advantages of Arduino UNO

1. **Ease of Use**: Arduino is designed with simplicity in mind, making it accessible even to beginners. The Arduino Integrated Development Environment (IDE) is user-friendly and allows for quick and easy programming using Arduino C++. The availability of pre-built libraries for various sensors and components simplifies the development process.

2. **Open-Source**: Both the hardware and software for Arduino are open-source, meaning that users can freely modify and adapt designs to meet their specific needs. This also encourages collaboration and innovation within the large Arduino community.
3. **Affordability**: Arduino boards, including the UNO, are relatively inexpensive compared to other microcontrollers, making them ideal for students, hobbyists, and prototypers who need an affordable solution for building projects.
4. **Versatility and Flexibility**: Arduino UNO can be used in a wide range of projects, from simple sensor data collection to more complex systems like robotics and automation. Its multiple input/output pins and compatibility with a variety of sensors, actuators, and modules make it highly flexible for different applications.
5. **Large Community and Support**: Arduino has a vast global community, which provides abundant resources such as tutorials, forums, and project guides. Whether users need help troubleshooting or want to find inspiration, this community support enhances learning and project development.
6. **Cross-Platform Compatibility**: The Arduino IDE works across major operating systems such as Windows, macOS, and Linux, allowing developers to use it on different machines without worrying about compatibility issues.
7. **Modularity and Expandability**: Arduino supports various shields (add-on boards) and modules, which can be plugged into the board to extend its functionality. Examples include Wi-Fi, Bluetooth, and motor control shields that enable users to build more complex systems without extensive hardware modifications.
8. **Real-Time Applications**: Arduino can handle real-time processing efficiently, making it suitable for applications that require real-time response, such as monitoring systems, interactive devices, and control systems.
9. **Low Power Consumption**: Arduino boards, including the UNO, consume relatively little power, making them suitable for battery-powered or energy-efficient projects. This is especially useful for remote sensing and portable devices.
10. **Prototyping and Testing**: Arduino is widely used for rapid prototyping because it allows developers to quickly build, test, and iterate on their designs. The easy-to-connect components (using jumper wires and breadboards) facilitate testing and troubleshooting without permanent hardware changes.

Fig 2.2 Arduino UNO BOARD

2.3 Servo Motor

A **servo motor** is a rotary actuator designed for precise control of angular position, velocity, and acceleration. Unlike regular motors, servo motors provide accurate movement control by using feedback systems. They consist of a motor, a position sensor, a control circuit, and a gearing mechanism. These motors are commonly used in robotics, automated systems, and control mechanisms where exact motion control is critical.

Servo motors operate based on Pulse Width Modulation (PWM) signals sent from a controller (like an Arduino). The width of the pulse determines the angle to which the motor will rotate, typically within a range of 0 to 180 degrees. This precise control makes them ideal for applications such as robotic arms, camera positioning systems, and door locks, where specific, controlled movements are needed.

Servo motors are valued for their small size, lightweight design, and low energy consumption, making them well-suited for projects requiring precision without consuming much power. Their simple interface with microcontrollers, such as Arduino, makes them easy to program and integrate into various systems.

Advantages of Servo Motor

1. **Precise Position Control**: Servo motors are designed to achieve exact positions, which is vital for applications requiring accuracy, such as robotic arms or locking mechanisms.
2. **High Torque in a Compact Size**: Despite their small size, servo motors can generate significant torque, allowing them to move heavier loads with precision.
3. **Fast Response Time**: Servo motors can quickly reach the desired position, making them suitable for applications that require fast and frequent adjustments.
4. **Feedback Mechanism**: The built-in feedback loop allows the motor to adjust its

position accurately, ensuring precise control and correcting any deviations.

5. **Energy Efficient**: Servo motors consume power only when necessary, making them more efficient than continuous motors in many applications.
6. **Stable and Reliable**: Servo motors are known for their smooth and controlled movement, which enhances reliability in tasks requiring delicate or repetitive operations.
7. **Easy Integration with Microcontrollers**: Servo motors can be easily controlled by microcontrollers like Arduino using PWM signals, making them simple to incorporate into DIY projects, robotics, and automation systems.
8. **Wide Range of Applications**: Servo motors are used in various fields, including robotics, aviation, home automation, and industrial machinery, due to their versatility and precise control capabilities.

Fig 2.3 Servo Motor

2.4 PIR Sensor

A **Passive Infrared (PIR) sensor** is a versatile and essential component in modern technology, particularly in motion detection applications. This sensor operates by detecting infrared radiation emitted by all objects, especially living beings. Every object with a temperature above absolute zero emits some form of infrared radiation, and the PIR sensor can pick up these radiations. However, it is particularly sensitive to the infrared wavelengths emitted by humans and animals, making it ideal for motion detection in various applications. The core functionality of the PIR sensor lies in its ability to sense infrared radiation in its environment. The sensor itself does not emit any infrared light; rather, it is passive, hence the term "passive" in its name. It simply detects the infrared energy that naturally radiates from objects in its field of view. A typical PIR sensor has two slots made of a material sensitive to infrared radiation. When the sensor is inactive, both slots detect the same amount of infrared radiation from the general environment. However, when a warm object such as a human or an animal moves into the sensor’s detection range, it disrupts the equilibrium. One of the sensor’s slots detects a change in infrared radiation before the other, creating a differential in the infrared levels between the two slots. This differential generates an electrical signal that the sensor processes as motion. PIR sensors are designed to detect motion by recognizing the change in heat signatures as a warm object moves across its field of view. They do not detect the specific type of object; instead, they respond to changes in infrared radiation levels. This makes them highly effective in security systems, where detecting human presence is crucial. PIR sensors are capable of distinguishing between the normal background IR radiation of a room and the distinct IR radiation pattern caused by a moving person or animal. One of the main features of PIR sensors is their wide detection range. Typically, a PIR sensor can detect motion within a range of 5 to 12 meters, though this can vary depending on the specific sensor model. Additionally, they have a broad field of view, usually ranging from 110° to 180°, allowing them to cover large areas with minimal blind spots. This wide-angle detection capability makes them ideal for use in rooms, hallways, or outdoor spaces where comprehensive coverage is necessary.

Fig 2.4 PIR Sensor

2.5 Ultrasonic Sensor

An ultrasonic sensor is a widely used electronic device that measures distance by emitting and receiving high-frequency sound waves, typically at frequencies around 40 kHz. The sensor consists of two main components: a transmitter that emits sound waves and a receiver that detects the echo of these sound waves after they bounce off an object.

When the sensor is activated, the transmitter sends out a pulse of ultrasonic sound waves. These waves travel through the air until they encounter an object, where they reflect back toward the sensor. The receiver captures the reflected waves, and the time elapsed between the emission of the sound wave and the reception of the echo is measured. This time measurement, combined with the speed of sound in air, is used to calculate the distance to the object.

Ultrasonic sensors are particularly useful for a variety of applications due to their non-contact measurement capabilities. In robotics, they are employed for obstacle detection and collision avoidance, allowing robots to navigate around obstacles safely. In automotive systems, ultrasonic sensors are used in parking assist features to help drivers park by detecting the distance to obstacles behind or in front of the vehicle. Additionally, in industrial automation, these sensors can measure the level of materials in containers or detect the presence of objects on a conveyor belt.

One of the key advantages of ultrasonic sensors is their ability to work in various lighting conditions, including complete darkness, because they rely on sound waves rather than light. They are also relatively inexpensive and straightforward to use. However, their effectiveness can be limited by factors such as the texture and shape of the object being measured. Soft or irregularly shaped objects may absorb or scatter sound waves, leading to inaccuracies. Additionally, ultrasonic sensors can be affected by environmental factors such as temperature, humidity, and air pressure, which can influence the speed of sound and thus the accuracy of distance measurements.

Fig 2.5 Ultrasonic Sensor

CHAPTER 3
DESIGN CONSIDERATIONS FOR SMART HOME

3.1 SYSTEM REQUIREMENTS

Hardware Requirements

1. **Arduino UNO**: A versatile microcontroller board that serves as the brain of the system. It reads input from the keypad, processes the entered password, and controls the servo motor to lock/unlock the door. The Arduino UNO is chosen for its simplicity, affordability, and wide community support.
2. **Servo Motor**: A small, precise motor that controls the door's locking mechanism by rotating to specified angles. It offers smooth and controlled movements, making it ideal for mechanical functions like opening or closing a lock.
3. **PIR Sensor**: A Passive Infrared (PIR) sensor detects motion by measuring infrared radiation emitted by warm objects like human beings and animals. It operates by sensing changes in infrared levels within its field of view, triggering an output when significant movement is detected.
4. **Ultrasonic sensor**: It measures distance by emitting high-frequency sound waves and detecting the time it takes for the echo to return after bouncing off an object. The sensor calculates the distance based on the time elapsed and the speed of sound.
5. **Jumper Wires and Breadboard**: These components are essential for building and testing the circuit without soldering. Jumper wires establish temporary connections between components, while the breadboard serves as a reusable base for the circuit design, making prototyping easier and more flexible.
6. **Power Supply**: Provides the necessary electrical power to run the Arduino and its components, ensuring the system operates reliably and efficiently.

Software Requirements

1. **Tinkercad**: An online simulation platform that allows users to design and test electronic circuits in a virtual environment. Tinkercad enables you to visualize the connections and interactions between components without needing to physically assemble them, which is ideal for troubleshooting and refining designs before implementation.
2. **Arduino IDE**: The official Integrated Development Environment (IDE) used to write, compile, and upload code to the Arduino board. It supports Arduino C++, a simple

language that allows for easy integration of hardware components through predefined libraries.

3.2 METHODOLOGY

The methodology for implementing a smart home automation system involves a structured approach that integrates various hardware and software components to create an interconnected, automated environment.

Component Selection: Choose suitable sensors (e.g., PIR for motion detection, gas sensors, LDR for light control, and ultrasonic sensors for proximity detection), actuators (e.g., servo motors, relays), and microcontrollers (e.g., Arduino or Raspberry Pi) based on the required home automation tasks, such as lighting, security, or appliance control.

System Design and Integration: Design the system by mapping out the sensor placements and connecting them to the microcontroller. Sensors and actuators are connected through GPIO pins, with the microcontroller serving as the central control unit, executing commands based on sensor inputs. For example, the PIR sensor triggers lights or alarms, and the ultrasonic sensor controls doors or proximity-based functions.

Programming and Control: Write code (typically in languages like C++ for Arduino) to program the microcontroller. The code interprets sensor data and responds with predefined actions, such as turning on lights when motion is detected or triggering a buzzer when gas levels exceed safety thresholds. Control logic can also include timers, thresholds, and automated routines.

Simulation and Testing: Test the system using simulation software like Tinkercad to ensure proper functionality before physical implementation. This step involves simulating sensor inputs, verifying code execution, and making adjustments to the hardware configuration or code logic as necessary.

Deployment and Maintenance: Install the sensors and actuators in their final locations within the home. Monitor the system's performance, ensure all components communicate properly, and update or modify the system as needed based on user requirements or environmental changes.

This methodology provides a structured process to ensure the smart home automation system works efficiently and is tailored to the needs of the user.

The flow diagram for the above simulation is as shown in Figure:

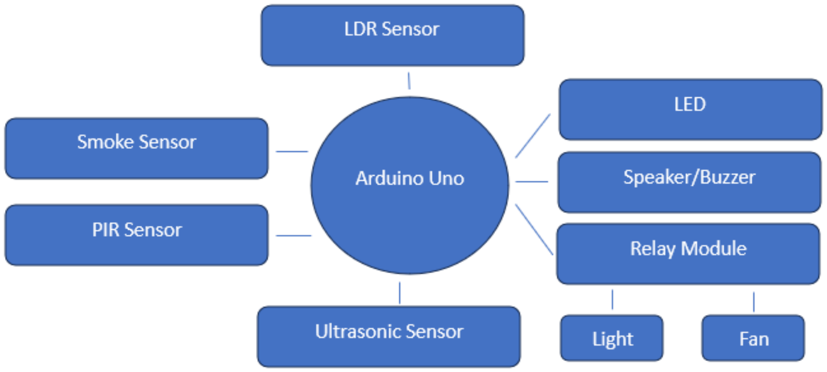

Fig 3.1 Flow diagram of smart home

The design incorporates the following: a light-dependent resistor (LDR), temperature, and smoke sensors, a relay that is used to combine the system with electrical devices. The relay module connects the desired circuit voltage which is high voltage with the Arduino voltage which is a low voltage. Combining all sensors with an Arduino forms a microcontroller for home automation. Different sensors sense the input and send it to the Arduino to process the input and provide outputs through output devices. The LDR sensor senses the intensity of light and provides input to Arduino accordingly if decrease in light level electric bulb connected to the board through the relay will turn on and when the intensity of light will increase the bulb will turn off. The PIR sensor will sense any motion or movement in home the centralized air-cooling system and lights and ambient lights will be switched on and off. The smoke sensor continuously senses if there is any smoke inside the house, if it detects the fire the buzzer will constantly beep until the smoke is put out. The ultrasonic sensor will help open and close doors automatically based on the detection of distance of objected detected, if the distance is lower than the set distance the door opens else door closes All these state changes are informed with the help of a beep sound through the buzzer.

CHAPTER 4
IMPLEMENTATION OF SMART HOME

4.1ALGORITHM

Algorithm for Smart Home Automation System is:

Initialize System

- Import Servo library
- Define sensor pins and variables

Function: readUltrasonicDistance(triggerPin, echoPin)

- Send pulse from `triggerPin`
- Measure echo duration on `echoPin`
- Return duration

Setup

- Start serial communication
- Set pin modes for sensors, relays, LEDs, buzzer, and servo

LDR Control

- Read LDR value
- If value > 500, turn light ON; else, turn light OFF

PIR Sensor Control

- Read PIR sensor value
- If motion detected, turn on fan and Green LED; else, turn off fan and turn on Red LED

Gas Sensor Control

- Read gas sensor value
- If value > limit, sound buzzer

Servo Control

- Measure distance
- If distance < 100 cm, set servo to 90 degrees (Door Open); else, set to 0 degrees (Door Closed)

Delay

- Wait for 10 milliseconds

4.2 SOURCE CODE FOR SMART HOME

```
#include <Servo.h>

int output1Value = 0;

int sen1Value = 0;

int sen2Value = 0;

int const gas_sensor = A1;

int const LDR = A0;

int limit = 400;



long
readUltrasonicDistance(int
triggerPin, int echoPin)

{

  pinMode(triggerPin,
OUTPUT);  // Clear the
trigger

  digitalWrite(triggerPin,
LOW);

  delayMicroseconds(2);

// Sets the trigger pin to
HIGH state for 10
microseconds

  digitalWrite(triggerPin,
HIGH);
```

```
 delayMicroseconds(10);

  digitalWrite(triggerPin,
LOW);

  pinMode(echoPin,
INPUT);

  // Reads the echo pin, and
returns the sound wave
travel time in microseconds

  return pulseIn(echoPin,
HIGH);

}

Servo servo_7;

void setup()

{

   Serial.begin(9600);
     //initialize serial
communication

  pinMode(A0, INPUT);
     //LDR

  pinMode(A1,INPUT);
     //gas sensor

  pinMode(13, OUTPUT);
                 //connected to
relay

  servo_7.attach(7, 500,
```

```
2500); //servo motor


  pinMode(8,OUTPUT);
    //signal to piezo buzzer

  pinMode(9, INPUT);
    //signal to PIR

  pinMode(10, OUTPUT);
              //signal to npn as
switch

  pinMode(4, OUTPUT);
    //Red LED

  pinMode(3, OUTPUT);
    //Green LED

}

void loop()

{

 //------light intensity
control------//

//-------------------------------
-------------------------------

   int val1 =
analogRead(LDR);

  if (val1 > 500)

    {

    digitalWrite(13, LOW);
```

```
    Serial.print("Bulb ON =



");

    Serial.print(val1);

     }

  else

     {

     digitalWrite(13, HIGH);

     Serial.print("Bulb OFF
= ");

    Serial.print(val1);

     }

 //------ light & fan control -
-------//

  sen2Value =
digitalRead(9);

  if (sen2Value == 0)

     {

     digitalWrite(10, LOW);
//npn as switch OFF

     digitalWrite(4, HIGH);
// Red LED ON,indicating
no motion

     digitalWrite(3, LOW);
```

```
//Green LED OFF, since no
Motion detected

   Serial.print("    || NO



Motion Detected    " );

    }

  if (sen2Value == 1)

    {

    digitalWrite(10,
HIGH);//npn as switch ON

   delay(5000);

    digitalWrite(4, LOW); //
RED LED OFF



    digitalWrite(3,
HIGH);//GREEN LED ON
, indicating motion
detected

    Serial.print("     ||
Motion Detected!      " );

    }

// ------- Gas Sensor --------//

int val =
analogRead(gas_sensor);
//read sensor value
```

```
  Serial.print("|| Gas Sensor
Value = ");

  Serial.print(val);
                  //Printing in
serial monitor



//val = map(val, 300, 750,
0, 100);

  if (val > limit)

     {

     tone(8, 650);

     }

     delay(300);

     noTone(8);



       servo motor

  sen1Value = 0.01723 *
readUltrasonicDistance(6,6
);

 if (sen1Value < 100)

     {

     servo_7.write(90);

    Serial.print("      || Door
Open!  ; Distance = ");
```

```
    Serial.print(sen1Value);

   Serial.print("\n");

}

else

     {



     servo_7.write(0);

    Serial.print("      || Door
Closed! ; Distance =  ");

    Serial.print(sen1Value);

    Serial.print("\n");

  }

  delay(10); // Delay a little
bit to improve simulation
performance

}
```

CHAPTER 5

EXPERIMENT RESULT AND ANALYSIS

5.1 EXPERIMENTAL SETUP

The Implemented simulation in tinkercad software is as depicted in Figure-5.1.1

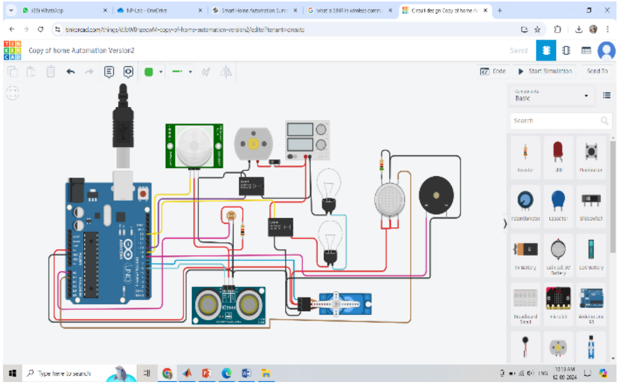

Fig 5.1.1 Circuit diagram of smart home

The hardware connections of each component with the arduino board is as below:

Connect the Arduino Uno to your computer using the USB cable.

Connect the PIR sensor for motion detection to detect movement in the environment.

Connect the Ultrasonic sensor to measure distance, useful for proximity-based control.

Connect the temperature and humidity sensor to monitor the environmental conditions.

Relays are used to control the light bulbs, turning them on/off based on sensor inputs.

Servo Motor may control a door lock or other moving parts in your home automation.

Buzzer will sound an alert in case of specific events like motion detection.

The **pushbutton** could act as a manual override or control for lights or other actions.

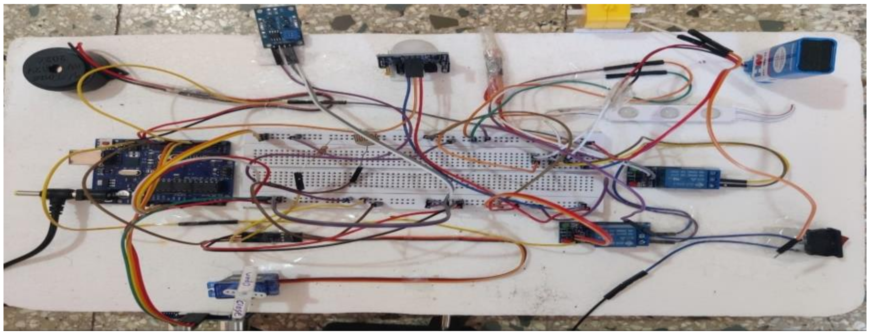

Fig.5.1.2 Experimental hardware setup

RESULTS AND ANALYSIS

- When the system is powered, it should monitor the sensors (PIR, LDR, ultrasonic) for real-time input.
- Motion detection via the PIR sensor would trigger an action (turn on lights or sound a buzzer).
- Light detection by the LDR would control the light bulbs depending on ambient light levels.
- This setup can be used for smart home automation where lights and appliances are controlled based on environmental factors like motion, light intensity, or proximity.
- The PIR sensor and LDR are working as key inputs for automating lighting systems.
- The ultrasonic sensor and servo motor could be involved in more advanced control mechanisms like door or curtain automation.
- If correctly programmed, this system can save energy by only activating lights or devices when necessary.
- Proximity detection using the ultrasonic sensor could lead to controlling the servo motor, e.g., moving it based on the distance of an object

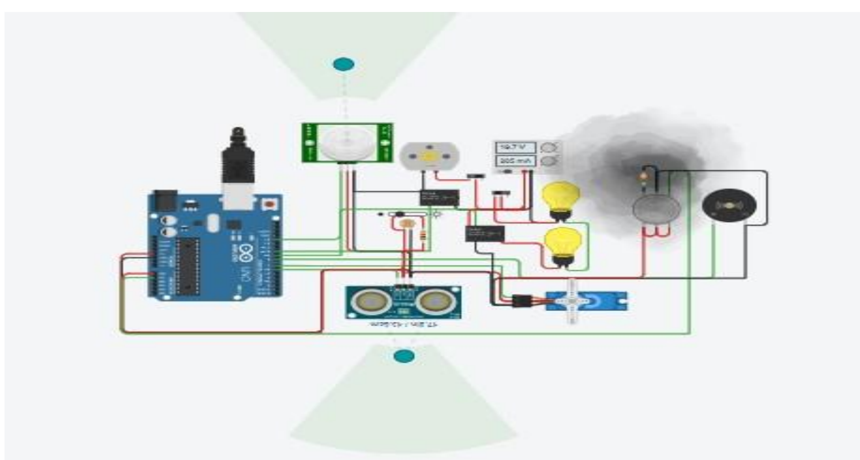

Fig.5.1.3 Software Model Simulation Result

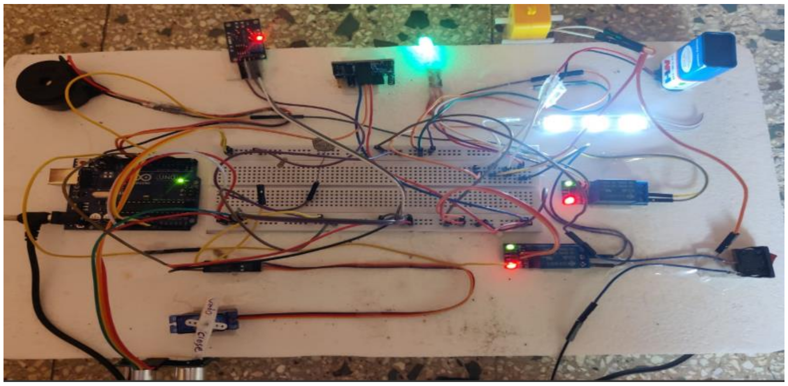

Fig.5.1.4 Hardware Model Simulation Result

Table 1. Operating states of PIR sensor

Light intensity	Person in room	Light	Fan
Day	Yes	OFF	ON
Day	No	ON	OFF
Night	Yes	ON	ON
Night	No	OFF	OFF

Table 2. Operating states of Smoke sensor

Smoke Detected	Buzzer/Alarm
Yes	ON
No	OFF

CHAPTER 6

CONCLUSION

In conclusion, while smart home automation systems offer numerous advantages such as convenience, energy efficiency, and enhanced security, they also come with several limitations that need to be addressed. High costs, complex installation, and limited interoperability between devices can be barriers to widespread adoption. Additionally, the reliance on stable internet connections, potential security vulnerabilities, and concerns over privacy highlight the challenges that come with integrating advanced technologies into everyday living.

As the technology continues to evolve, addressing these limitations through more affordable solutions, universal standards, better security protocols, and user-friendly interfaces will be essential. By overcoming these obstacles, smart home systems can become more accessible, reliable, and beneficial, paving the way for more intelligent, secure, and sustainable homes in the future.

Despite these limitations, ongoing advancements in AI, machine learning, and IoT standards hold promise for improving the reliability, affordability, and accessibility of smart home automation systems. As these technologies continue to develop, we can expect smarter, more secure, and interconnected homes that better serve the needs of users while minimizing current drawbacks. However, it will be essential for manufacturers and developers to prioritize user-friendly designs, strong security measures, and device compatibility to make these systems more practical and appealing for everyday use.

The proposed system is designed and implemented using tinkercad software simulation tool. The use of Arduino UNO has enabled us to control all the electronic devices such as bulbs, fans, safety systems, alerts, buzzers in case of fire or smoke break out. The smart home system simulated works smoothly and intelligently to reduce human effort and save energy efficiently.

6.1 LIMITATIONS

Despite its strengths, the enhanced and secure door locking system has several limitations that may impact its overall effectiveness and applicability. Understanding these limitations is crucial for improving the system and considering potential adjustments for various use cases.

Interoperability between devices from different manufacturers remains a challenge. While progress has been made toward creating universal standards, many smart devices still operate within closed ecosystems, limiting their ability to work together. This lack of compatibility can force users to rely on devices from a single manufacturer or invest in additional hubs and bridges to integrate multiple platforms, complicating the setup.

Reliability and connectivity issues are also common limitations. Smart home systems depend heavily on a stable internet connection, and any disruption in connectivity can result in loss of functionality. Devices might fail to communicate with each other or with the central hub, causing delays or errors in automation. Additionally, some devices may require constant software updates to function optimally, and failure to maintain this can result in performance issues.

Security and privacy concerns are critical limitations as well. As smart home systems collect and store sensitive data, they become potential targets for cyberattacks. Hackers may exploit vulnerabilities in the system, compromising personal information or gaining control of home devices. Ensuring robust security measures, such as encryption and frequent updates, is essential but may not always be sufficient, especially as new threats emerge.

Energy consumption can also be a concern. While smart home systems are designed to optimize energy use, the constant operation of sensors, controllers, and connected devices can increase the overall power consumption. In some cases, the energy savings from automation may not offset the electricity used to keep these devices running 24/7.

Lastly, **user dependence on technology** can be a limitation. As users become accustomed to automation, they may rely too heavily on technology, leading to a lack of preparedness in the event of system failures. Additionally, if a user is not fully engaged in managing or understanding the system, important features or security settings may be neglected, resulting in suboptimal performance or vulnerability.

Addressing these limitations involves considering potential upgrades or alternative solutions, such as incorporating more robust security measures, enhancing user interfaces, and improving the system's resilience to environmental factors. By understanding and addressing these constraints, the system can be further refined to meet a wider range of needs and applications.

6.2 FUTURE WORK

The potential for the evolution of smart home automation systems using Tinkercad and hardware components is vast, driven by advancements in technology and increasing demand for convenience and efficiency. One of the most significant future possibilities lies in the integration of artificial intelligence (AI) and machine learning (ML). With AI, these systems can learn and adapt to user preferences, making homes more intuitive by automatically adjusting lighting, temperature, and appliances based on daily routines. This creates a more personalized and seamless experience, reducing the need for manual control and making homes smarter over time.

Voice-controlled automation is another area poised for expansion. The integration of voice assistants like Amazon Alexa, Google Assistant, and Apple Siri will allow users to operate their home devices more effortlessly, offering a hands-free solution that enhances accessibility.

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