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بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

DEDICATION

*First, We dedicate our dissertation work to the sake of **Allah**, our Creator and our Master. Our great teacher and messenger, Mohammed (May **Allah** bless and grant him), who taught us the purpose of life.*

We dedicate our dissertation to all our families. A special feeling of gratitude to our loving parents, whose words of encouragement and push for tenacity ring in our ears. Our sisters and our brothers have never left our side and are very special.

We also dedicate this dissertation to all friends who have supported us throughout the process. We will always appreciate all they have done.

May ALLAH grant them Jannah Firdaus. Ameen

ACKNOWLEDGEMENTS

*Prima facie, We are grateful to **ALLAH** for the guidance, good health, wellness and willpower that were necessary to complete this thesis.*

*We would like to thank **our Parents**, who always believed in us. It is thanks to their support and prayers that we accomplished this work, they already know how much we owe them.*

*We also would like to thank our supervisor, Doctor **Bekakra Youcef**, whose expertise was invaluable in formulating the research methodology. Your insightful feedback pushed us to sharpen my thinking and brought our work to a higher level..*

We also place on record, our sense of gratitude to one and all, who directly or indirectly, have lent their hand in this venture. Finally, We also want to thank the jurors for agreeing to review and judge our work.

ABSTRACT

This project's goal is to create and deploy a simple smart home system based on Internet of Things (IoT) technology utilizing an Arduino microcontroller. The technology enables for remote management of household appliances as well as real-time monitoring of environmental variables using a smartphone application that uses Bluetooth connectivity.

The system incorporates many sensors, including the MQ9 gas sensor for leak detection, the DHT11 sensor for temperature and humidity monitoring, an RFID reader for access control, and a servo motor for door automation. With the Android-based application, users can easily and efficiently manage lights, fans, and other devices.

The system underwent successful testing and proved excellent responsiveness, ease of use, and the capacity to improve safety, comfort, and energy efficiency. This study adds to the developing area of smart homes and serves as a platform for more complicated and integrated systems in the future, such as cloud connectivity and artificial intelligence integration.

ملخص

يهدف هذا المشروع إلى تصميم وتنفيذ نظام منزل ذكي بسيط يعتمد على تقنيات إنترنت الأشياء باستخدام وحدة التحكم اردوينو، ويتيح التحكم في الأجهزة المنزلية ومراقبة البيئة الداخلية عن بُعد عبر تطبيق هاتف ذكي يعمل بتقنية بلوتوث يتضمن النظام مجموعة من الحساسات مثل للكشف عن تسرب الغاز، و لقياس درجة الحرارة والرطوبة، بالإضافة إلى قارئ للتحكم في الدخول، ومحرك سيرفو للتحكم في فتح وإغلاق الأبواب. كما تم توصيل النظام بتطبيق يُمكِّن المستخدم من التحكم في الإضاءة والمراوح والأجهزة الأخرى بسهولة تامة. تم اختبار النظام عمليًا وأظهر كفاءة عالية في الاستجابة، وسهولة في الاستخدام، وقدرة على توفير الأمان والراحة وتخفيض استهلاك الطاقة. يُعد هذا العمل مساهمة فعالة في مجال المنازل الذكية، ويشكل قاعدة لتطوير أنظمة أكثر تعقيدًا وتكاملًا في المستقبل باستخدام تقنيات الاتصال السحابي والذكاء الاصطناعي.

CONTENTS

LIST OF FIGURES

ACRONYMS

- **MCU** Microcontroller Unit
- **IOT** internet of things
- **SOC** Asystem on a chip
- **GPIO** Ageneral-purpose input/output
- **USB** Universal Serial Bus
- **SD** Secure Digital
- **UART** Auniversal asynchronous receiver-transmitter
- **SPI** The Serial Peripheral Interface
- **SDIO** Secure Digital Input Output
- **LED** Alight-emitting diode
- **PWM** Pulse-width modulation
- **ADC** analog-to-digital converter
- **DAC** digital-to-analog converter
- **BLE** Bluetooth Low Energy
- **GND** Ground
- **FreeRTOS** Real-Time Operating System

- **IDE** integrated development environment
- **SDK** Software Development Kit
- **OTA** Over-The-Air
- **IOS** iPhone Operating system
- **CPU** Central Processing Unit
- **TLS** Transport Layer Security
- **AI** Artificial Intelligence
- **SHS** Smart Home System

GENERAL INTRODUCTION

The concept of smart homes has transitioned from science fiction to reality, becoming an integral part of modern living. A smart home integrates advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and automation to create an interconnected ecosystem that enhances convenience, security, energy efficiency, and overall quality of life. With the global smart home market projected to grow exponentially in the coming years, driven by advancements in technology and increasing consumer demand, understanding the implications, challenges, and opportunities of smart homes has never been more critical.

The proliferation of IoT devices, coupled with the rise of AI-driven systems, has enabled homes to become "smarter" by learning user preferences, automating routine tasks, and optimizing resource usage. For instance, smart thermostats adjust temperatures based on occupancy, while intelligent security systems provide real-time monitoring and alerts. These innovations promise to revolutionize how we interact with our living spaces, making them more adaptive, efficient, and secure.

However, the rapid adoption of smart home technologies also raises significant concerns. Issues such as data privacy, cybersecurity vulnerabilities, interoperability challenges, and the digital divide have sparked debates among researchers, policymakers, and consumers. As smart homes become more pervasive, it is essential to address these challenges to ensure that the benefits of this technology are accessible and equitable for all.

Despite the growing interest in smart homes, there is a lack of comprehensive research that examines the interplay between technological advancements, user adoption, and the socio-economic and ethical implications of these systems. Existing studies often focus on specific aspects, such as energy efficiency or security, but fail to provide a holistic understanding of how smart homes impact individuals and society as a whole. This gap in the literature highlights

the need for a more integrated approach to studying smart homes, one that considers both the technical and human dimensions of this technology.

The primary objective of this thesis is to explore the multifaceted nature of smart homes, with a focus on understanding their technological foundations, user experiences, and broader societal implications. Specifically, this research seeks to answer the following questions:

1. What are the key technologies driving the development of smart homes, and how do they interact to create a seamless user experience?
2. What are the primary benefits and challenges associated with the adoption of smart home technologies from the perspective of users?
3. How do smart homes impact energy consumption, security, and quality of life?
4. What are the ethical and societal implications of widespread smart home adoption, particularly in terms of privacy, security, and accessibility?

Organization of the thesis

Our master thesis is organized as follows:

- **General Introduction:** We will begin our thesis with a general introduction on the context of this work, problematic and motivation, and aim of the work.
- **Chapter 1 Literature Review:** In this chapter, we explained everything there is to know about Smart Homes starting from its basic building block to its implementation.
- **Chapter 2 Methodology and Definitions:** This chapter describes the methodology of the system and hence the basic definitions.
- **Chapter 3 Implementations and Results:** This chapter discusses the implementation tools, the code, and the results obtained.
- **General Conclusion:** We conclude our thesis with a broad conclusion and gives insights into future work.

CHAPTER 1

THE CONCEPT OF SMART HOMES AND SECURITY SYSTEM

1.1 Introduction

The market of smart homes has witnessed a great development in these past few years due to the facilitations of equipment installation without harming or touching the infrastructures of the home. This equipment are all connected to internet based on complex development environment and specific interfaces. Now, it's possible to create your own scenario about the home, starting from the light, heating and cooling system, meaning; the automation of your daily activities according to your life and people close to you. A smartphone or tablet are used to control the entire system of the home, the orders are analyzed to get the necessary information about the residents of and his there to create the home's system, with putting in consideration the priorities like the fire. An intelligent home is the best way to facilitate and upgrade a human's life, with a distance control it makes the far close, humans are motivated to use it especially for saving energy, comfort and security.

1.2 History of smart home

The earliest smart houses were concepts, not constructions. The concept of house automation was inspired by Ray Bradbury's short tale "There is a Light Rain Coming." It envisions a future when homes are interactive and self-managing, and can continue to function long after humans

pass away.

- Although the concept of a smart home has been around for a while, it has only recently become popular. This timeline focuses on the real technologies that lead to today's smart homes and what we might expect in the near future.

- **1901 - 1920:** The creation of household appliances. Home appliances, while not considered "smart," were a significant advancement in the early 20th century. The first engine-powered vacuum cleaner was introduced in 1901, marking the beginning of these milestones. In 1907, a workable electric vacuum was created. Refrigerators, clothes dryers, washing machines, irons, toasters, and other appliances were created during the course of two decades.

- **1966-1967:** ECHO IV and the Kitchen Computer - Although it was never commercially available, the ECHO IV was the first smart gadget. This ingenious gadget can compute shopping lists, adjust house temperature, and turn appliances on/off. The Kitchen Computer, released a year later, could save recipes but had the disastrous slogan "If she can only cook as well as Honeywell can computer" and so sold no models.

- **1991-Gerontechnology** blends gerontology and technology to improve the lives of older adults. In the 1990s, there was a lot of new research and technology in this industry.

- **1998–early 2000s:** Smart Homes - In the early 2000s, smart houses, also known as home automation, became increasingly popular. As a result, several technologies began to emerge. Smart homes have suddenly become more inexpensive, making them a feasible solution for customers. Domestic technology, home networking, and other devices started to emerge on store shelves.

- **Today's Smart Homes -** Smart homes are more secure and environmentally friendly. Our smart houses are environmentally friendly and contribute to the reduction of excessive energy consumption. They also assist us detect intruders (whether we are present or not).

- Current home automation trends include remote mobile control, automated lighting, automatic temperature adjustment, appliance scheduling, mobile/email/text notifications, and remote video monitoring[1].

1.3 Smart Home definition

A smart home, also known as a smart house, is one that has modern automation technologies to offer residents with sophisticated monitoring and control over the building's activities. For example, a smart house may handle lighting, temperature, multi-media, security, window and door operations, among many other functions.

In 2003 the UK Department of Trade and Industry (DTI) came up with the following definition of a smart home:

"A dwelling incorporating a communications network that connects the key electrical appliances and services, and allows them to be remotelycontrolled, monitored or accessed".

Smart homes use 'home automation' technologies to provide homeowners with 'intelligent' feedback and information by monitoring many aspects of a home. For example, a smart home's refrigerator may be able to catalogue its contents, suggest menus, recommend healthy alternatives, and order replacements as food is used up. A smart home might even take care of feeding the cat and watering the plants. Many new houses are being designed with the additional wiring and controls needed to operate modern home automation systems. Retrofitting (adding smart home technologies to an existing property) a house to make it a smart home is obviously far more expensive than adding the necessary technologies to a new home owing to the complexity of routing wiring and positioning sensors in appropriate locations[2].

1.4 Smart home technology

Smart home technology has covered over all of life's requirements, as seen in (figure 1.1) at the bottom. Smart home products, such as smart thermostats, smart lighting, smart doorbells, smart locks, and even smart washers and dryers, may all benefit from this technology. Given their high usage, these smart gadgets are being engineered to consume less energy. As they become increasingly dependant on the internet, you will see a decrease in energy use at your home[3].

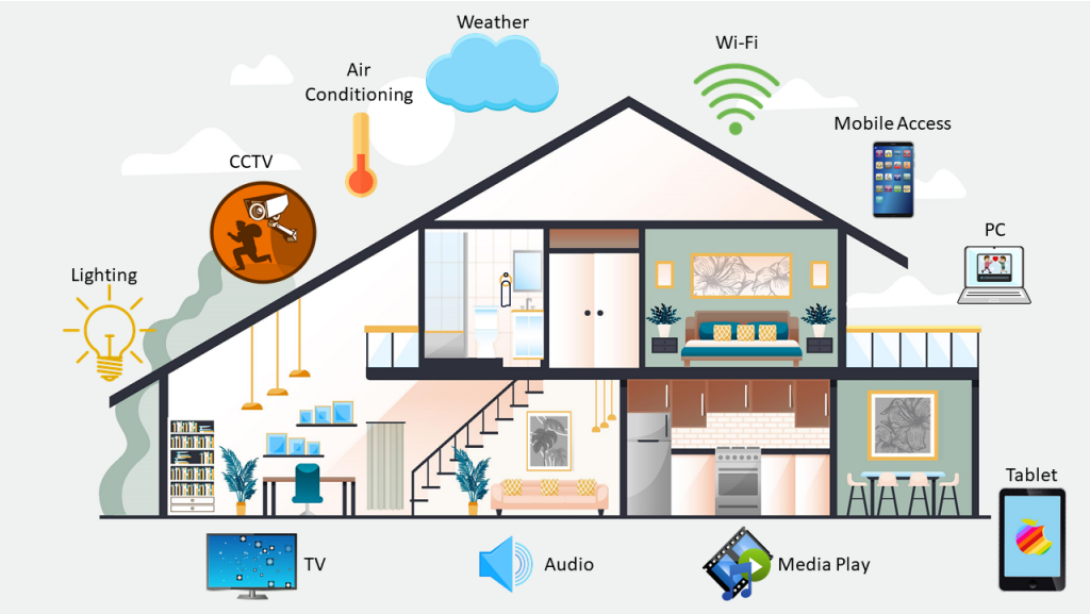

Figure 1.1: General architecture of a smart home

1.5 Smart Home characteristics

The Smart Home combines protection (alarms, cameras, remote monitoring), comfort (automation and programming of everyday routines), energy efficiency (heating, lighting), health (telehealth, telemedicine), and connectivity (network, Bluetooth, wifi, etc.) (see to figure 1.2).

Figure 1.2: Smart Home characteristics

1.5.1 Security:

One of the domains of application of smart home is the protection of products and people through alarm systems, which, on the one hand, prevent technical dangers (breakdowns or gadget malfunctions) and, on the other, possible intrusions into the house (burglary). In general, we found:

- **Technical alarms**

  Technical alarms are based on sensors that may detect a variety of disasters, including fires (figure 3.2c) and hazardous discharges (figure 3.2b), as well as water and gas leaks. These many sensors are connected to an alert center.

(a) Smoke detector **(b)** carbon monoxide detector

Figure 1.3: Gas leak detectors

- **Anti-intrusion alarms**

  These are often sensors on doors (opening detection) or in rooms (presence detection) that are also linked to an alarm center. These sensors may be integrated into a network of digital security cameras. During an infiltration, a warning message might be delivered by e-mail or mobile phone (Figure 1.4).

Figure 1.4: alarmes anti-intrusion

1.5.2 Monitoring:

Smart Home Monitoring allows you to stay connected at multiple aspects of your home no matter where you are. You can keep an eye on your home from anywhere, monitoring systems allow you to control your home's security system, lighting, temperature and more remotely with an Internet connected device such as a laptop, tablet, smart phone and even a smart watch such as the Apple Watch!

This type of technology allows you to operate your house from anywhere, at any time. Smart home monitoring ensures safety, security, and convenience.

Figure 1.5: monitoring system in smart home

You may monitor your system's status via the Internet or mobile devices. Lighting, thermostat, and lock control technologies put your house at your fingertips. When using a private WI-Fi network, additional modules require just little cabling. Integrating your heating, lighting, air conditioning, alarm, video, internet, and telephone systems allows you to operate everything from a single, centralized software system. Smart houses are extremely effective ways to manage your property (Figure 1.5)[5].

1.5.3 Control:

When you leave a house or company, the alarm will trigger the following controls and activities (command centralization):

- Closing of all the lights, cutting off the gas supply,
- Checking that all windows are closed,
- Turning on the outside light for a few minutes if it is dark..

With a single button, the lighting in the living room may be adjusted to suit the occupant's activities, whether it's supper, watching TV, or creating a bright mood.

1.5.4 Communication

Smart home communication combines information, communication technology, and electronics. In terms of home automation standards, there are many sorts of connections in a smart house:

- io-homecontrol is a wireless and secure radio technology, shared by specialists habitat with two-way communication.
- Bluetooth is a radio protocol that allows for transparent communication between all equipment within a few meters.
- DSP (Digital Signal Processor) utilized in home theatre amplifiers to handle the transmission of the sound signal to the system's speakers (audio home automation).
- xPL is a free, simple, and documented home automation management protocol that enables communication across any installation devices.
- P2P refers to data sharing between two computers linked to the Internet. Create a direct link between the two devices without using a central server;

- Ethernet is a communication technology that allows information to be sent across networks in computer science.
- ZigBee, a high-level standard for tiny radio transmission, reduces energy usage in personal networks.

1.5.5 Comfort:

A Smart Home can detect when you get home using your smartphone and automatically unlock the gate. The shutters can adjust to the seasons and temperature, allowing for natural light and heat in winter and keeping cool in summer by closing on sun-exposed windows.
Your house automatically adjusts its heating to your preferred temperature based on your presence. It is also possible to have your favorite music playlist automatically play when you wake up or return home. All of this is not science fiction; it is entirely possible today (see Figure 1.6).

Figure 1.6: Illustrates comfort in the Smart home.

1.5.6 Health:

The Smart Home is also finding new uses in the healthcare industry. Installing technologies in the homes of individuals with impairments, neurological disorders like Alzheimer's, and the elderly can automate complicated chores to improve their everyday lives.
It also lets the person to stay at home for extended periods of time and be monitored from a distance. For instance, we can identify whether a person is not drinking enough water or forgets to feed. If a behavior is deemed "worrying," the command interface can trigger alerts to family or emergency services based on predefined scenarios.

1.5.7 Energy Saving:

Smart home systems may save energy and money by controlling shutters and heating based on season, even if the primary goal is comfort. Energy use may be measured quite precisely, whether it's your consumption of electricity, water, or even gas.

When you leave, just pressing the alarm will convert the heating to eco mode, as shown in figure 1.7, and turn off all lighting and appliances that have been left on standby, lowering your energy use while you are gone. And this without any activity from you.

Figure 1.7: saving energy in smart home

1.6 Connected home

A linked home is one in which windows, doors, lights, heating, alarms, and a variety of other features may be controlled remotely by smartphone. To claim that a home is connected, there must be connected things. It also includes the installation of a home automation system and the mobile apps of a smartphone or tablet (figure1.8).

Figure 1.8: connected home

1.7 Smart home features

Smart houses have a few major features:

- The smart home connects users to the power grid, provides information on electricity consumption and prices, allows for consumption planning, promotes energy efficiency, and promotes environmental awareness.
- Smart homes may improve comfort, safety, convenience, and interaction while optimizing people's lifestyles.
- A smart house can accept remote payments.
- Smart house may monitor and interact with the home by telephone, mobile phone, and distant network, detecting abnormalities and processing them in a timely manner.
- The smart house offers real-time meter reading and security services for water, electricity, and gas meters, ensuring easy and high-quality service.
- Support "triple networks" business and the perfect intelligent service[6].

1.8 Smart home devices

Today's smart home systems and devices are more remarkable and comprehensive than ever. Here are some instances.

1.8.1 Lights (Philips Hue):

Philips Hue bulbs allow you to customize the intensity and color of the light. You may create specific moods with constant hue, and these lights are compatible with the majority of smart home systems (figure 1.9).

Figure 1.9: Philips Hue bulbs

1.8.2 Thermostat Ecobee:

The Ecobee allows you to manage air temperature using voice commands, but unlike other smart thermostats, it also functions as an Amazon speaker. Ecobee4 works smoothly with applications and various home ecosystems, such as Alexa and Apple Home Kit.
Furthermore, it may manage the room you are in rather than the area where it is located.

Figure 1.10: Ecobee thermostat

1.8.3 Security NetGear Arlo Q:

The Netgear Arlo Q is a very valuable home security equipment. The NetGear Arlo Q camera captures high-quality video and audio, including photos of people in complete darkness.

Compared to other smart security systems, it proved to be a reasonable investment[7].

Figure 1.11: NetGear Arlo Q

1.9 Conclusion:

The smart home is such a large and diverse sector that its notion emerges and evolves in everyday life. This chapter discusses the impact of smart homes on daily life and activities, including the use of IOT, various communication methods, a large number of sensors, actuators, and microcontrollers, as well as development environments. These factors contribute to the creation of an intelligent home that ensures comfort, energy efficiency, and safety.

CHAPTER 2

METHODOLOGY AND DEFINITIONS

2.1 Introduction

The home control system represents an important step towards automating everyday life in an affordable and convenient way. This system consists of a group of integrated smart devices that work in harmony to manage various home functions. In our project, we have inputs consisting of sensors, such as an MQ9 gas sensor to detect gas leaks, a DHT11 sensor that measures temperature and humidity, and an RFID-RC522 Reader module. All of these sensors are connected to a microcontroller (Arduino). The microcontroller processes the sensor data and transmits it wirelessly via the HC-05 Bluetooth module, which include lights, a servo motor (a precise electromechanical motor), and a relay used to control devices such as a fan. All of these devices are monitored and controlled via android application named SSH.

2.2 Materials Used

For the implementation of the project, we used the following electronic components:

- Arduino UNO
- A gas sensor (MQ9)
- A temperature and humidity sensor (DHT11).
- RFID RC522

- Bluetooth HC05
- Servo motors.
- Relays.
- Fans 12V.
- Breadboard
- LEDs
- Resistors
- Connection wires

2.2.1 Arduino UNO:

Arduino is an electric board with open-source hardware and software that can be programmed using software called Arduino IDE (Integrated Development Environment), which is based on the programming language C++ and is used to develop and upload computer code to the physical board[8].

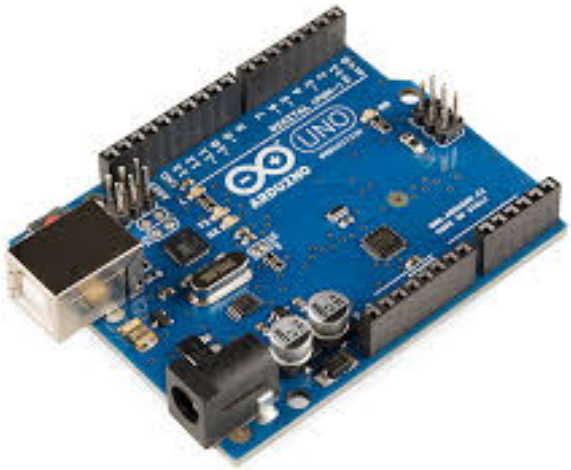

Figure 2.1: Arduino UNO

2.2.1.1 Arduino Uno Component:

1-Digital pins.

2-Pin 13 LED.

3-Power LED.

4-ATmega Microcontroller.

5-Analog Pins.

7-Power connector.

6-GND and 5V pins.

8-TX and RX LEDs.

9- USB port.

10- Reset button.

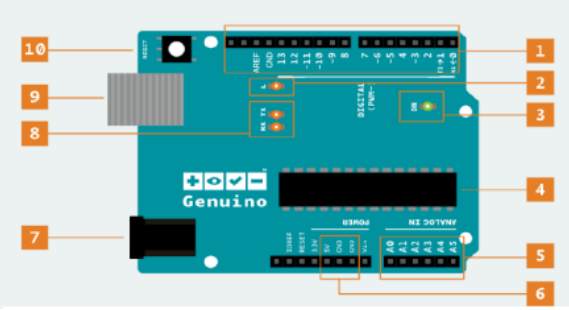

Figure 2.2: Arduino Uno Component)

2.2.2 Gas sensor (MQ9):

The semiconductor-based MQ-9 sensor detects the presence of gas/smoke at concentrations ranging from 300 ppm to 10,000 ppm. The concentration of gas/smoke in the air is detected by the MQ-9, and the result is displayed as an analog voltage. A detection concentration ranging from 300 ppm to 10,000 ppm can be used to detect leaks. The sensor's operating temperature ranges from -10°C to 50°C, and its power consumption is less than 150 mA at 5V[9].

Figure 2.3: Gas sensor (MQ9)

2.2.2.1 The Characteristics of the MQ9 are:

- Power Supply: 5V.
- Interface Type: Analog and Digital.
- Connections:
  Output
  GND
  VCC
- Wide detection range.
- Fast response and high sensitivity.
- Stable system with a long lifespan.
- Dimensions: 40x20 mm.

2.2.2.2 Pinout of the MQ9 Sensor:

The MQ2 sensor typically has 4 pins (sometimes 6, but the 4 main pins are the most commonly used). Here is a description of the pins and their functions:

VCC → 5V (power supply).

GND → GND (ground).

AO → Analog input of a microcontroller (e.g., A0 on Arduino).

DO → Digital input of a microcontroller (e.g., D2 on Arduino).

Figure 2.4: The pins of the MQ2 gas sensor

2.2.3 DHT11 Temperature and Humidity Sensor

The DHT11 is a digital humidity and temperature sensor capable of measuring ambient temperature and relative humidity of the surrounding air. It is frequently used in fields where monitoring environmental conditions is essential, such as environmental control systems in buildings, greenhouses, incubators, growth chambers, or DIY projects. Home automation projects also commonly use the DHT11 sensor to monitor air temperature and humidity and adjust air conditioning or heating systems accordingly[10].

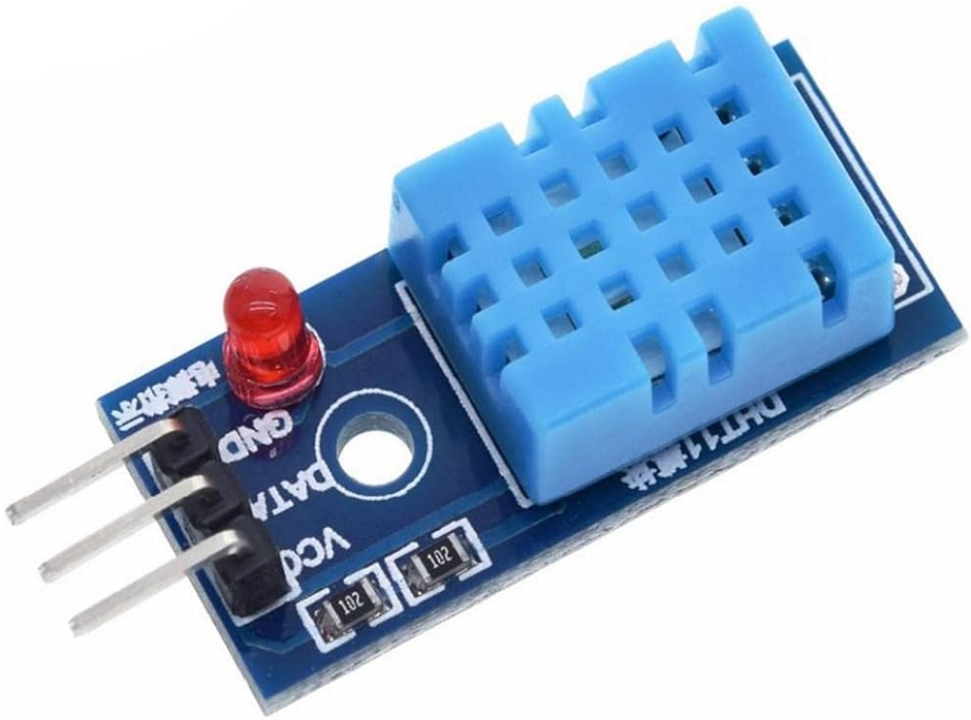

Figure 2.5: DHT11 Temperature and Humidity Sensor

2.2.3.1 Specifications:

Power supply: 3.3 to 5 VCC.

Temperature: 0 to 50°C, accuracy: ±2°C.

Humidity: 20 to 96 RH, accuracy: ±5 RH.

Maximum current consumption: 2.5 mA.

Dimensions: 16 x 12 x 7 mm.

2.2.4 DHT11 Pin Configuration:

VCC (Power Supply) Connects to 3.3V or 5V (works with most microcontrollers like Arduino, ESP8266, etc.).

DATA (Signal Output) Transmits digital signals (temperature/humidity data) to the microcontroller. Requires a pull-up resistor (4.7kΩ–10kΩ) between VCC and DATA for stable communication.

GND (Ground) Connects to the ground (0V) of the circuit.

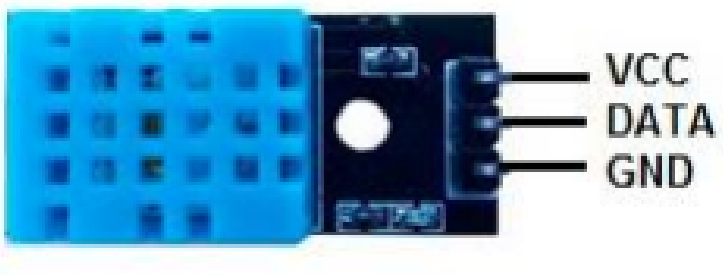

Figure 2.6: DHT11 Pin Configuration:

2.2.5 RFID RC522:

MFRC522 is a kind of integrated read and write card chip. It is commonly usedintheradio at 13.56MHz. Launched by the NXP Company, it is a low-voltage, low-cost, andsmall-sized non-contact card chip, a best choice of intelligent instrument andportable handheld device. The MF RC522 uses advanced modulation and demodulation concept whichfullypresented in all types of 13.56MHz passive contactless communicationmethodsandprotocols. In addition, it supports rapid CRYPTO1 encryption algorithmtoverifyMIFARE products. MFRC522 also supports MI-FARE series of high-speednon-contactcommunication, with a two-way data transmission rate up to 424kbit/s. Asanewmember of the 13.56MHz highly integrated reader card series, MF RC522ismuchsimilar to the existing MF RC500 and MF RC530 but there alsoexistsgreatdiffer-ences. It communicates with the host machine via the serial manner whichneeds less wiring. You can choose between SPI, I2C and serial UART mode(similartoRS232), which helps reduce the connection, save PCB board space (smaller size), andreduce cos[11].

Figure 2.7: RFID RC522

2.2.5.1 RC522 Pin Configuration:

SDA (SS): Microcontroller's SS pin .

SCK: Microcontroller's SCK pin.

MOSI: Microcontroller's MOSI pin.

MISO: Microcontroller's MISO pin.

IRQ: Not connected (optional)

GND: Ground (GND).

RST: Microcontroller's reset pin .

3.3V: 3.3V power supply Do not connect to 5V.

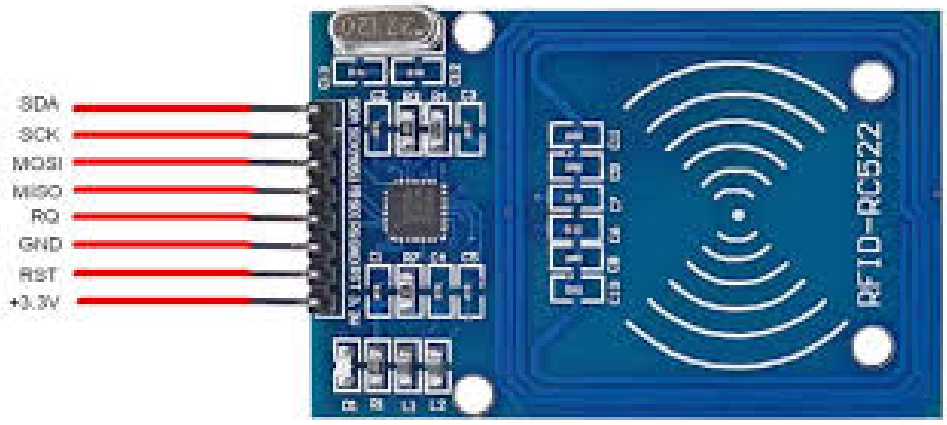

Figure 2.8: RC522 Pin Configuration

2.2.6 Bluetooth HC-05:

The HC-05 Bluetooth SPP module enables transparent wireless serial connection establishment. Serial port Bluetooth module is fully certified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps. Modulation using a full 2.4GHz radio transceiver and baseband. The device utilizes the CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and AFH (Adaptive Frequency Hopping Feature). It has a modest footprint of 12.7mmx27mm. We hope this simplifies your design and development cycle[12].

Figure 2.9: Bluetooth HC-05

2.2.6.1 HC-05 Pin Configuration:

EN/KEY: Mode selection (HIGH for AT commands)

VCC: Power (3.3V-5V)

GND: Ground

TXD: Transmit (connects to MCU's RX)

RXD: Receive (connects to MCU's TX)

STATE: Connection status indicator

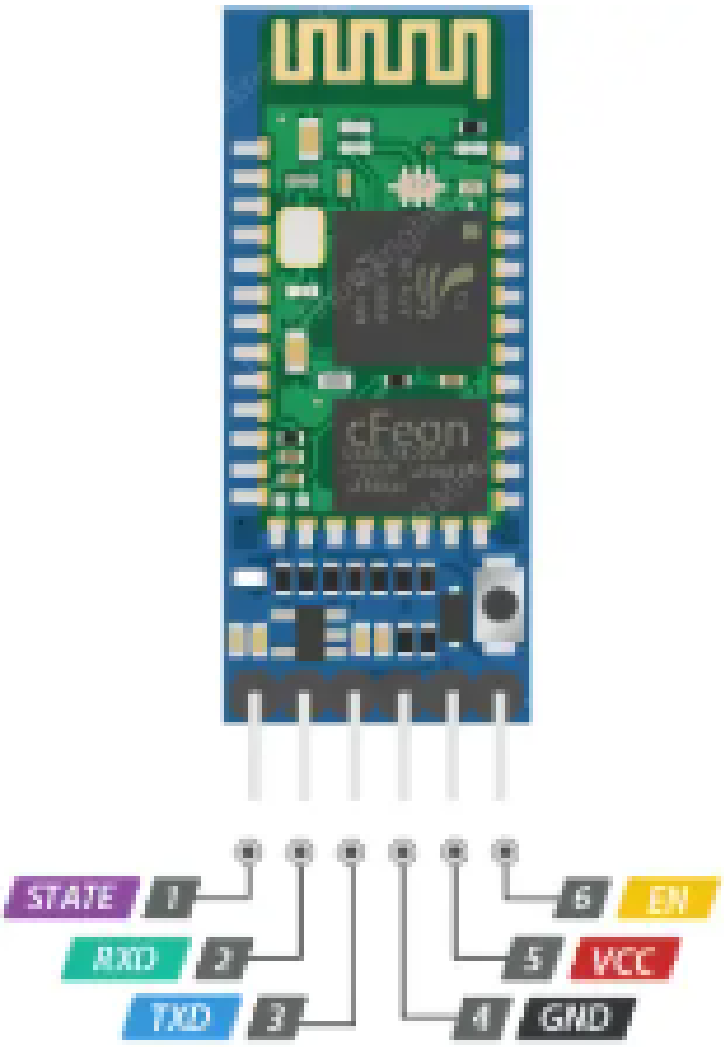

Figure 2.10: HC-05 Pin Configuration

2.2.7 Servo MotorSG90 :

The SG90 servo motor is a compact and inexpensive type of servo motor that is widely utilized in robotics and automation projects. This motor provides fine control over the device's angular

position. The SG90 weighs roughly 9 grams, has a torque of up to 1.8 kg/cm, and can spin around 180 degrees.

SG90 servo motors are mostly used in small-scale hobby projects such as remote-controlled automobiles, robots, and airplanes. These motors can be employed to regulate the position of the steering wheel, wings, and other components that need precision placement. Furthermore, the SG90 servo motor is often utilized in DIY projects involving robotic arms, machines, and other mechanical systems that require precise motion control[13].

Figure 2.11: Servo motor SG90

2.2.7.1 Servo Motor SG90 pin Configuration:

Brown (GND): GND

Red (VCC): 5V (or external 6V supply)

Orange (SIG) : Digital Pin 9 (PWM-capable)

Figure 2.12: Servo Motor SG90 pin Configuration

2.2.8 Relays:

A 5V relay is a type of relay that requires a 5V DC input to operate. The relay itself and the control module are composed of two distinct parts. Inside the relay are the coil that generates the magnetic field, the armature that moves to connect or disconnect a circuit, and the contacts that open and close to operate the load switch. The interface or the part of the relay module with which the user interacts is the relay control module. The control module also includes LEDs for power and status indicators, as well as other components such as a protection diode, transistor, resistor, and other semiconductor devices essential for its operation[14].

Figure 2.13: Relays

2.2.9 Fans(12v):

A fan or extractor is used to remove hot and humid air from a greenhouse, with the goal of promoting air circulation and regulating key parameters required for the greenhouse's proper operation, such as temperature, humidity, or gas concentrations, while keeping them close to the desired set points[15].

Figure 2.14: Fans(12v)

2.2.10 Breadboard:

A breadboard (sometimes called a protoboard) is a board with holes that are electrically linked within. Electronic components and cables can be arranged on the board to create and test electronic circuit[16].

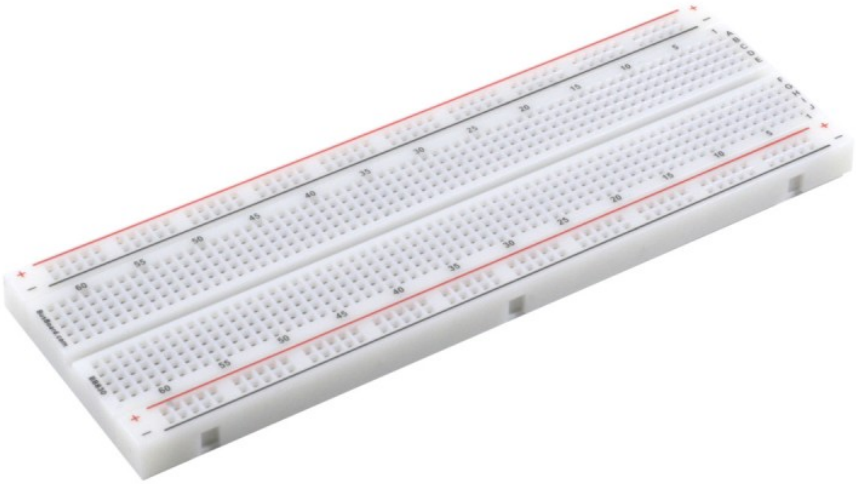

Figure 2.15: Breadboard

2.2.11 LEDs:

LEDs are PN junction diodes constructed from a strongly doped semiconductor material and intended for radiative recombination. The spontaneous emission of photons causes the LED to create an incoherent light output[17]. The LED has 2 pins:

The anode (+): the longer pin, which should be connected to the positive side of the power supply.

The cathode (−): the shorter pin, which should be connected to the negative side or ground.

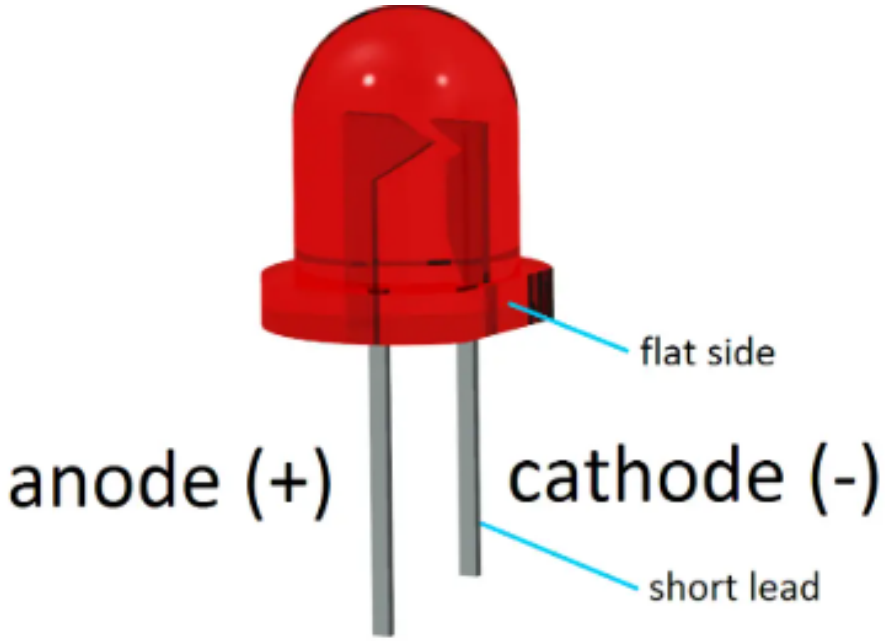

Figure 2.16: LEDs

2.2.12 Resistors:

As an electrical component (a dipole), it opposes the passage of electric current, just as the name implies. Its aim is to control the strength of an electric current in a circuit[18].

Figure 2.17: Resistors

2.2.13 Connection wires:

Connection wires are the connections that connect different smart devices, including lighting, heating and cooling systems, security cameras, and sensors, to one another and to the central control system. They facilitate the transfer of electricity and signals, allowing these devices to be controlled and coordinated in an automated and efficient manner.

Figure 2.18: Connection wires

2.3 Software Section:

The software used to create Arduino modules is a free, cross-platform Java-based tool that lets users write and build code. It may also upload the application over a serial connection (RS232, Bluetooth, or USB, depending on module). The Arduino interface may also be bypassed, and applications can be built via the command line. The programming language utilized is C++.

2.3.1 Definition of the IDE:

The Arduino Integrated Development Environment (IDE) is a Java application inspired by the Processing programming language. The IDE allows you to build and edit programs, as well as translate them into instructions that the board can interpret.

2.3.1.1 Description of the IDE:

The IDE is a code-oriented programming package with around fifty distinct instructions. When the software is launched, the visual interface displays a menu, command buttons at the top, a white editing space, and a black console bar at the bottom.

2.3.1.2 Menu bar:

The menu's many parts allow you to generate new sketches (programs), save them, and control the software options and communication settings with your Arduino board. The menu contains:
File: to create, save (by choosing the location), and launch a program.
edit: is to cut, copy, paste, erase, or select.
Sketch: a tool for organizing and grouping produced files.
Tools: define the board type, serial port, format, reload and fix encoding, and store the board's startup sequence when connected to the computer.

Figure 2.19: Menu bar:

2.3.1.3 Program Editing Window

This is the editor where the program is created. Each program adheres to specific standards to guarantee correct structure for effective compilation while avoiding syntax and other mistakes.

2.3.1.4 Message Area for Ongoing Actions:

This bar indicates if the program is proper or not and displays any mistakes that occur during programming, such as a missing semicolon, a missing brace, or any other instruction-related issue.

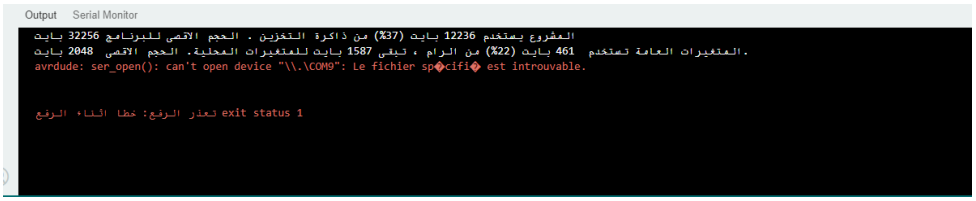

Figure 2.20: Message Area for Ongoing Actions:

2.3.1.5 Definition of Constants and Variables:

This part is optional. You define and declare each input and output by giving it an arbitrary name and associating it with the number of the desired input or variable, while also specifying the variable type.

2.3.1.6 Configuration of Inputs/Outputs:

These instructions come after the void setup() configuration. Once an opening brace is added, you can manipulate the board's pins by configuring them as inputs or outputs, depending on the needs of your project.

```
39  void setup() {
40    Serial.begin(9600); // Initialize serial communication
41
42    //Initialize the DHT sensor with the begin() method.
43    dht.begin();
44    pinMode(ROOM1BULB1, OUTPUT); // Set pin 13 as output (LED)
45    pinMode(ROOM1BULB2, OUTPUT);
46    pinMode(ROOM1BULB3, OUTPUT);
47    pinMode(VANRELAY, OUTPUT);
48    pinMode(GAZPIN, INPUT);
49    SPI.begin();
50   //Initiate MFRC522
51   mfrc522.PCD_Init();
52
53   myservo.attach(SERVO_PIN);
54  }
```

Figure 2.21: Configuration of Inputs/Outputs

2.3.1.7 Programming Interactions and Behaviors:

These appear after the void loop() function. This is the primary area where instructions and operations are written, such as reading data, loops, assignments, and so on. Every instruction must terminate with a semicolon.

2.3.1.8 Comments:

In the input/output configuration, comments should be followed by a slash, an asterisk, or both. Comments in a line of code are separated by two slashes.

2.3.1.9 Using the HC-05 Module with the Arduino IDE:

In this part, we'll look at how to use the HC-05 Bluetooth module with the Arduino Integrated Development Environment (IDE) and the C or C++ programming languages. Although the Arduino IDE supports a variety of peripheral modules, the HC-05 is not directly incorporated into the official board management or libraries. As a result, some manual configuration and proper cabling are necessary to enable successful Bluetooth connection between the microcontroller (such as the Arduino UNO) and the HC-05 module.

2.3.1.10 Configuration of the Arduino IDE for HC-05:

To set up the Arduino IDE to work with the HC-05 Bluetooth module, follow these steps:

1. Open the Arduino IDE: Open the Arduino IDE on your computer.

2. Select the Arduino Board: Go to Tools > Board and select the board you are using with the HC-05 module (e.g., Arduino Uno or Arduino Nano).

3. Select the Port: Go to Tools > Port and select the serial port that the Arduino is connected to.

4. Connect the HC-05 Module: Connect the HC-05 Bluetooth module to your Arduino. Typically, the connections are as follows:

VCC to 5V on the Arduino.

GND to GND on the Arduino.

TX (from HC-05) to RX on Arduino.

RX (from HC-05) to TX on Arduino.

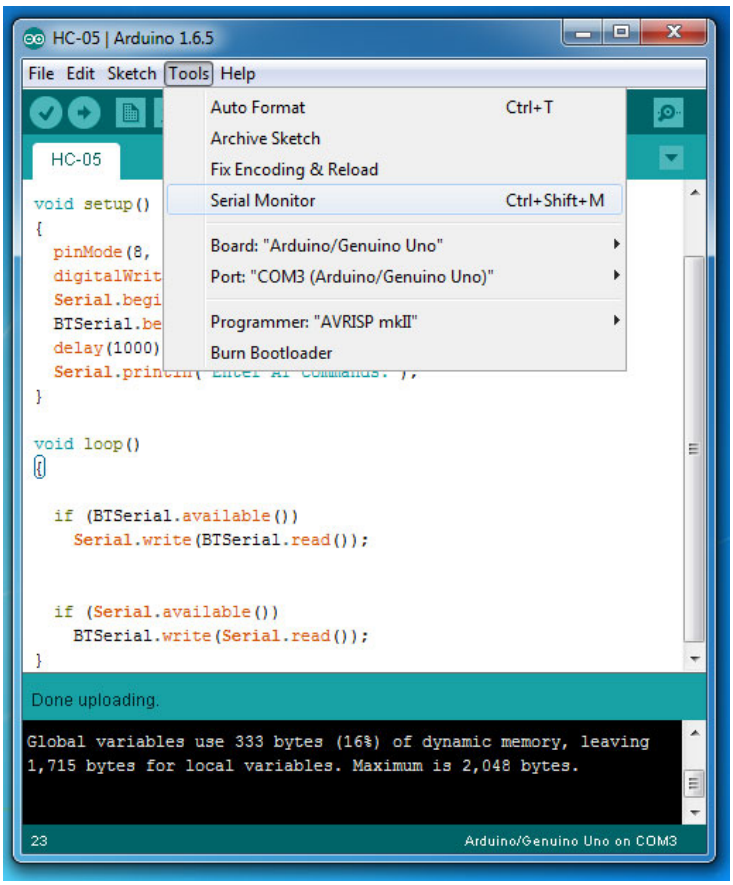

Figure 2.22: Configuration of the Arduino IDE for HC-05

2.4 Smart Home System APP:

The Smart Home operate Application is an Android-powered smartphone software that enables users to remotely operate household appliances and electrical equipment such as lights, fans, doors, and curtains. The solution relies on communication between the smartphone and a microcontroller (such as Arduino) via Bluetooth.

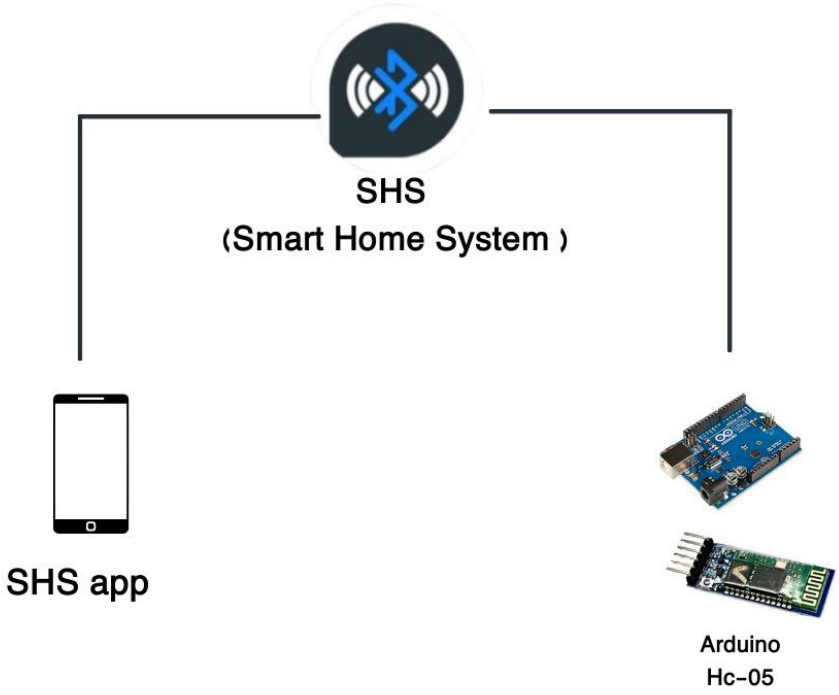

Figure 2.23: Configuration of the Arduino IDE for HC-05

2.4.1 Main components:

include an Android smartphone running a bespoke mobile application. Arduino board (Uno).
Communication Module:
Bluetooth module (HC-05).
Relays are used to regulate air conditioning units.
household equipment (lamps, fans).
Wires, power supply, and safety devices.

2.4.2 Working Principle:

2.4.2.1 On the Android application side:

When a user clicks a button, the app transmits a command ("Room1" or "FANOFF") to the Arduino board over Bluetooth.

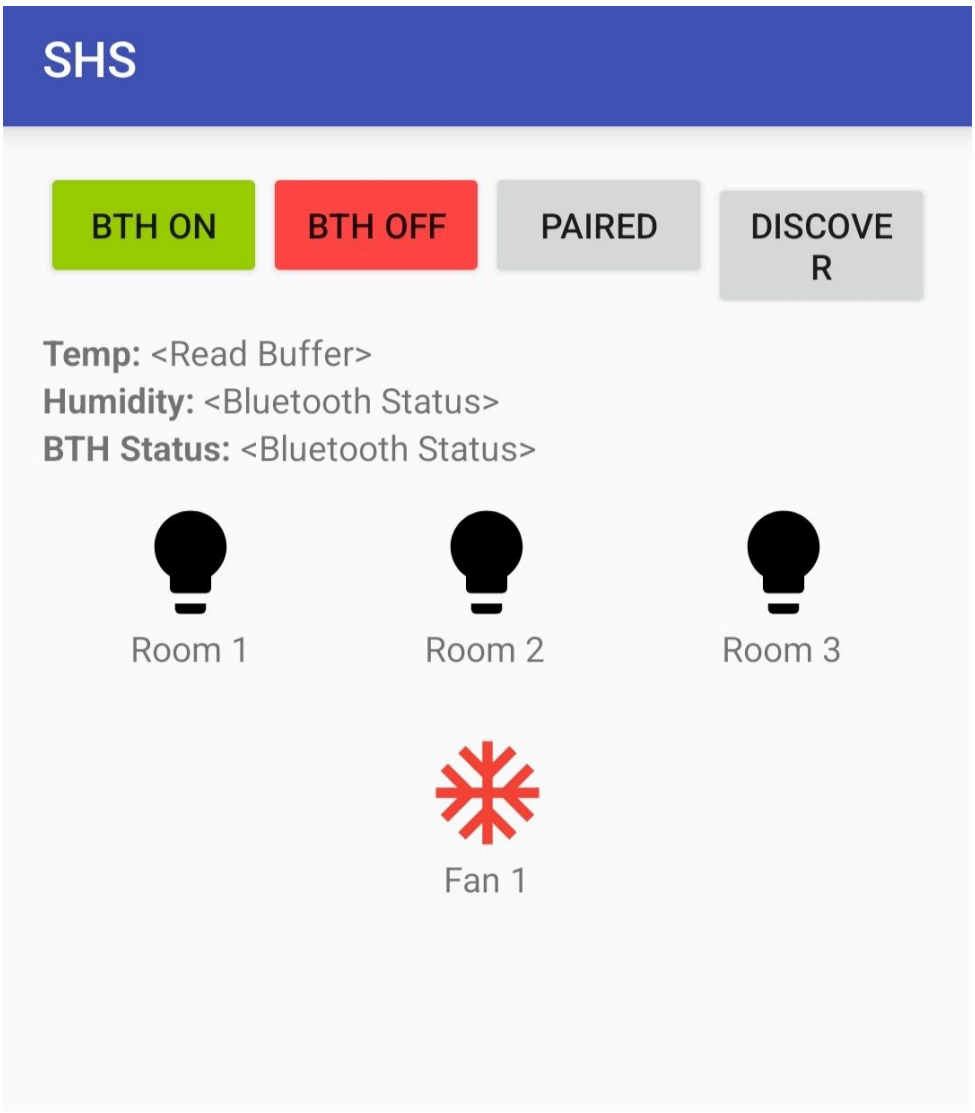

Figure 2.24: Application interface SHS

2.4.2.2 On the Arduino side:

The Arduino gets commands from the smartphone.

It analyzes the commands and activates or deactivates the relevant relay to operate the linked device.

2.5 Conclusion:

This chapter clearly presented the objectives of the development tools, and we were able to gain fundamental knowledge about the functionality of the HC-05 module and the various components required to set up our smart environment, as well as the software used to program the system. Understanding the principles presented in this chapter will be highly valuable for moving on to the following chapter, which will focus on the practical aspects of our project.

CHAPTER 3

IMPLEMENTATIONS AND RESULTS

3.1 Introduction

This smart home's design intends to ease everyday life by allowing intelligent and automatic control of numerous electronic components within the house, such as fans, lighting, air conditioning units, and more, using a smartphone and the SHS application.

This technology enables users to operate devices from anywhere in the globe, providing comfort and security while simultaneously monitoring device status and analyzing associated data in real time.

This concept was created in response to the fast expansion of Internet of Things (IoT) technologies, which help turn traditional homes into smart homes based on good human-technology interaction.

This system effectively implements functions such as reading and measuring interior environmental data for autonomous climate control, monitoring gas and smoke leaks, and providing fast alarms to avert mishaps.

Improved home security by tracking door status and providing a schematic of linked devices to the smart control unit.

This technology helps to minimize energy usage, improve device efficiency, and create a smarter and safer home environment.

3.2 Results :

After completing the project and connecting all of the electronic and software components as depicted in the (figure 3.1), favorable results were achieved, proving the usefulness of the suggested intelligent system in remotely monitoring and operating the property.

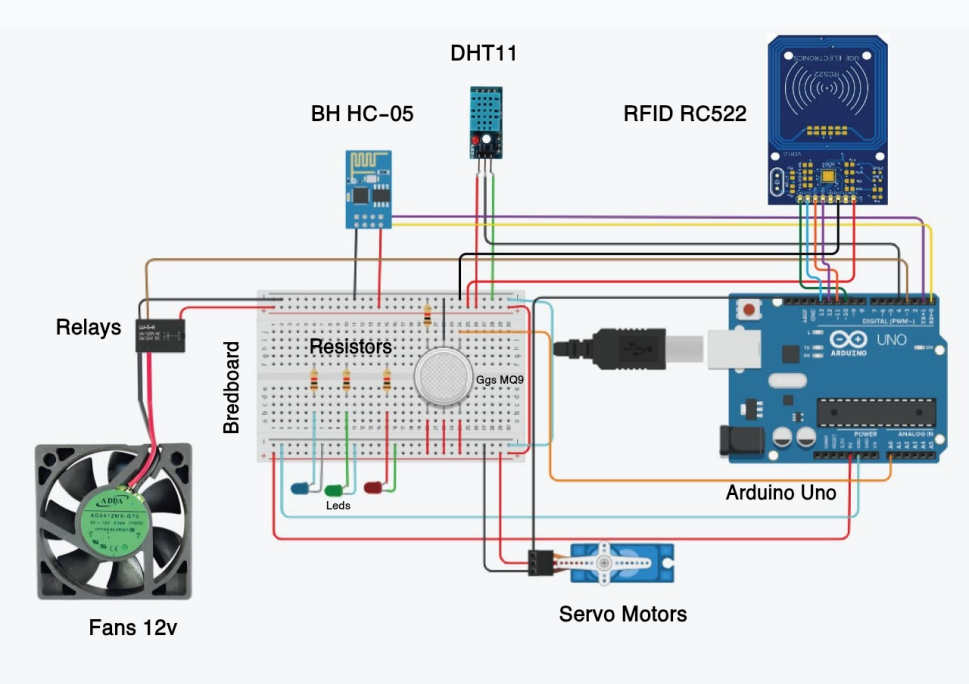

Figure 3.1: Main Diagram

3.2.1 Android (SHS App):

The user was able to turn on and off electrical equipment like lights and fans by sending orders from the phone to the Arduino unit via Bluetooth HC-05 technology. The response time was quick. The user was provided with an application interface that was basic, clear, and easy to use.

3.2.2 Reading Environmental Values (DHT11):

The DHT11 sensor was attached to measure the temperature and humidity in the house. The values were presented in real time on the phone's screen. If the temperature rises over a specified level, the system may be set to turn on the fan automatically.

3.2.3 Gas Leak Detection (MQ9):

The MQ9 sensor was used to test the system with a diluted gas (often home gas). When a leak is detected, an audio alarm is activated, and the user receives notifications via the application.

3.2.4 Identification System Using RFID Card:

RFID Card Identification System: The RC522 reader successfully recognized approved cards. Door opening (using the SG90 servo motor) occurs only when a programmed card is read, which improves security

3.2.5 Stability and Security:

Throughout the testing time, the system ran well and consistently. No unexpected disconnections occurred between the phone and the Arduino. The program offers safety measures to prevent device activation errors.

3.3 Conclusion:

This chapter described the practical execution of the smart house project, including how the electronic components were linked and integrated with the Arduino control unit and smartphone application. The findings showed that the system is efficient and responsive, allowing remote control of a variety of household gadgets. The sensors supplied precise and relevant data that improved house comfort and security.

Furthermore, the use of technologies such as Bluetooth and RFID helped to improve the system's functionality and expand the possibilities for smart control, demonstrating the importance of incorporating Internet of Things (IoT) technologies in the development of safer, smarter homes with higher energy efficiency. These findings validate the suggested design's viability as a platform for future development, including more advanced features and increased cloud connection.

GENERAL CONCLUSION

With the ongoing development of Internet of Things (IoT) and Artificial Intelligence (AI) technologies, the notion of the smart home has become more practical and significant in everyday human existence. We investigated, created, and implemented a smart home system based on a collection of sensors and electronic components linked to an Arduino control unit and administered via a simple and efficient smartphone app.

The project concentrated on the core components of any smart home, including security, comfort, energy efficiency, and remote control. The implementation findings demonstrated that the system is simple to use, extremely responsive, and has significant potential for future development—both in terms of hardware and interaction with network and cloud technologies.

Despite the system's simplicity in comparison to complicated commercial systems, the research marks a significant step forward in understanding and applying smart control ideas. It lays a solid platform for future research that might leverage artificial intelligence, machine learning, and data analysis to improve house behavior and create a smarter, more adaptable user experience.

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APPENDICES

Appendice A Overall system program

```
#include <DHT.h>
#include<MFRC522.h>
#include<SPI.h>
#include<Servo.h>

#define ROOM1BULB1 5 // light for room 1.
#define ROOM1BULB2 6 // light for room 2.
#define ROOM1BULB3 7 // light for room 3
#define VANRELAY 3 // van relay
#define DHT_PIN 4

//Define RFID reader pins
#define SS_PIN 10
#define RST_PIN 9
#define SERVO_PIN 2

//Create MFRC522 instance
MFRC522 mfrc522(SS_PIN, RST_PIN);

//Authorized UID variable
String authorizedUID = "83 73 3E 10"; // Change this to your own authorized UID
```

```
22
23 DHT dht (DHT_PIN, DHT11);
24 String data = ""; // Variable to store incoming data
25 float Temperature, Humidity;
26
27 // define MQ135 variable with A0 value that represent the input analog pin in the
28 int GAZPIN = A0;
29
30 // define standardAir variable with 200 value
31 int standardAir = 200;
32
33 //Create servo object to control a servo
34 Servo myservo;
35
36 //Variable to store the servo position
37 int pos = 0;
38
39 void setup() {
40   Serial.begin(9600); // Initialize serial communication
41
42   //Initialize the DHT sensor with the begin() method.
43   dht.begin();
44   pinMode(ROOM1BULB1, OUTPUT); // Set pin 13 as output (LED)
45   pinMode(ROOM1BULB2, OUTPUT);
46   pinMode(ROOM1BULB3, OUTPUT);
47   pinMode(VANRELAY, OUTPUT);
48   pinMode(GAZPIN, INPUT);
49   SPI.begin();
50  //Initiate MFRC522
51  mfrc522.PCD_Init();
52
53  myservo.attach(SERVO_PIN);
54 }
55
```

```
56 void loop() {
57
58   int sensorRead = analogRead(GAZPIN);
59   if (sensorRead > standardAir)
60   {
61     Serial.print("311");
62     return;
63   }
64   Temperature = dht.readTemperature();
65   Humidity = dht.readHumidity();
66   Serial.print(String(Temperature)+":"+String(Humidity));
67
68   if (Serial.available()) { // Check if data is available
69     data = Serial.readString(); // Read the incoming data
70     Serial.print("Received: ");
71     Serial.println(data); // Print the received data to Serial Monitor
72
73     if (data == "111") {
74       digitalWrite(ROOM1BULB1, HIGH); // Turn on LED
75       Serial.println("LED ON");
76     } else if (data == "112") {
77       digitalWrite(ROOM1BULB1, LOW); // Turn off LED
78       Serial.println("LED OFF");
79     } else if (data == "121"){
80       digitalWrite(ROOM1BULB2, HIGH);
81     }else if (data == "122"){
82       digitalWrite(ROOM1BULB2, LOW);
83     }else if (data == "131"){
84       digitalWrite(ROOM1BULB3, HIGH);
85     }else if (data == "132"){
86       digitalWrite(ROOM1BULB3, LOW);
87     } else if( data == "411"){
88       digitalWrite(VANRELAY, HIGH); // Turn on van.
89     } else if( data == "412"){
```

```
90        digitalWrite(VANRELAY, LOW); // Turn off van.
91      }
92    }
93
94      //Look for new cards
95    if (!mfrc522.PICC_IsNewCardPresent())
96    {
97      return;
98    }
99
100   //Select one of the cards
101   if (!mfrc522.PICC_ReadCardSerial())
102   {
103     return;
104   }
105
106   String content = "";
107 byte letter;
108 for (byte i = 0; i < mfrc522.uid.size; i++)
109 {
110   Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
111   Serial.print(mfrc522.uid.uidByte[i], HEX);
112   content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
113   content.concat(String(mfrc522.uid.uidByte[i], HEX));
114 }
115 Serial.println();
116 Serial.print("Message : ");
117 content.toUpperCase();
118
119 //Compare with authorized UID
120 if (content.substring(1) == authorizedUID)
121 {
122   //Print to serial monitor
123   Serial.println("Authorized access, The gate will open");
```

```
124     Serial.println();
125     myservo.write(90);
126     //Delay for 3 sec
127     delay(2000);
128     myservo.write(0);
129   }
130   else
131   {
132     //Print to serial monitor
133     Serial.println("Access denied, Please try again");
134     myservo.write(0);
135     //Delay for 3 sec
136     delay(300);
137   }
138    delay(500);
139 }
```

Appendice B The creation of the smart house

House model inside and exterior photos: