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Theme

Smart Houses
Based on IoT & Artificial Intelligence

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بسم الله الرحمن الرحيم

ملخص

الهدف من هذا المشروع هو تصميم وإنجاز منازل ذكية متكاملة باستخدام تقنية الإنترنت الأشياء والذكاء الاصطناعي لتحقيق العديد من الأهداف، مثل تعزيز الأمان والعصرنة . ويتم ذلك من خلال دمج العديد من التقنيات الذكية داخل المنزل، حيث تم إنشاء نموذج يعكس تصورنا للمنزل الذكي، والذي يشمل العديد من الوظائف الهامة التي يجب أن يتوفر عليها أي منزل ذكي، مثل نظام الإنذار، والباب الأوتوماتيكي، والإضاءة الذكية، واكتشاف تسرب الغاز، والتحكم في درجة الحرارة والرطوبة، وغيرها من الميزات المهمة . كل هذه الميزات يمكن التحكم بها بسهولة وبشكل مريح من خلال تطبيق يعمل على الهاتف الذكي، مما يوفر للسكان راحة البال والأمان في المنزل .

الكلمات المفتاحية: انترنت الأشياء، الذكاء الاصطناعي، المنازل الذكية .

Résumé

L'objectif de ce projet est de concevoir et de réaliser des maisons intelligentes entièrement intégrées en utilisant la technologie de l'Internet des objets (IoT) et l'intelligence artificielle (IA) afin d'atteindre plusieurs objectifs, tels que renforcer la sécurité et la modernité. Cela est réalisé en intégrant différentes technologies intelligentes au sein de la maison. Nous avons créé un modèle qui reflète notre vision d'une maison intelligente, comprenant plusieurs fonctions importantes que toute maison intelligente devrait avoir, telles qu'un système d'alarme, une porte automatique, un éclairage intelligent, la détection de fuites de gaz, le contrôle de la température et de l'humidité, et d'autres fonctionnalités importantes. Toutes ces fonctionnalités peuvent être facilement et commodément contrôlées via une application smartphone, offrant aux résidents une tranquillité d'esprit et une sécurité dans leur maison.

Mots-clés. *Internet des objets (IoT), Intelligence Artificielle (IA), Maisons intelligentes*

Abstract

The goal of this project is to design and create fully integrated smart houses using Internet of Things (IoT) technology and artificial intelligence (AI) to achieve multiple objectives, such as enhancing security and modernization. This is done by integrating various smart technologies within the house. We have created a model that reflects our vision of smart houses, which includes s many important functions that any smart house should have, such as an alarm system, automatic door, smart lighting, gas leak detection, temperature and humidity control, and other important features. All of these features can be easily and conveniently controlled through a smartphone application, providing residents with peace of mind and security in their houses

Keywords. *Internet of Things (IoT), Artificial Intelligence (AI), Smart Houses.*

Dedicate

I dedicate this work:

To my dear parents.
To my sister and brothers.
To my entire family and friends.

"And to all those who contributed, directly or indirectly, to make this project possible, I say thank you."

Chaouche Rim *Tissemssilt, June 12, 2023.*

Appreciation

First, we praise and thank **Allah**, who has facilitated our path to accomplish and complete this work.

I would like to extend our heartfelt appreciation and thanks to **Mr. Taibi Ahmed**, the Chairman of the Evaluation Committee, and the esteemed members of the committee, including **Mr. Nail Bachir**, for graciously agreeing to evaluate this work.

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I also thank my professors at the Faculty of Science and Technology for their teaching and the information they provided, especially **Dr .Chebbah Kheira**, who never hesitated to give us her advice and support.

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Chaouche Rim

Tissemssilt, June 12, 2023.

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IDE Integrated Development Environment . . . 37

ICTs information and communication technologies . . . 28

IEEE Institute of Electrical and Electronics Engineers . . . 20

LED Light-Emitting Diode . . . 49

LCD Liquid Crystal Display . . . 49

MIT Massachusetts Institute of Technology . . . 8

URI Uniform Resource Identifier . . . 6

RFID Radio Frequency Identification . . . 6

WSN Wireless Sensor Networks . . . 13

Wi-Fi Wireless Fidelity . . . 6

GENERAL INTRODUCTION

Sommaire

1 introduction

As technology continues to advance at a rapid pace, the future of smart houses holds tremendous potential. Artificial Intelligence (AI) and Internet of Things (IoT) technologies is revolutionizing the way we live and interact with our homes. Smart houses, also known as homes incorporating smart technologies, are becoming increasingly popular due to the numerous benefits they offer. From advanced voice assistants to predictive automation and personalized experiences, these smart houses are transforming the way we manage household tasks and enhance our quality of life. In this era of ubiquitous computing, the possibilities for smart houses are endless, and we can anticipate the emergence of even more innovative and exciting developments in the field. In this article, we will explore the fascinating world of smart houses and delve into the potential they hold for the future. There are numerous key applications to accomplish safety and comfort in houses in the Smart houses project, which depends on IoT technology and AI. How to combine and improve these apps to increase their efficiency is one of the issues.

1. To address the issue of outside incursions (burglars), we have implemented an intelligent security system with two components:
   - **The first part**: is a system that allows door access through fingerprint recognition.
   - **The second part**: is the creation of an alarm system using an ultrasonic distance sensor (HC-SR04).
2. To tackle the problem of gas leakage (a silent killer), we have developed a gas detection system incorporating a gas sensor (MQ-2). This system is designed to safeguard the home by detecting and alerting occupants to the presence of dangerous gas leaks.
3. To regulate the temperature and humidity levels in the house, we have implemented a system that controls and maintains optimal conditions. This system may include various components such as temperature and humidity sensors, actuators, and a central control unit to adjust heating, cooling, and humidity devices accordingly.
4. For water tank monitoring, we have employed a water level sensor. This sensor enables accurate measurement and monitoring of the water level in the tank, providing information on the current status and allowing for efficient management of water resources.

5. To control the operation of the fan, we utilize the LM35 temperature sensor. This sensor measures the ambient temperature and provides the necessary input to a control system. Based on the temperature readings, the system can adjust the fan speed to maintain optimal cooling or ventilation conditions within the desired temperature range.

2 Dissertation Organization

This dissertation is divided into four chapters, each of which describes the strategy I employed to develop this project.

I. Bibliographic studies : It contains two chapters:

➢ Chapter 1: This chapter presents definitions and generalities of the Internet of things .

➢ Chapter 2: Theoretical notions on Smart houses.

II. Experimental Study: It contains two chapters :

➢ Chapter 3: this chapter represents the Equipment used in this laboratory study.

➢ Chapter 4: The last chapter, is devoted to the practical realization of our prototype as well as the interpretation of test results.

CHAPTER 1

INTERNET OF THINGS

Sommaire

1.1 Introduction

A Network made up of numerous linked items is referred to as the "Internet of Things." These things have individual identification numbers, embedded intelligence, and the ability to sense and respond. People and things can connect to this network and communicate with one another online [1].

IoT is an ecosystem of connected devices that exchange data over wired or wireless networks, such as, smartphones, laptops, smart office equipment, or anything equipped with sensors. Data generated by these devices is then shared with cloud or on-premises servers, where it is processed to generate insights that help inform decision-making. With millions of sensors and new tools on the Internet every month, the IoT is expanding rapidly . Understanding the development of IoT makes sense whether you're an ordinary user or a business owner offering IoT-related goods and services. IoT ushers in a new era in information technology and has the potential to modernize and intelligently transform our lives and work. Future uses for this technology, such as smart homes and residential neighborhoods, will become possible by building the appropriate infrastructure. When something is connected to the internet, it can send or receive information. This makes the device smart and is a system of interconnected objects, usually called smart devices, through the Internet Based on this technology, very useful services can be provided to improve the quality of life . it has progressed from its infancy to the point where it is about to turn the current fixed Internet into a fully integrated future Internet. The market adoption of this is expected to take 5 to 10 years. By providing a variety of services, the IoT network paradigm is an excellent candidate for enabling smart living.

1.2 Definition

There are many definitions available ,the following are a few examples:

1.2.1 Connected Object

A connected object is a piece of hardware with sensors and data exchange devices that can wirelessly transmit information in real time to another connected object (a computer server, a computer, a tablet, or a smartphone), giving us remote access to information about a specific area of our environment or exchanging data to create a service.

The devices connected to the Wireless Fidelity (Wi-Fi) network include application PCs, application servers, PCs, biomedical equipment, scanners, printers, smart mobile devices, tablets, laptops, video cameras, Internet Protocol (IP) telephones, vehicles, and wireless sensor nodes connected to a wireless gateway [2].

1.2.2 Internet

The Internet is a strong and expansive global network of interconnected computer systems that communicate with one another using standardized communication protocols. The Internet is made up of millions of private, public, academic, research, commercial, and government networks with local and international reach that are connected to a wide range of electronic, wireless, and wireless networking technologies. Anyone with a device they can connect to has access to the Internet.

The ultimate goal of an Internet of connected objects is to promote economic growth, enhance human welfare, and address some of the societal issues of today, namely by using real-world interactions as a source of virtual world communication opportunities. [3].

1.2.3 Things

A thing is an entity, idea, or quality that is perceived as having its own existence in the world. Things is also often used interchangeably with the word "object". When we talk about things, we can refer to both living things and non-living things. Once something has a unique identifier, you can tag it, assign it a Uniform Resource Identifier (URI) , and monitor, automate, and even communicate with it on the network. Also Radio Frequency Identification (RFID) one of the most widely used object-linking technologies today.

Things are another aspect of the Smart Things phenomenon [4].

1.2.4 Smart Things

The industry has seen a huge increase in the popularity of smart home appliances due to the rapid development of home IoT service technologies. Smart TVs, smart speakers, smart plugs, and Internet protocol cameras are now people's top choices when purchasing home appliances thanks to the pros-perity of the smart home appliance market [5].as shown in Figure1.1.

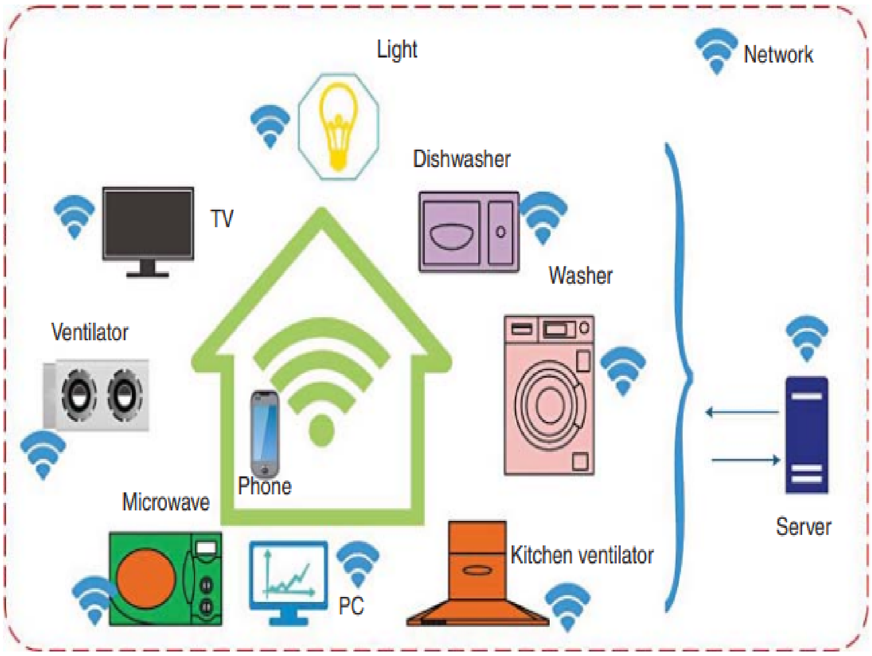

Figure 1.1: Smart Things [6].

Smart objects are independent physical or digital objects enhanced by sensor, processing, work and network capabilities. Add intelligence to the everyday things in our world so that our lives can be more wonderful. Smart things put the world of things connected at your fingertips. They are smarter, fitting, safer, safer and efficient. These make it easy to connect things in our physical world to the Internet for automation, monitoring, control and enjoyment from anywhere and at any time through any network by anyone [4].

1.2.5 Internet of Things

In 1990, the term "Internet of Things" was first used. Was created by British engineer Kevin Ashton while he was working at the Massachusetts Institute of Technology (MIT) facility. The main concept of IoT is “the integration of virtuality and reality and the interconnection of all things, which can also be understood as the phenomenon that all things in the world, whether humans, things, time, locations, or objects, can be interconnected by the Internet [7]. All things can now be connected to the Internet thanks to IoT technology.IoT is used in a variety of industries, including smart homes, industrial monitoring, aged care, intelligent transportation, environmental protection . Buildings for smart homes based on IoT security are being constructed as the economy grows. Because they already have all the required services, we can argue that these smart homes can serve as a metropolis in our modern period [8]. All of the various definitions of the term IoT share the idea that it refers to the blending of the real world and the online virtual environment [9].

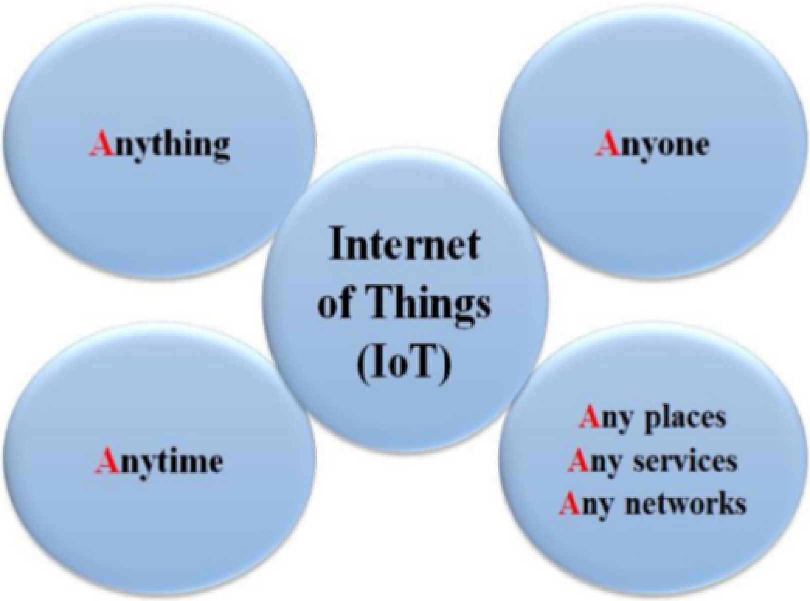

Figure 1.2: Internet of Things concept [10].

1.3 History of IoT

History of IoT is [11] [12] [13] :

- In 1999, Bill Joy introduced the concept of Device-to-Device communication in his internet taxonomy, while the term "Internet of Things" was coined by Ashton. Additionally, the establishment of the Auto-ID Center at acMIT contributed to the advancement of RFID technology, with the aim of producing an affordable chip capable of storing information and linking objects to the internet.

- In 2004, the term "Internet of Things" began to appear in book titles and was mentioned in various media outlets.
- In 2007 witnessed the debut of the first iPhone, which provided the general public with a revolutionary way to engage with Internet-connected devices and interact with the world around them.
- The year 2008 marked a significant milestone in the history of IoT with the first international IoT conference held in Zurich, Switzerland. Interestingly, it was also the year when the number of Internet-connected devices exceeded the world's population for the first time.
- In 2013, Google released Google Glass, which was a groundbreaking step in the field of wearable technology and IoT. However, it was perhaps ahead of its time and did not gain much success, resulting in a significant setback for the project.
- In 2017-2019: IoT development became more affordable, user-friendly, and widely accepted, which led to a series of innovative breakthroughs across the industry. The development of self-driving cars continued to progress, while block chain and AI were increasingly integrated into IoT platforms. Moreover, the rising penetration of smartphones and broadband technology has made IoT an increasingly attractive proposition for the future.
- Currently, there are over 26 billion connected IoT devices, expected to exceed 75 billion by 2025.

1.4 What exactly is the Internet of things?

IoT connected devices and machines can improve how we work an live [14] .

The IoT allows for the automation and simplification of tasks that are complicated and occasionally beyond the capability of humans. Today's Internet of Things is made up of billions of connected devices [15].

IoT enables sensors and everyday objects to exchange and use data with little to no human engagement by giving them network access and processing capacity. IoT is thus a dynamic global network architecture with self-configuring capabilities based on well-established and interoperable communication protocols, where physical and virtual items have identities, physical characteristics, and virtual personalities, and are easily incorporated into data, utilizing an intelligent interface network.

IoT is the term used to describe the interconnection of numerous physical sensors, including smart mobile phones, meters, vehicles, and personal digital assistants, as well as radio frequency identification tags and other electronic devices that are wirelessly capable of communicating and exchanging data. This interconnection has been occurring at an unprecedented rate in the widely acknowledged communication network revolution.The IoT can participate as a major player in the provision of numerous applications in a variety of sectors, from transportation and industry disaster response to all facets of smart cities and healthcare [16].

1.5 IoT as a Network of Networks

The IoT is made up of various networks, such as vehicles. Several networks allow for increased road safety while saving time. Commercial and residential buildings are also outfitted with various systems to provide overall control of various equipment dedicated to safety, lighting, heating and ventilation, and so on. Through the evolution of the IoT , these networks will be linked to advanced security and analytics functions [17].

1.6 IoT Architecture

Various IoT architecture models exist, and they differ based on the particular requirements of the application. Nevertheless, similar elements found in the majority of IoT architectures include :

1.6.1 Coding Layer

The bottom layer of the IoT architecture involves assigning a distinct code to each object of interest to ensure its unique identification [11].

1.6.2 Network Layer

This layer It is frequently called the transmission layer. Between the two layers—the perception and applications layers—it acts as a conduit or routing. It is also in charge of wirelessly transmitting and receiving actual information from physical things like sensors that are obtained from a lower tier of the layer. They become more sensitive as a result, making them more open to attack by adversaries. It could be crucial in a number of situations involving the reliability and security of data transit between network layers [18].

1.6.3 Application Layer

The IoT application is part of this layer, which is at the top of the architecture and is in charge of delivering different IoT apps to diverse users. Applications may come from a variety of business sectors, including manufacturing, logistics, retail, environment, public safety, healthcare, food and medicine, etc. A variety of IoT-related applications are developing as a result of the maturation of RFID technology [2].

1.6.4 Interface Layer

IoT connects a wide range of devices, however these devices have different owners and may not always follow the same standards. The incompatibility issue between two things must be resolved before they can interact. Compatibility is influenced by data interchange, communication, and event processing. An effective interface mechanism must simplify the management and connectivity of things. The interface layer primarily acts at the application frontend, or Application Program Interface (API) [19].

As demonstrated and described in Fig1.3, these three levels are sensor, network, and application.

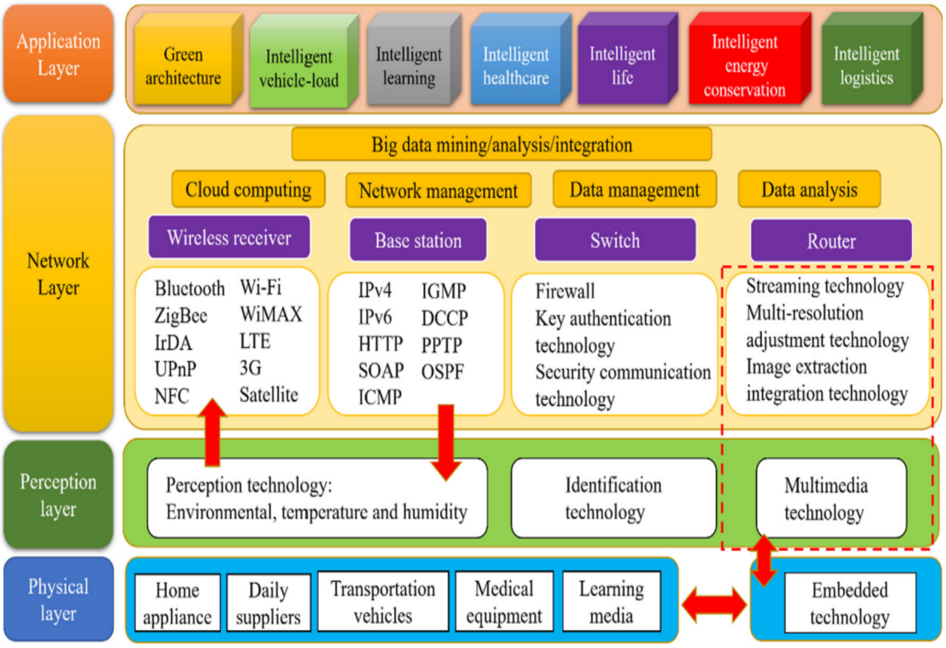

Figure 1.3: IoT Architecture in our system [20].

IoT architecture is crucial for creating secure, scalable, and dependable IoT systems that may offer both organizations and individuals beneficial insights and outcomes.

1.7 IoT Elements

The IoT is made up of various components, including:

1.7.1 Radio Frequency Identification

RFID technology is useful when building microchips for wireless data communication. Any device may be instantly recognized by its bar code thanks to this design [21] .

1.7.2 Wireless Sensor Networks

Sensor data is exchanged between sensor nodes and transmitted to a centralized or distributed system for analysis. The elements that constitute the monitoring network of Wireless Sensor Networks Wireless Sensor Networks (WSN) comprise of [22] :

- WSN hardware.
- WSN communication stack.
- Middleware.
- Secure Data aggregation.

1.7.3 Visualization

Visualization is crucial for an IoT application because it allows users to interact with their surroundings. Recent developments in touch screen technologies have made using smart tablets and phones incredibly intuitive. As we move from 2D to 3D screens for consumers, more information can be made accessible to customers in beneficial ways [22].

1.7.4 Data storage and analytic

One of this field's most important outcomes is the generation of a huge volume of data. Ownership, expiration, and storage of data become very important factors. As a result, energy efficiency and dependability will be guaranteed by centrally located data centers that run on gathered energy. The data must be saved and used intelligently for intelligent monitoring and actuation [22].

1.8 IoT platforms

Using IoT platforms as indicated in Figure 1.4 to collect, store, analyze, and manage the enormous volumes of data generated by your connected assets and assets, you can develop unique hardware and software products.IoT devices are made up of a variety of components, such as hardware, software, and communication technologies. applications for end users and a central repository [23].

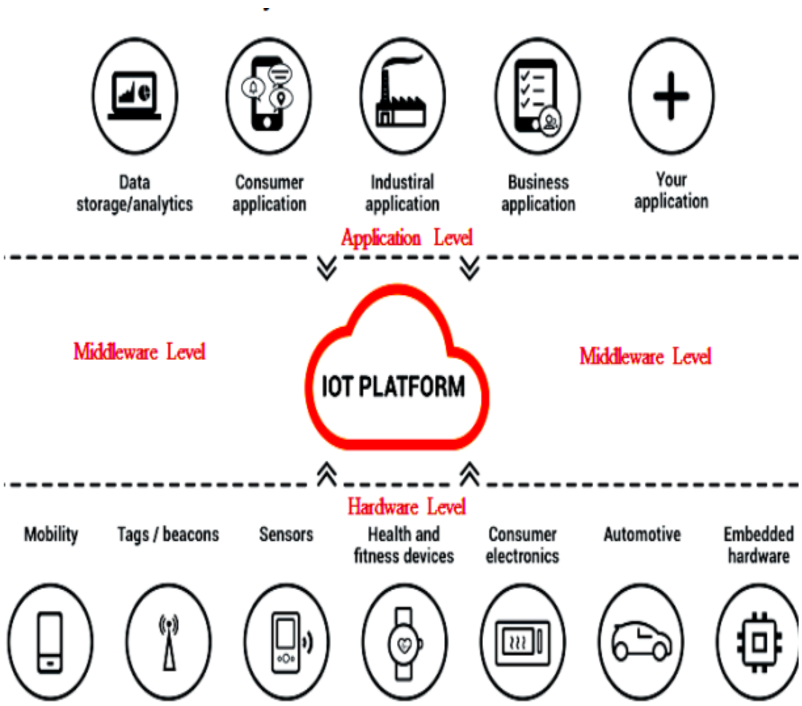

Figure 1.4: The Internet of Things Platform [24].

1.9 IoT applications

The IoT has a significant and varied impact on all facets of daily life. The following are some common examples of IoT applications :

1.9.1 Smart Homes

Smart homes and equipment, including smart TVs, home security systems, lighting controls, fire detection systems, and temperature monitoring, are actually made possible by IoT technology. Thanks to the sensors of these appliances, which continuously monitor the conditions and environment and give surveillance data to a central controller at home, the homeowner is able to continuously watch and operate the home even from outside and make the best decision at all times. These surveillance data also assist us in maintaining our high standard of life, convenience, security, and comfort by enabling us to take wise precautions in advance. In this case, homeowners can share certain surveillance data to help detect an accident or report incidents to the authorities, such as video from an outside camera [25] As shows in the Figure 1.5.

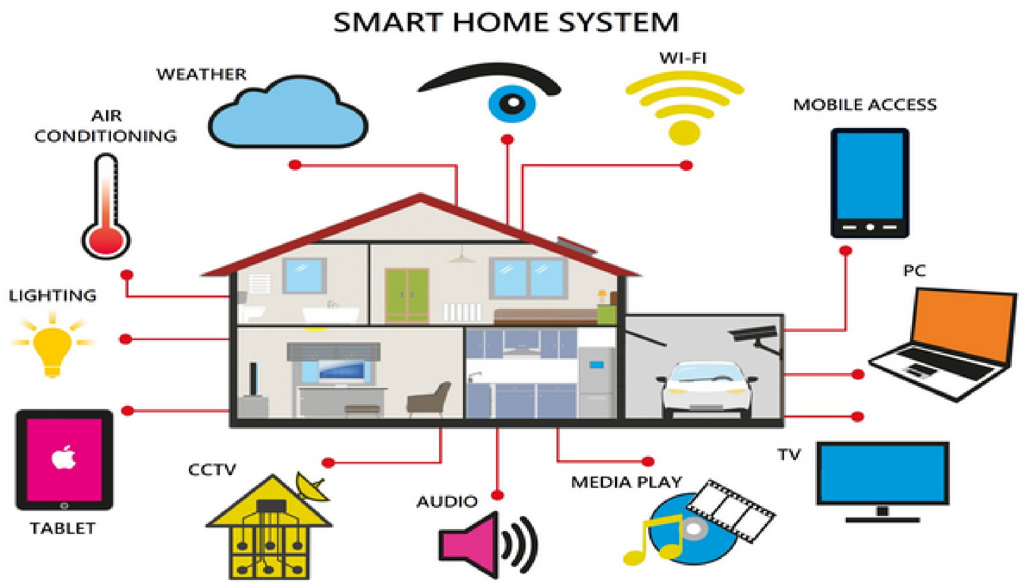

Figure 1.5: example of Smart Home [26]

1.9.2 Retail and Logistic

Retail and the supply chain employ IoT to track storage conditions with the chain.RFID and WSN IoT applications are utilized for product monitoring and payment. In the IoT, logistics includes, among other things, delivery quality, item placement, and tracking.RFID , sensors, and individual sensors were used in IoTcomponents [27] As exemplified in the Figure 1.6.

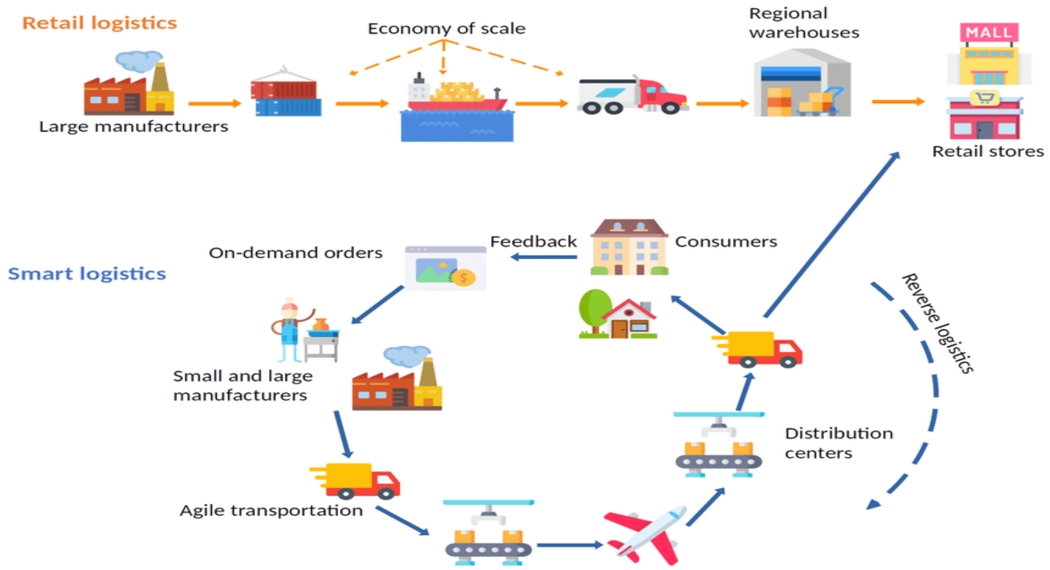

Figure 1.6: example of Retail and Logistic [28]

1.9.3 Smart Cities

The smart city As displayed in the Figure 1.7 is becoming smarter than in the past as a result of the current expansion of digital technologies. Smart cities consist of various kinds of electronic equipment applied by some applications, such as cameras in a monitoring system, sensors in a transportation system, and so on. Hence, with taking the heterogeneous environment into account, various terms, like characteristic of objects, participants, motivations and security policies would be studied . Smart citizens, smart energy, smart buildings, smart technology, smart healthcare, smart infrastructure, smart governance and education and finally smart security are the aspects of smart cities [25]. IoT can be used to create smart cities, where sensors are used to monitor traffic, air quality, and other environmental factors. This information can be used to improve city planning and make cities more efficient.

Figure 1.7: example of Smart Cities [29]

1.9.4 Healthcare

IoT is utilized in the healthcare sector to track objects, identify people, sense their surroundings, and authenticate them. For the purpose of identifying a person or moving object, tracking is utilized. In order to reduce medical record upkeep and avoid mismatches, this is used to track patient flow and authenticate the patient inside the facility. This application offers a variety of prescription-required telemedicine options.RFID , NFC, WSN, Wi-Fi, Bluetooth . as well as techniques of the function like temperature, heart rate, and glucose, are the parts of the IoT healthcare area that are currently in style [27]. Examples of healthcare IoT devices include blood glucose monitors, ECG monitors, and medication dispensers As as shows in the Figure 1.8.

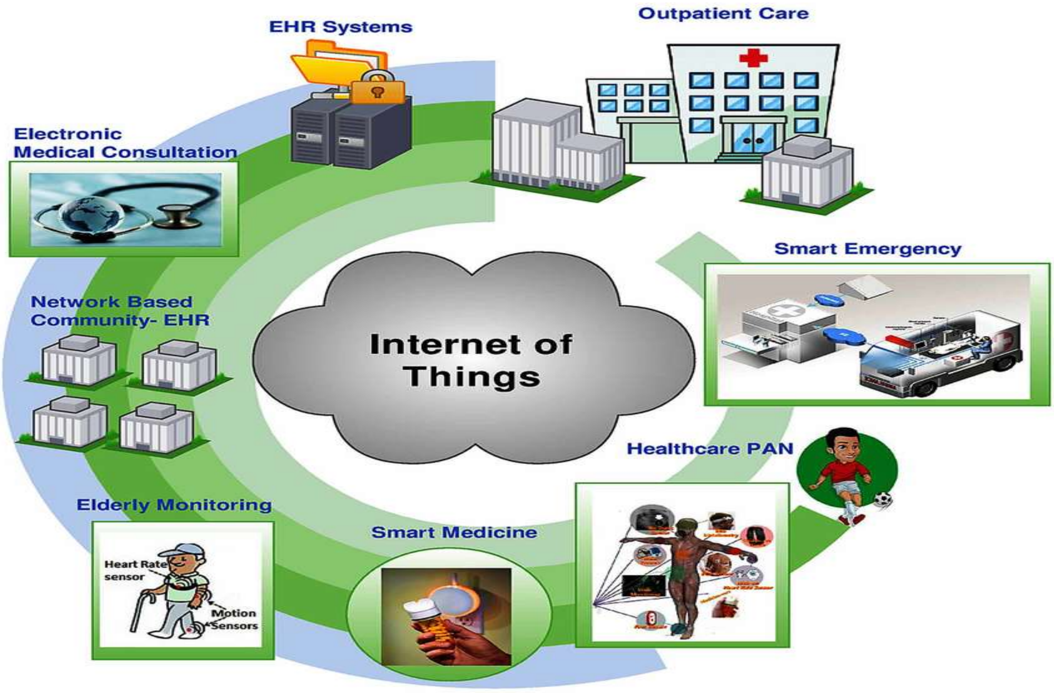

Figure 1.8: example of Healthcare [30]

1.9.5 Transportation

All modes of transportation, including air, sea, and land transit, rely on IoT. Every element of these transportation fields is built using smart devices like sensors and processors, and they are all connected via cloud servers or other servers that relay data to networks. In addition to making it easier to get from one place to another,IoT in transportation also increases safety and appropriateness. A smart car, for instance, performs several activities at once, including communication, entertainment, navigation, and safer and more effective transportation. Travelers may stay connected to all kinds of transportation at all times thanks to IoT . Several wireless technologies, such as Bluetooth, Wi-Fi, 3G, 4G, intelligent traffic systems, and even other vehicles are used to connect the vehicle to the internet [24].

In the figure 1.9 below, smart transportation is being utilized.

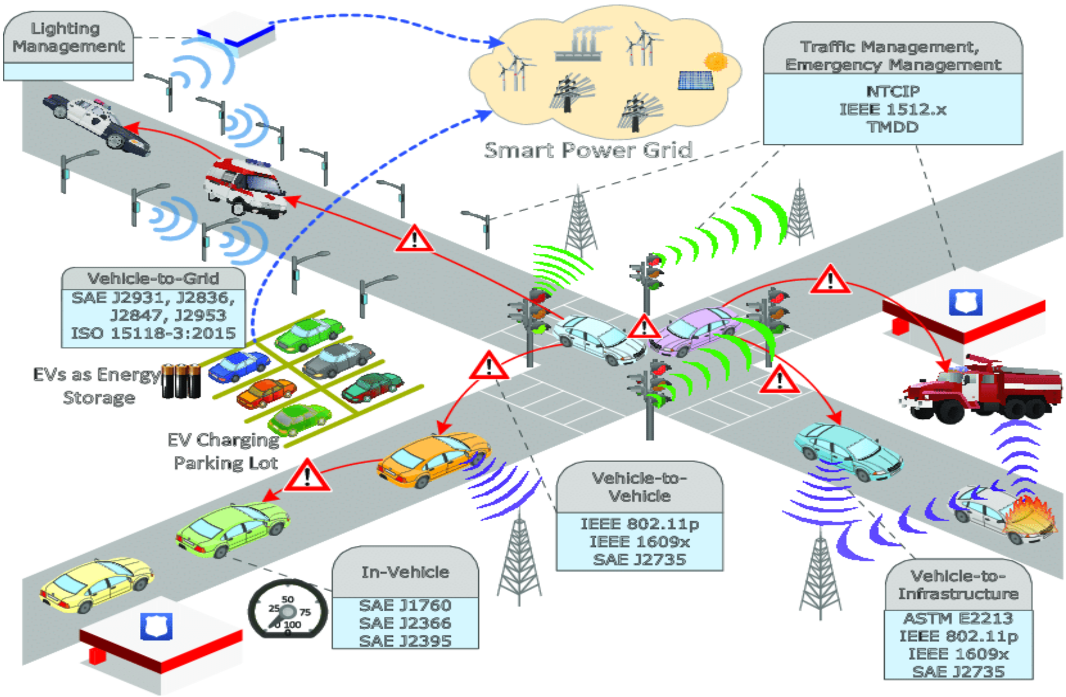

Figure 1.9: example of Transportation [31]

1.9.6 Smart Agriculture

It will monitor Soil nutrition, Light, Humidity etc and improve the green housing experience by automatic adjustment of temperature to maximize the production. Accurate watering and fertilization will help improving the water quality and saving the fertilizers respectively [32] as shows in the Figure 1.10.

Figure 1.10: example of Smart Agriculture [33]

These are just a few of the numerous uses for IoT technology. In the future, we may anticipate seeing even more cutting-edge IoT applications as technology develops.

1.10 The IoT Communication Technologies

IoT is a vast network of physical items, systems, and devices that are linked to the internet. IoT devices use a number of communication protocols to exchange data with other systems and with one another. Technologies used for IoT 1.11 connectivity include some of the following [34] [27] :

1.10.1 Bluetooth

Most smartphones and mobile devices come with Bluetooth, a short-range communication technology that has several advantages for personal objects, notably wearables. Users of smartphones are accustomed to Bluetooth. Nevertheless, Bluetooth Low-Energy (BLE), sometimes referred to as Bluetooth Smart, quickly became the next crucial protocol for Internet of Things applications. This technology may potentially operate as the foundation for the Internet of Things because it is scalable and adaptable to all or any market improvements.

1.10.2 Zigbee

Zigbee is a low-power wireless network designed for industrial settings that operates at a low data rate. The technology is based on the Institute of Electrical and Electronics Engineers (IEEE) standards. The ZigBee Alliance has developed Dotdot, a universal IoT language, which allows smart devices to communicate securely on any network and perform their functions.

1.10.3 Wi-Fi

Wi-Fi is the name of the technology used for radio wireless device networking. It can quickly transfer data and analyze large amounts of data. This form of networking is the most typical in LAN configurations.

1.10.4 Cellular

Cellular is the best solution for IoT applications that need long-distance power and applications with high data throughput. This might expand the benefits of the data to 4G cellular connectivity. Although this protocol is used by the majority of mobile devices, local network connections do not use it.

1.10.5 LoRaWAN

The LoRaWAN (Long Range Wide Area Network) protocol is used by wide area networks. It was designed primarily to support massive networks with millions of low-power devices. It can provide low-cost mobile and secure bidirectional communication in a range of industries.

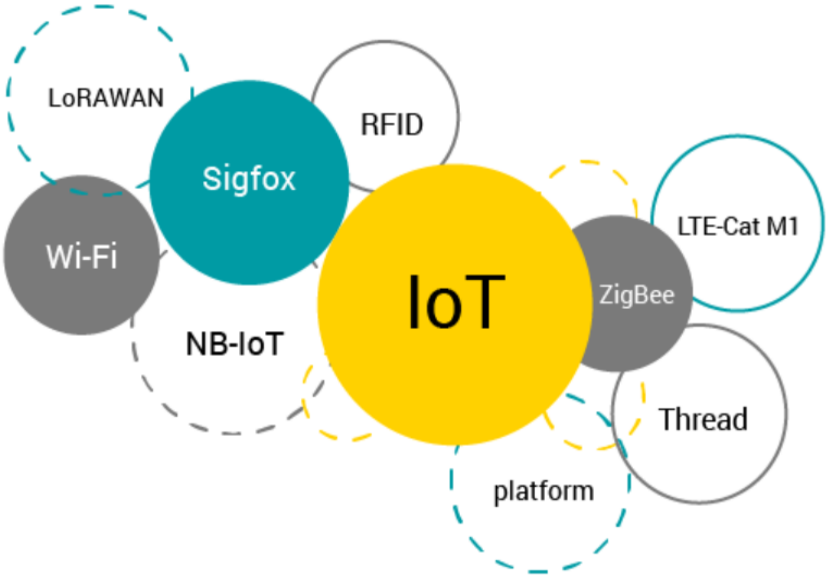

Figure 1.11: Communication Technologies [35]

1.11 Challenges of Internet of Things

Although the IoT has many benefits, such as better productivity, efficiency, and user experiences, there are also a number of difficulties in implementing and using it. IoT faces a number of key difficulties, including:

1.11.1 Privacy and Security

New challenges identified for privacy, trust and reliability are: [36]

- Prioritize trust and quality of information in shared IoT models for re-use across multiple applications.
- Ensure secure data exchange between IoT devices and consumers for privacy and confidentiality.
- Protect vulnerable IoT devices with adequate security mechanisms.

1.11.2 Data Management

Large volumes of data are produced by sensor networks in an IoT context and are kept on servers or centralized nodes. Every gadget could want some kind of service, thus it's crucial to quickly locate the server that can fulfill the request. The detection of energy usage or help for various enterprises may be made possible by the production of relevant information from raw sensor data [37].

1.11.3 Device Level Energy Issues

Knowing that communication consumes the most energy on devices, connecting "things" in an interoperable manner while taking energy limits into consideration is one of the key difficulties in the Internet of Things [36].

1.11.4 Real-Time

Real-time usage of IoT devices is necessary. IoT systems using sensors must have quick and reliable sensors in order to maintain real-time performance. Consequently, the IoT system must provide real-time assistance for the device or user even for embedded devices with limited capability [38].

1.12 IoT Essential Characteristics

Shows IoT essential characteristics discussed as follows [39] [10] :

- Safety: IoT networks are designed with a comprehensive security model to ensure the safety and security of personal data and associated objects, as well as protect data transmission points from attacks and pollutants.
- Intelligence: IoT utilizes algorithms, software, and hardware to create an intelligent network that can respond intelligently to situations and perform tasks. The network's capabilities can be enhanced by surrounding intelligence, and it features a user-friendly graphical interface for interaction between the user and device through standard saving methods.
- Inter-connectivity: The Internet of Things enables anything to be linked to the worldwide information and communication facilities, allowing for seamless inter-connectivity between objects.

- Localization: Intelligent objects within IoT are able to determine their physical location, or can be located using suitable technologies such as mobile phone networks.
- Identification: Objects within IoT can be identified using reader media such as RFID or a mobile device, allowing for efficient and accurate tracking and management.

1.13 Advantages and Disadvantages

Here are some advantages and disadvantages of IoT:

1.13.1 Advantages of IoT

IoT offers numerous advantages, including [40] :

- Tasks can be automated and efficiency can be improved with IoT.
- IoT provides increased accessibility and convenience of information.
- Devices and systems can be better monitored and controlled with IoT.
- IoT enables greater data gathering and analysis capabilities.
- Decision-making can be improved with IoT.
- Cost savings can be achieved through the use of IoT.

1.13.2 Obstacle of IoT

IoT offers many benefits, it also has several potential obstacle :

- Security Risks: With the rise of IoT, there are concerns about data privacy and security. As IoT devices collect and transmit sensitive data, they may be vulnerable to hacking, malware, and other cybersecurity risks.
- Dependence on Internet Connection: IoT devices rely on a stable internet connection to function. If the internet goes down, the devices may not work properly, leading to potential disruptions in business operations and personal life.
- Data Overload: With the massive amount of data collected by IoT devices, there is a risk of information overload. This can make it difficult to filter and interpret the data effectively, potentially leading to missed opportunities or incorrect conclusions.

1.14 Conclusion

In conclusion, The Internet is no longer just a computer network; it has grown into a network of devices of all shapes and sizes, including cars, smartphones, home appliances, toys, cameras, medical instruments, and industrial systems, all of which are constantly Communicate and share information.It is refers to all the devices and technologies we use every day that can be connected to the internet and controlled by software on our smartphones, laptops and other devices. It is a state-of-the-art international technology based on the Internet as an information technology infrastructure.

The Internet has proven its presence in our lives, from virtual interactions to social relationships. The Internet of Things has expanded the internet's potential by allowing communication between objects and humans, resulting in a smarter and more intelligent planet. This has practically realized the vision of "anytime, anywhere, anyway, anything" communications. To that end, it is observed that the IoT should be regarded as a core component of the existing internet based on its future direction, which is clearly distinct from the current phase of internet that we see and use in our daily lives [41]. IoT ushers in a new age in information technology and has the power to intelligently modernize and revolutionize our daily lives and jobs. Future studies may tackle these problems and offer workable solutions, strengthening the security, dependability, and stability of the IoT architecture. This infrastructure, including smart homes, can be constructed.

CHAPTER 2

SMART HOUSES

Sommaire

2.1 Introduction

SMart houses is growing and it is one of the latest technologies used in modern times, this technology relies on the use of IoT and AI to make the home secure and comfortable for residents.

Smart Houses offer a seamless integration of IoT technology with your daily activities, resulting in a comprehensive and energy-efficient system that is safe, comfortable, and convenient. These systems are becoming increasingly user-friendly and designed with overall interaction in mind. Through the use of the Internet and IoT technologies, smart houses are able to connect various devices such as lighting systems, temperature regulation, surveillance and security systems, audio and video equipment and cleaning tools. Equipped with sensors, controllers, and communication devices, smart houses allow homeowners to remotely manage and control various aspects of their homes. For example, smart thermostats can learn heating and cooling preferences and adjust accordingly, while smart locks can be locked and unlocked using a smartphone. Additionally, smart cameras offer enhanced security features for remote monitoring of home security systems, cameras, and alarms.

IoT technology is being used in strong and interesting ways in the field of smart houses, which has several advantages for homeowners. We may anticipate that as technology advances, smart house systems will get even smarter and easier to operate. However, while assuring compatibility with other devices, it is crucial to address any security and privacy issues that may arise [6].

2.2 Smart Houses History

History of smart houses is [8] :

- In 1901 appliances were invented with the first vacuum cleaner.
- In 1907 the vacuum cleaner was developed. After several years, electric dryers, refrigerators, irons, and others were invented.
- In 1966-1967 - The ECHO IV was the first device used to control appliances in terms of turning them on and off, and the temperature of house.
- In the 1970s security monitoring and lighting control devices.
- In the 1980s, most of England had color television.
- In 1990, half of the population of England had video recorders.
- In 1991 - Aging technology to help the elderly.
- In 1994, Rotary dryers are increasingly used by people in addition to cordless house phones, DVDs, Play Stations, and multimedia computers, 1998 - Provides new communication networks such as ISDN, the Internet, and peripherals such as web television and video phones.
- In the year 2000, the popularity of smart house began to spread with the emergence of different types of technologies at an affordable cost.
- In 2002 perform the remote control for smart house users.
- In 2005 First wearable smart health system.
- In 2009 The cloud has been used as part of the smart house system.
- In 2015 the voice was used as a smart house controller.

Figure 2.1: City of the 20th century [13].

2.3 Definition

2.3.1 What is a Smart Houses ?

With the rise of the IoT , information and communication technologies (ICTs), big data, and AI, people's daily lives have begun to alter. First and foremost, a smart house is a technological construction that integrates all engineering systems into a single system, ensures that it is controlled by programmable artificial intelligence, and is set up for the most practical use [42].

Using a smartphone or other networked device, a "smart house" is a practical house design that enables internet-based remote control of devices and appliances from any location. A smart houses technology is connected to the internet, enabling users to remotely control features like temperature, lighting, security access, and home entertainment systems [43].

The growing interest in intelligent buildings and the rapid pace of innovation in this field have prompted extensive research to develop various types of applications. These applications include energy management, simplified building management, improved resident comfort, reactive alarm management, personal security, asset protection, intruder event management, among others [44].

2.3.2 How smart houses works ?

Smart houses can be observed by utilizing the data produced by various sensors. IoT technology, in fact, leads to smart homes and appliances such as smart TVs, home security systems, lighting control, fire detection, and temperature monitoring. The sensors in these appliances monitor the conditions and environment and send surveillance data to a central controller at home, allowing the householder to continuously monitor and control the home even from outside and make the best decision in any situation [25].

Here are some examples of how a smart houses works:

- Lighting: Smart lighting systems can be controlled remotely using a smartphone app or through voice assistants like Alexa or Google Assistant. These systems allow you to turn lights on or off, dim them, and even change the color of the lighting.
- Thermostat: A smart thermostat can be programmed to adjust the temperature of your house based on your preferences and can be controlled remotely through an app. This allows you to save energy and money by only heating or cooling your house when you need it.
- Security: Smart house security systems typically include cameras, motion sensors, and door and window sensors that can be monitored remotely through a smartphone app. Some systems also include smart locks that can be controlled remotely, allowing you to grant access to your house to trusted individuals.
- Entertainment: Smart house devices can also control your house entertainment systems. For example, you can use a voice assistant to turn on your TV, play music, or stream a movie.
- Appliances: Many appliances, such as refrigerators, ovens, and washing machines, are now being designed to be connected to the internet. This allows you to monitor and control these appliances remotely, ensuring that they are working efficiently and effectively.

2.4 Difference Between IoT and AI

In the below table 2.1 comparison of AI and IoT .

Table 2.1: Comparison between Artificial Intelligence and Internet of Things [45].

Aspect	Artificial Intelligence	Internet of Things
Cloud Computing	AI utilizes cloud computing for high computations and learning tasks.	IoT efficiently supports cloud computing for data management.
Data Acquisition	AI learns from data, encounters errors, and makes decisions.	IoT captures data from sensors and retrieves it as needed.
Cost	AI costs more due to high system requirements for computations.	IoT costs less but requires interconnecting hardware devices.
Scalability	AI scalability is limited, but it can be implemented on IoT devices.	IoT scalability is higher, especially when based on the cloud.
Data	AI requires large amounts of meaningful data for operations and modeling.	IoT depends on sensor data, and more sensors lead to better efficiency.
Objects	AI is a self-contained system and doesn't require specific devices.	IoT relies on connected devices with sensors for data capture.
Algorithms	AI focuses on learning algorithms to mimic human behavior.	IoT customizes algorithms to manipulate system functionality.

2.5 AI and IoT in Smart houses

Making a house AI-enabled offers smart house owners a variety of advantages. The effectiveness of smart house appliances is increased by AI compatibility.AI frees up more time for the user by reducing the need for human intervention in a variety of tasks [46].

AI and IoT integration will almost certainly be available on any house device in the near future. Any house equipment will almost probably support AI and IoT integration in the near future. IoT frameworks give the data in smart houses, and AI uses that data to carry out specific duties that lessen human stress. Smart gadgets with AI and IoT integration respond to voice commands from users or AI commands that have already been programmed. In order to assure comfort when people are at home and energy economy when they are not, Google's Nest thermostat, for instance, learns how people use it over time and utilizes that data to automatically alter the temperature. From basic electrical equipment like lights, fans, air conditioners, washers, and freezers found in homes to more substantial electrical equipment like pumps and fire alarm systems, are all examples of gadgets and appliances [47].

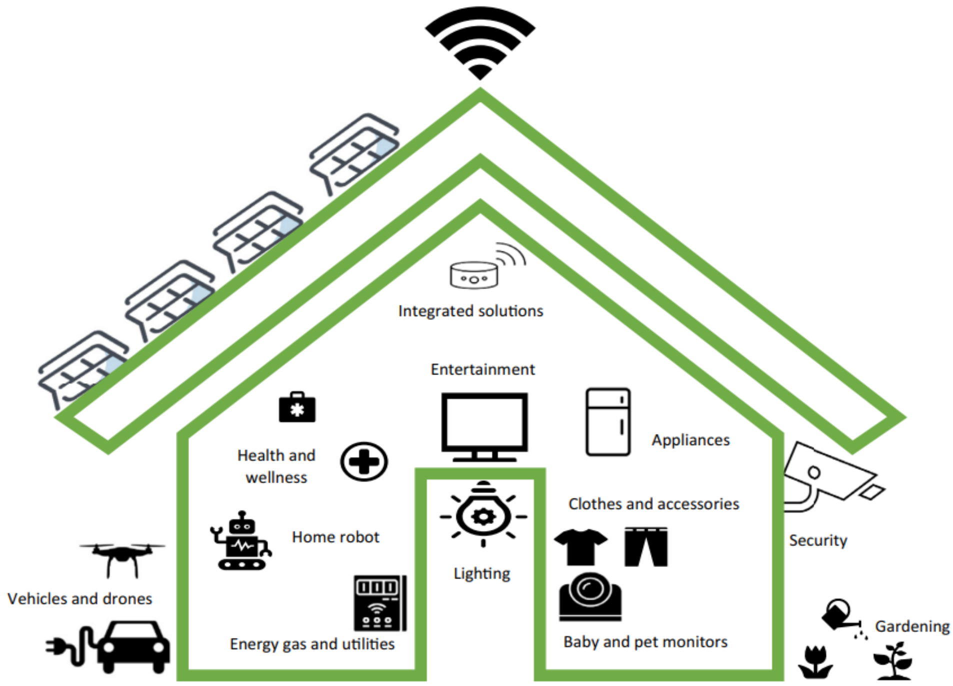

Figure 2.2: smart house [48].

2.6 Benefits of AI and IoT in Smart House

The principal benefits of utilizing AI and acIoT in a smart houses system [49] :

- Even while traveling to a different country in the world, the user can turn on or off every equipment in the house that is linked to the AI.
- The application on the smartphone receives all information about how smart technology functions, ensuring comprehensive management over them.
- When the user leaves the house, all smart devices will automatically switch off if desired.

2.7 Benefits of Smart Houses

Smart houses offer several benefits, including:

2.7.1 Quality of Life

Smart house technology offers a range of benefits, including improved quality of life through enhanced convenience and comfort, as well as increased independence for individuals with special needs. The popularity of smart house can be attributed to the positive impact they have on the lives of their occupants. Additionally, the ability to control various aspects of the house from anywhere has been identified as one of the most attractive features of smart house technology [50].

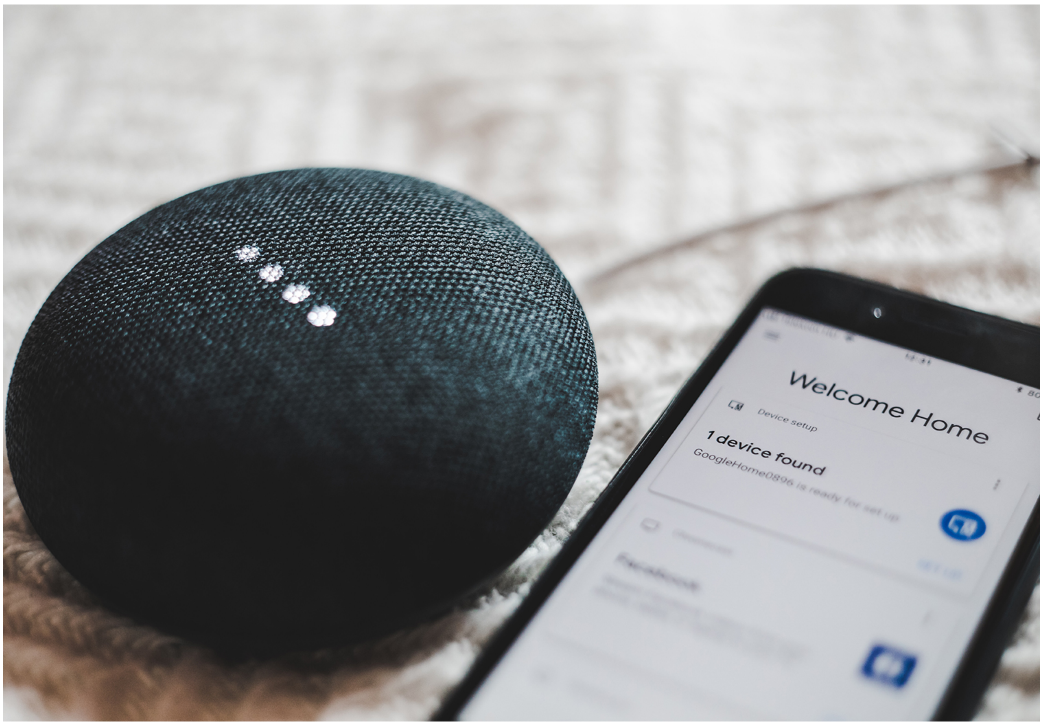

Figure 2.3: Example Quality of Life [51].

2.7.2 Remote Accessibility

One of the key benefits of a smart house is the ability to access and control it remotely, which is particularly useful for security surveillance when homeowners are away from their residence. This feature is especially advantageous when homeowners go on vacation and want to keep a close eye on their property from a distance [50].

2.7.3 Monitoring Through Sensors Network

Embedded sensor networks are being utilized to monitor the activities of elderly individuals and address the possibility of chronic conditions and conduct health assessments.

These service providing systems deploy various sensors, such as gas sensors, smoke sensors, remote monitoring, smart locks, smart irrigation, and others, to create automatic predictive systems that offer numerous benefits to the lifestyle of the elderly [50].

2.7.4 Enabling better Opportunity

Smart house provide countless opportunities to introduce smart gadgets, network them together, and remotely operate them. These networks offer an environment that is favorable for testing and implementing innovative devices [50].

2.7.5 Remote Monitoring & Check-Ins

If smart house are connected to a smartphone or personal computer, they can be monitored remotely from anywhere and at any time. This allows homeowners to keep an eye on various components of their homes and property in real-time [52].

2.8 Advantages and Disadvantages

Here are some advantages and obstacle of smart houses :

2.8.1 Advantages of smart houses

Here are some of the main advantages of smart houses [53] :

- By installing a smart houses technology system, homeowners can enjoy added convenience. Instead of having to use multiple devices to control appliances, thermostats, lighting, and other features, they can now manage everything using just one device, typically a smartphone or tablet
- One of the benefits of using a smart house technology system is that it allows users to receive notifications and updates about issues in their homes, all through a portable device. For example, with the use of smart doorbells, homeowners can see and communicate with visitors at their doorstep, even when they are away from houses. Additionally, users can set and control their home's internal temperature, lighting, and appliances through the same device.

- While there may be an initial cost involved in setting up a smart houses system, homeowners can ultimately enjoy significant cost savings. This is because appliances and electronics can be used more efficiently with the help of smart technology, which can lead to lower energy costs in the long run.

2.8.2 Obstacle of smart houses

Here are some of the main disadvantages [54]:

- Replacing all gadgets and appliances can be costly.
- Slows down Internet and wi-fi.
- Potential privacy issues or hacking.
- Won't work during potential network outages.

2.9 Conclusion

Smart houses are an emerging technology that is changing the way we live. We can control and automate various aspects of our houses, from lighting and temperature to security and entertainment, by using sensors, cameras, and smart devices. Smart houses provide numerous advantages, including increased convenience, energy efficiency, and improved safety. However, there are privacy and security concerns, as these systems are vulnerable to cyber-attacks and data breaches. As technology advances, homeowners must carefully weigh the risks and benefits of implementing smart house systems, as well as take precautions to protect their privacy and security. Smart houses research covers a wide range of disciplines. The architecture of a smart house is determined by various factors such as technology, space and services. With the common development of different fields, smart home is getting better and more popular.

Although there are some limitations to using this smart house system, it will allow users to enjoy some technological advancement. This will keep their houses safe because it will be inaccessible without the registered users [55].

CHAPTER 3

THE EQUIPMENT

Sommaire

3.1 Introduction

In this chapter, we will explore the essential components that are integral to the functionality of the smart house system. These components include sensor devices, which are responsible for converting physical measurements into electrical signals, the Arduino Uno board that serves as the control center of the system, and programming languages such as the Integrated Development Environment (IDE) and Proteus.

Sensor devices play a vital role in collecting data from various aspects of the smart house, such as temperature, humidity, motion, and light intensity. These sensors are designed to accurately measure the physical parameters and relay the information to the control system.

The Arduino Uno board acts as the central hub for controlling and coordinating the smart house system. It receives input from the sensors and processes the data accordingly, triggering appropriate actions or responses. The board's versatility and programmability make it a reliable choice for managing the functionalities of the smart house.

To program the Arduino Uno board and develop the necessary logic for the smart house system, we utilize programming languages provided by the IDE, such as C/C++ based Arduino programming language. The IDE offers a user-friendly interface for writing, compiling, and uploading code to the Arduino board.

Additionally, we utilize Proteus, a simulation software, to validate and test the functionality of the smart house system before implementing it in a physical environment. Proteus enables us to create a virtual representation of the smart house, allowing us to verify the interaction between the components and detect any potential issues or conflicts.

By leveraging these key components, including sensor devices, the Arduino Uno board, and programming languages like the IDE and Proteus, we can ensure the efficient and seamless operation of the smart house system.

3.2 Software

We explore various software components such as IDE, Proteus, and programming languages. These software elements are crucial for the smooth operation of the smart home system. Without them, the smart house system would be unable to function effectively.

3.2.1 Integrated Development Environment (IDE)

The Arduino IDE is a software application that can be used on Windows, macOS, or Linux operating systems. It is designed to help developers write and upload programs to Arduino Uno compatible boards using functions from the C and C++ programming languages. Other software, such as Proteus, can also be used in conjunction with the IDE to assist in this process. Before the code can be uploaded to the Arduino Uno, it needs to be verified for errors within the IDE. If any errors are found, a warning message will prompt the user to make the necessary changes. Once the code has been verified, it can be uploaded to the Arduino board in the Proteus software. This enables the system to function as a remote control for turning home lighting on or off. Once the code has been verified, it will generate a "hex" file which can be uploaded to the Arduino board [56]. Figure 3.1 shows the interface of Arduino IDE used in our program.

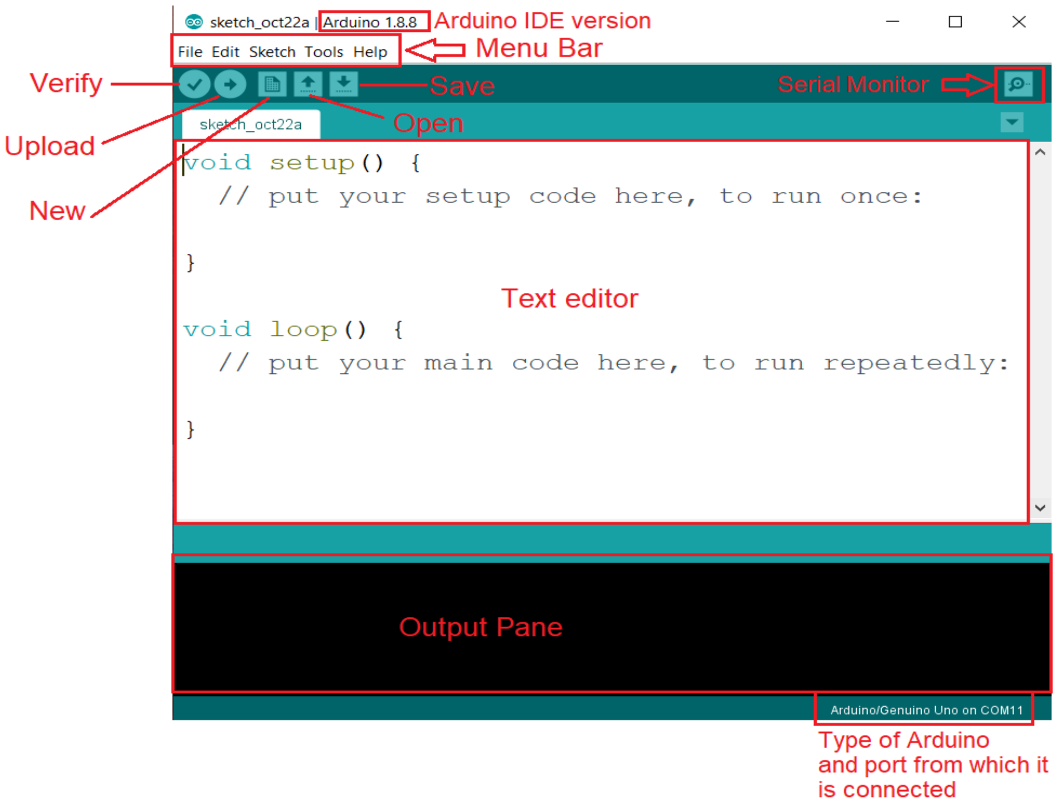

Figure 3.1: The interface of Arduino IDE [57].

3.2.2 Proteus

Proteus Figure 3.2 is a software suite for electronics developed by Labcenter Electronics that facilitates CAD in the electronics field. The suite consists of two primary programs:

ISIS and ARES, as well as PROSPICE and VSM. ISIS is a popular program in Proteus that specializes in designing electrical schematics. Furthermore, the software enables simulation of these schematics, which aids in identifying errors during the design process. As a result, the circuits designed using this software can be indirectly used in documentation, as the software provides control over most of the graphical aspects of the circuits [58].

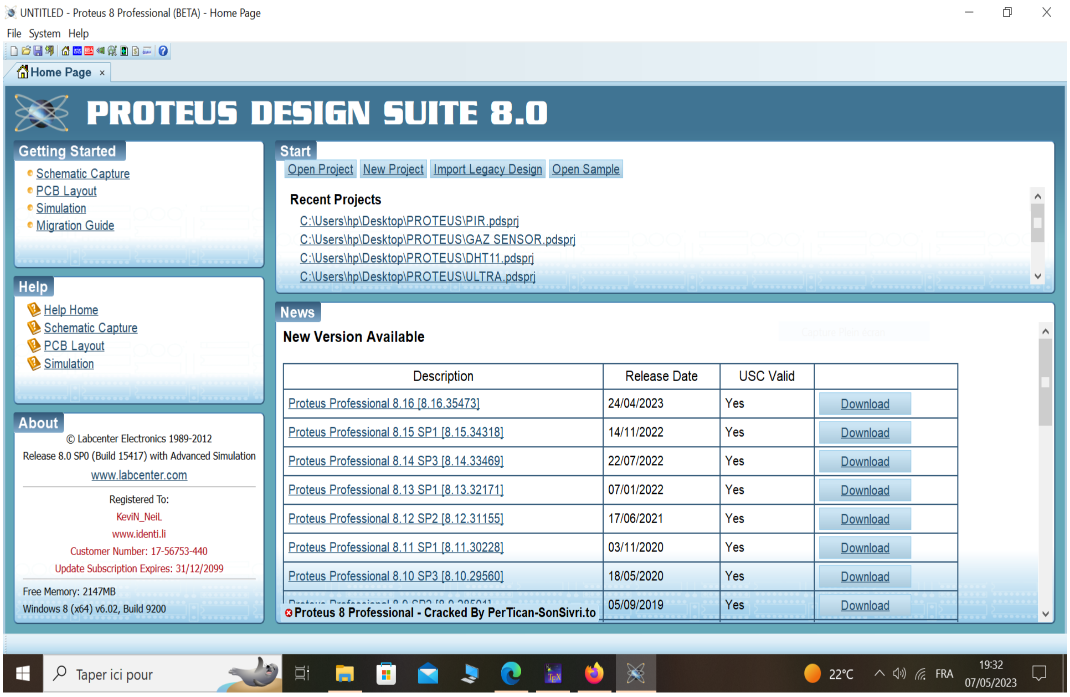

Figure 3.2: Interface of Proteus

3.3 Materials used

We will look at the hardware parts used to construct our smart home system in this section. The sensors and modules that are used with the Arduino UNO will be examined.

3.3.1 Hardware side

To achieve the desired functionality of the house, we have installed several devices. Here is an overview of these components:

3.3.1.1 Arduino

Arduino is an open-source electronics platform with straightforward hardware and software. Using an Arduino board to capture inputs such as light on a sensor, a finger on a button, or a tweet, you may start a motor, switch on an LED, and publish something online. Your board will be given instructions on what to do by sending a set of commands to its micro-controller. You accomplish this by utilizing the Processing-based Arduino Software (IDE) and the Wiring-based Arduino programming language [59].

3.3.1.2 The different Arduino boards

Here are some of the most popular Arduino boards [60] :

1. **Arduino Uno**
2. **Arduino Mega**
3. **Arduino Nano**
4. **Arduino Due**
5. **Arduino Leonardo**
6. **Arduino Pro Mini**
7. **Arduino LilyPadb**
8. **Arduino Bluetooth**
9. **Arduino Esplora**
10. **Arduino Zero**

The figure 3.3 displays a collection of different Arduino boards

Figure 3.3: Types of Arduino Boards [61].

See the following Table 3.1.

Table 3.1: Features of Different Types of Arduino Boards [60].

Arduino Board	Memory	Digital I/O	Analogue I/O
Arduino Uno	2KB SRAM, 32KB flash	14	6 input, 0 output
Arduino Due	96KB SRAM, 512KB flash	54	12 input, 2 output
Arduino Mega	8KB SRAM, 256KB flash	54	16 input, 0 output
Arduino Leonardo	2.5KB SRAM, 32KB flash	20	12 input, 0 output

3.3.1.3 Arduino UNO

The Arduino Uno open-source micro controller board runs on the ATmega328P CPU. As inputs, there are six analog inputs, fourteen digital I/O pins, a USB port, a power jack, an ICSP header, and a reset button. The micro-controller is supported by all necessary modules. It may be turned on with an adapter or by using a USB cable to connect it to a computer [61].

The following figure 3.4 shows the Arduino UNO board.

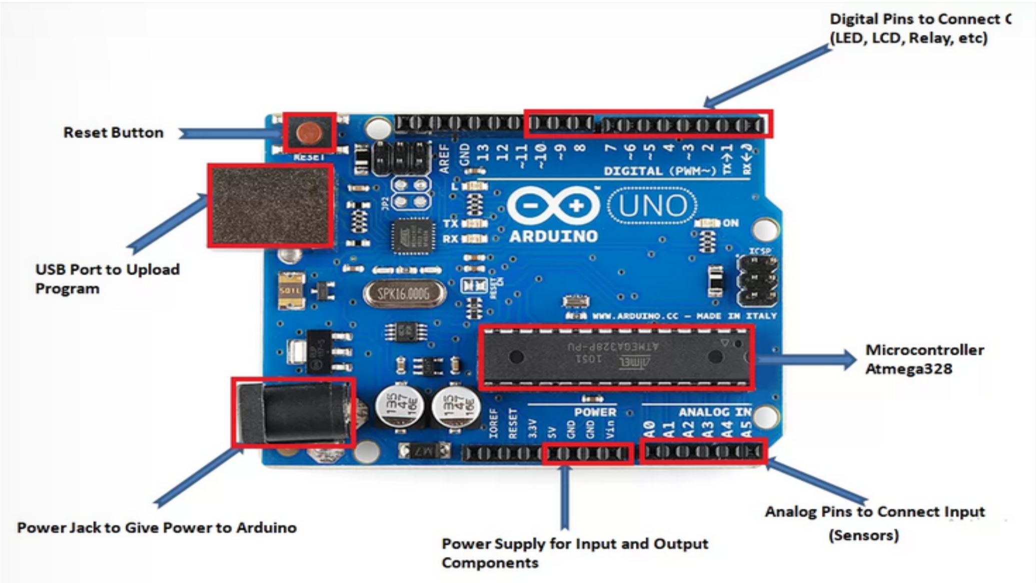

Figure 3.4: Arduino Uno [61].

3.3.1.4 The hardware structure of Arduino Uno

The Arduino Uno has a simple yet robust hardware structure that comprises several key components. These components include [61]:

- Microcontroller is the core processing unit of Arduino Uno that serves as its central nervous system.
- Arduino Uno has 14 digital pins that enable connections with various components such as LED, LCD, and other digital devices.
- The Uno also has 6 analog pins that are primarily used to connect sensors because sensors usually produce analog signals. Most of the input components are connected to these pins.

- Various power supply pins such as IOREF, GND, 3.3V, 5V, and Vin are used to connect sensors and input components that require power.
- Uno board can be powered either through an external power source or via a USB cable.
- The USB port is used for programming the board or uploading the program to the board using the Arduino IDE and USB cable.
- The reset button is used to restart the uploaded program on the board.

3.3.1.5 Characteristics techniques of Arduino Uno

Table 3.2 represents the technical characteristics of Arduino Uno.

Table 3.2: Characteristics techniques of Arduino Uno [62].

Arduino UNO	Specifications
Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Digital I/O Pins	14 (Out of which 6 provide PWM output)
SRAM	2 KB
EEPROM	1 KB
Frequency	16 MHz

3.3.2 The Sensors Used

3.3.2.1 Fingerprint Sensor

A fingerprint sensor 3.5 is a security device that uses an individual's fingerprints to identify and authenticate the person in order to grant or deny access to a physical space or computer system [63].

- **Fingerprint Sensor Pin**

Here is a general pin description for a fingerprint module as shown in 3.3:

Table 3.3: Pin Description of fingerprint [64].

Pin	Description
Pin 1	Provides a power supply of DC 3.3V or 5V
Pin 2	Used for GND connection (GND)
Pin 3	Outputs data (TXD)
Pin 4	Receives data input (RXD)
Pin 5	Signals finger detection
Pin 6	Provides power supply for touch induction

Figure 3.5: Fingerprint Sensor [65].

3.3.2.2 DHT11 Temperature and Humidity Sensor

The DHT11 sensor As shows in Fig 3.6 is an affordable and uncomplicated digital sensor capable of measuring humidity and temperature simultaneously. By utilizing a capacitive humidity sensor and a thermistor, it produces a digital signal on the data pin without requiring any analog input connections. While it is user-friendly, precise timing is essential for accurate data collection [66].

- **DHT11 Sensor pin**

Table 3.4 presents the pin description of temperature and humidity sensor.

Table 3.4: Pin Description of DHT11 [67].

Pin	Description
Pin 1	Provides a power supply of DC 3.3 to 5.5 volts (VCC)
Pin 2	Used for digital output (DATA)
Pin 3	Connected to ground (GND)

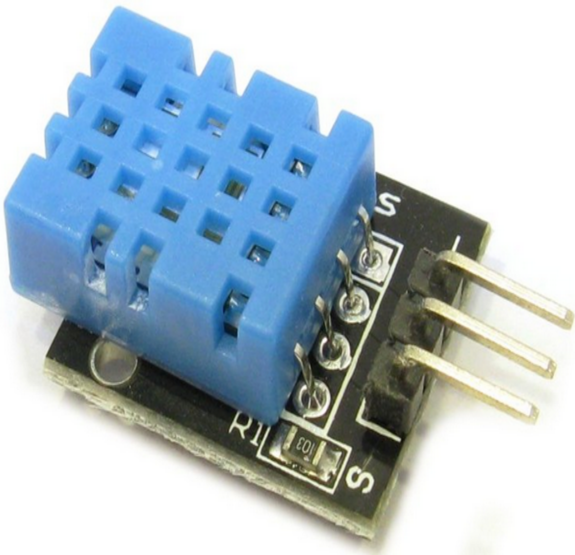

Figure 3.6: DHT11 Sensor [68].

3.3.2.3 MQ-2 Gas Sensor

MQ-2 As shows in fig 3.7 sensitive material of gas sensor used in clean air low conductivity tin oxide (SnO_2). When there is the environment in which the fuel gas sensor, the conductivity sensor with an increasing concentration of combustible gases in the air increases. Using a simple circuit to convert the change in conductivity of the gas concentration corresponding to the output signal [69].

- **Gas Sensor Pin**

Table 3.5 presents the pin description of gas sensor.

Table 3.5: Pin Description of MQ-2 [70].

Pin	Description
Pin 1	Provides a power supply of DC 3.3 to 5.5 volts (VCC)
Pin 2	Connected to ground (GND)
Pin 3	Digital Out (DO)
Pin 4	Analog Out(AO)

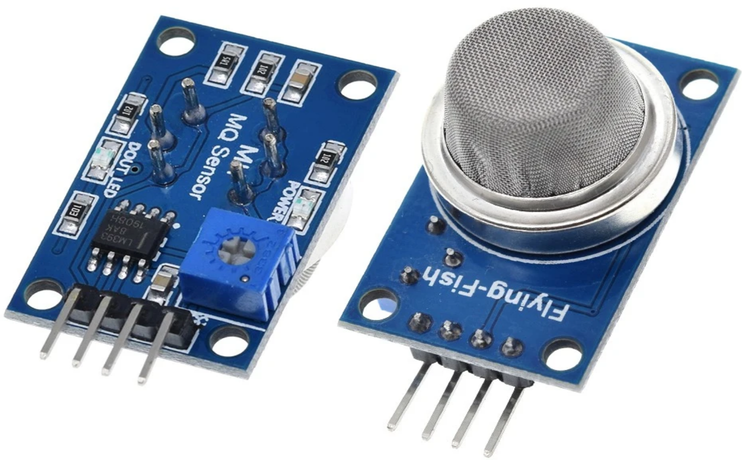

Figure 3.7: MQ-2 Gas Sensor [69].

3.3.2.4 HC-SR04 Ultrasonic Sensor

The HC-SR04 ultrasonic as shows in fig 3.8 distance sensor uses sonar to calculate the distance to an object. The HC-SR04 uses non-contact ultrasound sonar to calculate the distance to an object. It is made up of two ultrasonic transmitters (basically speakers), a receiver, and a control circuit [74].

- **Ultrasonic Sensor HC-SR04 Pin**

Table 3.6 presents the pin description of ultrasonic sensor.

Table 3.6: Pin Description of Ultrasonic Sensor [75].

Pin	Description
Pin 1	Supplies +5V power to the sensor (VCC)
Pin 2	input pin (Trigger)
Pin 3	output pin (Echo)
Pin 4	Connected to ground (GND)

Figure 3.8: Ultrasonic Sensor HC-SR04 [74].

3.3.2.5 ST045 Water Level Sensor

The ST045 Water Level Sensor as shows in fig 3.9 is a type of sensor used to measure and monitor the water level in a number of applications. It is used to show if water is present or not at a certain concentration. The sensor is often composed of electrodes or probes that make contact with the water. When the water reaches a certain level, an electrical circuit is finished, indicating the presence of water.

- **ST045 Water Level Sensor Pin**

Table **??** presents the pin description of Water Level sensor.

Table 3.7: Pin Description of Water Level Sensor [72].

Pin	Description
Pin 1	S (Signal) is an analog output pin
Pin 2	Vcc
Pin 3	GND

Figure 3.9: Water Level Sensor [76].

3.3.3 The Rest of the Equipment

3.3.3.1 Servo Motor

The servo motor is a controlled feedback system that operates at regular intervals. It shares similarities with a DC motor but has the ability to rotate at specific angular positions. In certain servo motors, the rotation ranges from 0 to 180 degrees, while in others it can go from 0 to 360 degrees. The range depends on the specific application for which the servo motor is used.

3.3.3.2 LED

One of the most widely utilized light sources today is the Light-Emitting Diode (LED). The uses for LEDs are endless, from your home's living room lighting to your car's headlights (or daytime running lights) [79].

Figure 3.10: LED [79].

3.3.3.3 LCD

An optoelectronic device known as a Liquid Crystal Display (LCD), enables the display of all alphanumeric letters as well as certain special characters on one to four rows with 16 to 20 columns per row [80].

Figure 3.11: LCD [80].

3.3.3.4 Module Relay

An automated switch called a 5 volt relay is frequently used in automatic control circuits to regulate high currents with low current signals. The relay signal's input voltage spans the 0 to 5V range [81]

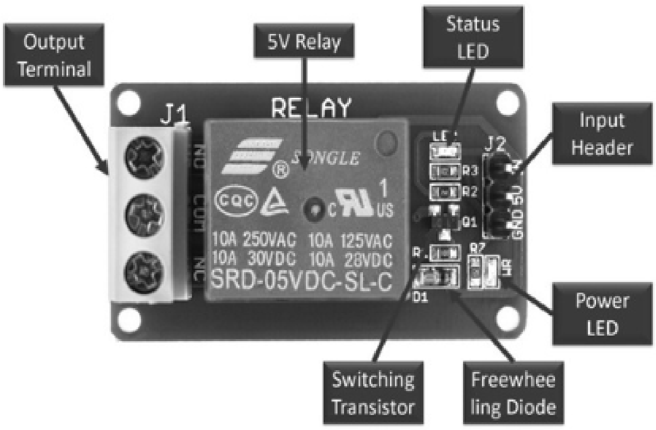

Figure 3.12: Module Relay [81].

3.3.3.5 Electric Lock

The electromagnetic mechanism of an electric lock is responsible for enabling the locking and unlocking of a door or access device. Once installed, this lock remains in a locked position until a 12V electrical signal is transmitted through its integrated circuit. Any signal with a voltage lower than 12V is interpreted as an absence of signal (0V), triggering the lock to open.

Figure 3.13: Electric Lock [82].

3.3.3.6 Buzzer

A buzzer, found in figure 3.14, is a type of uncomplicated device that can produce various beeps and tones. Its operation relies on a piezo crystal, which alters its shape in response to electrical stimulation. When the crystal applies pressure to a diaphragm resembling a miniature speaker cone, it generates a sound wave that can be perceived by the human ear. By modifying the frequency of the voltage supplied to the piezo, it can produce sound by rapidly altering its shape [83].

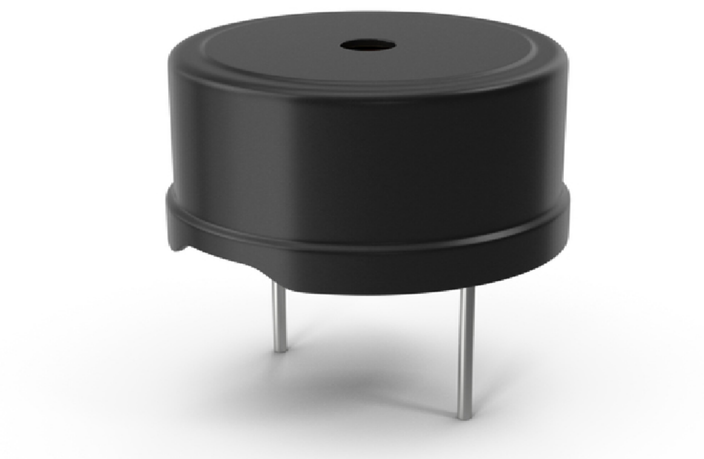

Figure 3.14: The Buzzer [84].

3.4 Conclusion

This chapter has emphasized key elements and programming languages that are essential to a smart home system's functionality. A smart house system may be created and executed by efficiently integrating these components to improve automation, efficiency, and convenience inside a home. The precise integration of these elements to create a smart home system that is fully functioning will be covered in more depth in the next chapters. These tools make it much easier to produce our project, which successfully protects people and property.

CHAPTER 4

SIMULATION AND REALIZATION

Sommaire

4.1 Introduction

The final chapter of our project encompasses the practical realization of our smart house. We commence by conducting a virtual simulation to thoroughly test and refine the system. This simulation serves as a crucial step in identifying potential challenges and optimizing the overall design.

To streamline the implementation process, we have meticulously outlined a detailed road map that encompasses the installation of various components. With a focus on enhancing safety, security, and comfort, we have segmented the installation into specific application tasks. Each task is carefully designed to address specific functionalities and ensure seamless integration within the smart house framework.

Furthermore, to provide a tangible representation of our solution, we will translate our design into a physical house model. This will enable us to demonstrate the practical application and functionality of our smart house system in a real-life setting. By showcasing a fully implemented prototype, we aim to highlight the effectiveness and benefits of our innovative solution.

4.2 Testing and implementation

It is vital to test the assembly using a virtual simulation before performing the actual assembly. Our project makes use of the program Proteus 8.

Note 1: we will use Arduino UNO in all application.

Note 2: Our project is structured into two main parts that play a vital role in ensuring both comfort and security.

4.2.1 Task 1: Automatic Door

Modern technology and automation are combined in the Automatic Door System, a cutting-edge system that offers easy access control and better security. incorporating cutting-edge features like bio metric fingerprint authentication

4.2.1.1 Materials used

The materials commonly used for creating an automatic door system include in Table 4.1 below:

Table 4.1: Materials used for Automatic Door .

Material	Characteristic	Number
ARDUINO UNO	Microcontroller board for programming	1
Fingerprint	Fingerprint recognition module	1
Module Relay	Relay module powered by 12V	1
Servo Motor	Standard servo motor powered by 12V	1
Electric lock	12V electric lock	1
POWER	12V power supply	1

4.2.1.2 Equipment wiring

Table 4.2 demonstrates how to connect the component's cable to the Automatic Door.

Table 4.2: The wiring of the circuits .

System	Pin system	Arduino pin
Fingerprint	Rx	3
	Tx	2
	Vcc	5v
	GND	GND
Module Relay	IN2	10
	VCC	5v
	GND	GND
Servo Motor	VCC	5v
	GND	GND
	Signal	11

4.2.1.3 realization

Figure 4.1 represents the practical installation of the automated door.

❏ If fingerprint is absent

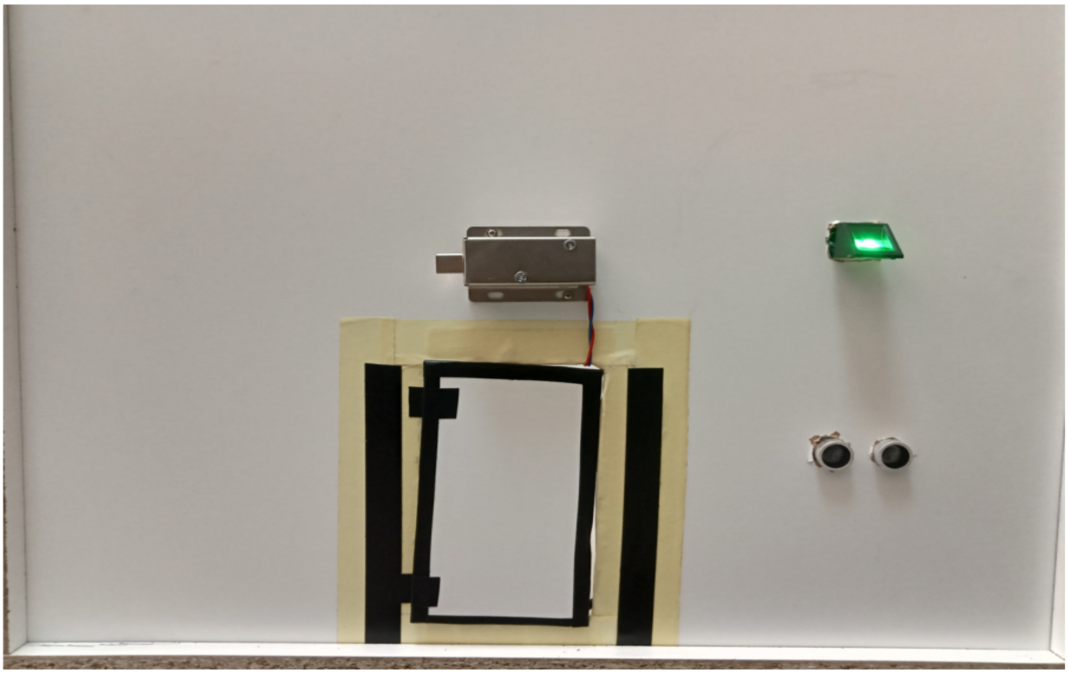

Figure 4.1: When fingerprint is absent .

❏ If fingerprint is present

Figure 4.2: When fingerprint is present .

4.2.1.4 Comments

➢ Upon placing the correct fingerprint, we observe the electric lock being unlocked and the door being opened through the rotation of the motor.

4.2.2 Task 2: Security Alarm

4.2.2.1 Materials used

In the table 4.3 The materials commonly used for a security alarm system :

Table 4.3: Materials used for the alarm system .

Material	Characteristic	Number
ARDUINO UNO	Microcontroller board for programming	1
LED	Red light-emitting diode	1
Resistor	Resistor with resistance of 220 ohms	1
Ultrasonic Sensor	Sensor for measuring distance using ultrasonic waves	1

4.2.2.2 Hardware cabling

Table 4.4 provides an illustration of how to attach the component's wire to the security alarm.

Table 4.4: The wiring of the circuits .

System	Pin System	Arduino Pin
HC-SR04	Vcc	5v
	Echo	12
	Trig	13
	GND	GND
LED	DATA	8
	GND	GND

4.2.2.3 virtual simulation

The outcomes obtained from the Proteus simulation are depicted in Figure 4.3 and Figure 4.4 below.

❑ If the distance is far

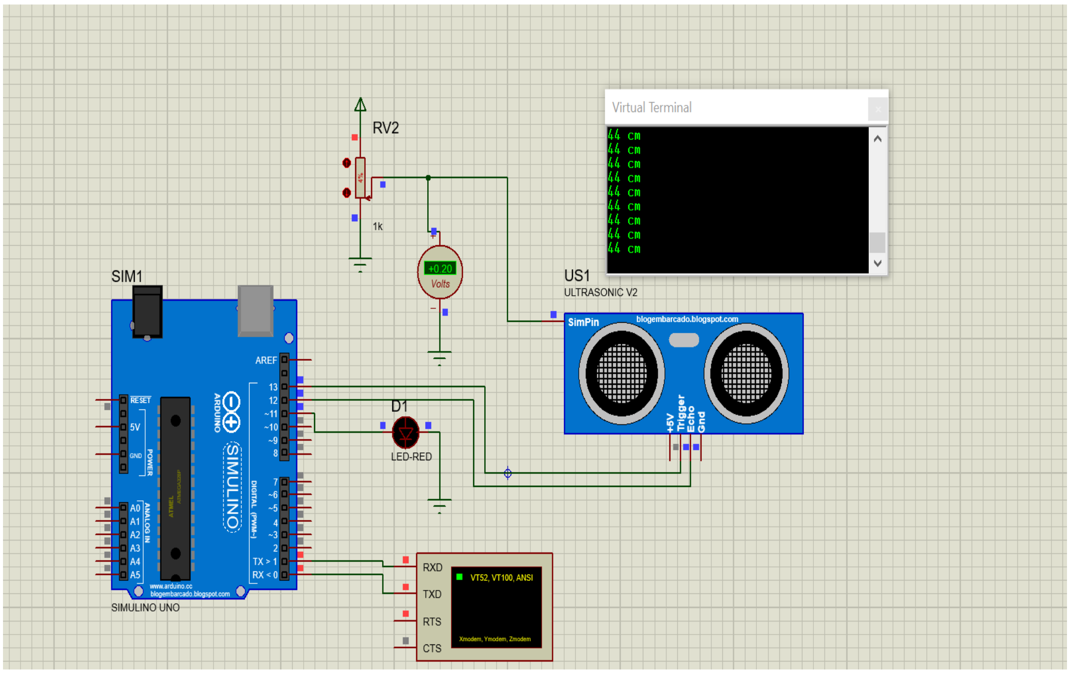

Figure 4.3: distance is far .

❑ If the distance is close

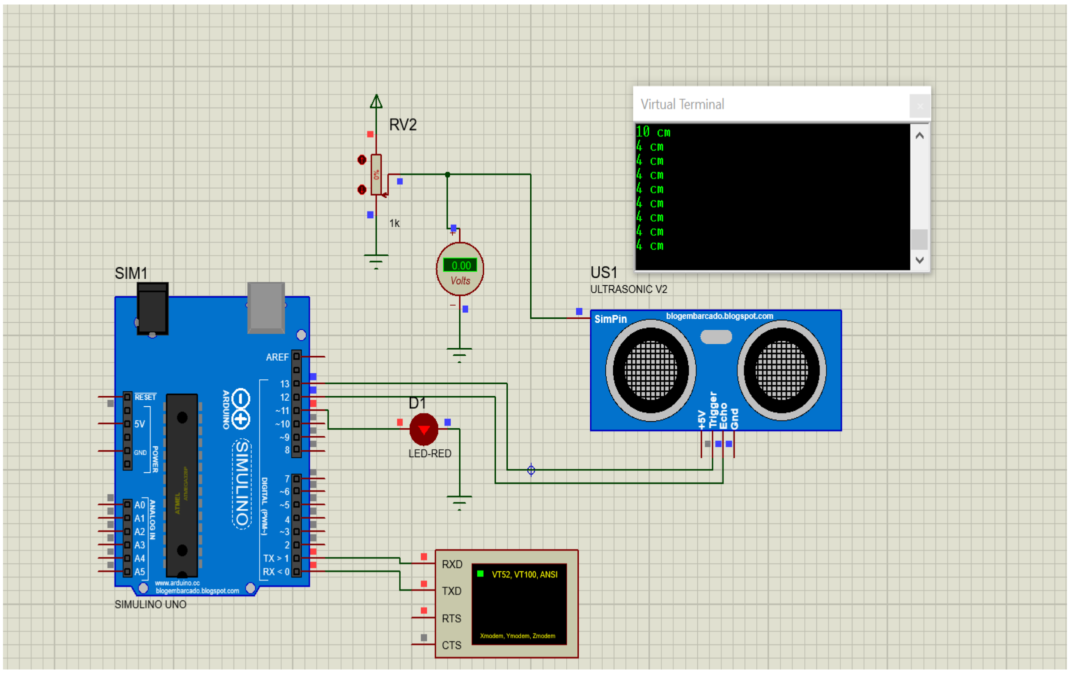

Figure 4.4: distance is close .

4.2.2.4 realization

Figure 4.5 demonstrates the practical setup when the distance > 50 cm

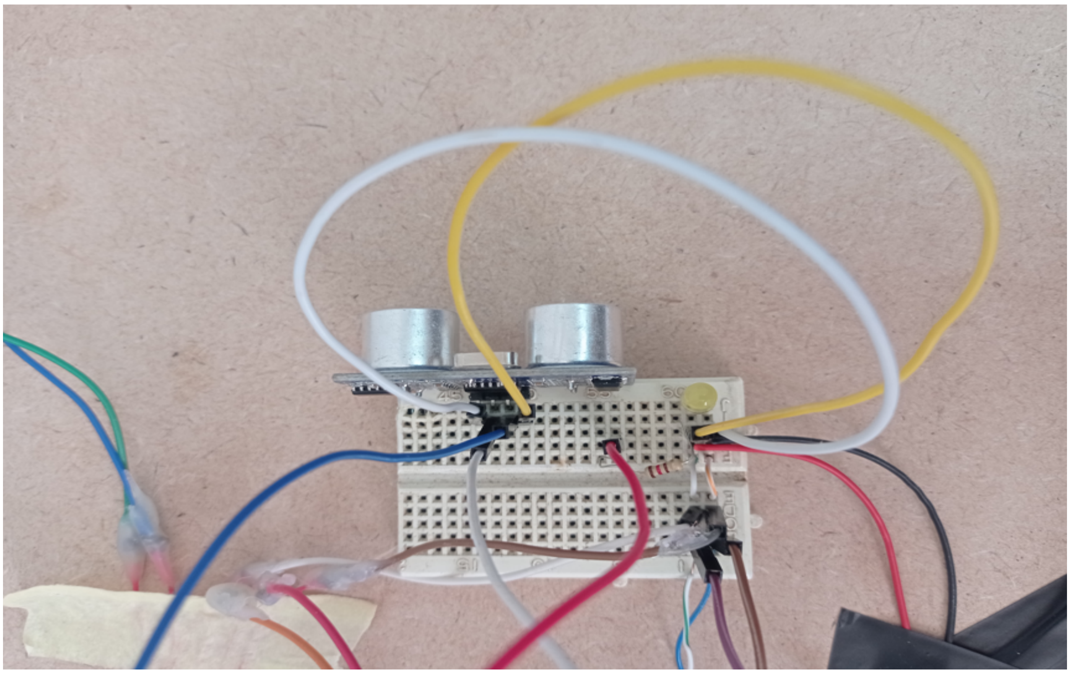

Figure 4.5: distance is close .

Figure 4.6 demonstrates the practical setup when the distance is less than 50 cm

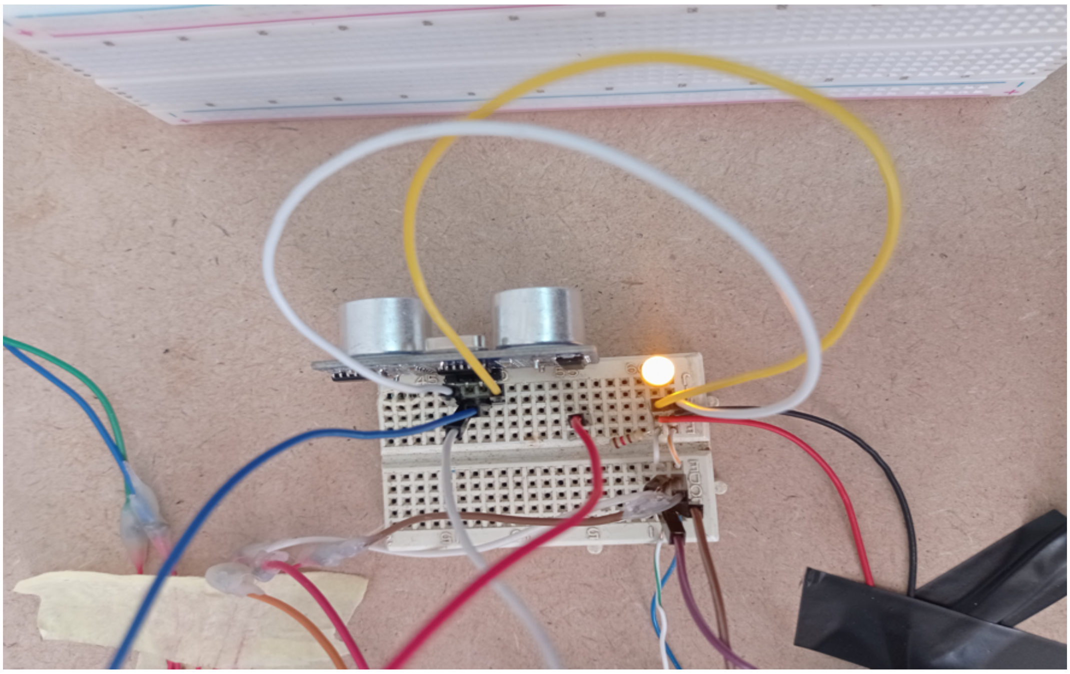

Figure 4.6: distance is close .

4.2.2.5 Comments

➢ The ultrasonic sensor is used to measure distance.

➢ When the distance is more than the specified threshold (the distance > 50 cm), the light remains off and the bell does not ring, signaling there is no alarm.

➢ When the distance is less than 50 cm and is within the predetermined range, the light illuminates and the bell jingles to sound a warning.

4.2.3 Task 3: Gas Leak Detection

The Detection of Gas Leakage project utilizes a gas sensor to detect gases like H2, GPL, CH4, and CO. When gas is detected, an alarm is triggered, and the gas leak status is displayed on an LCD screen.

4.2.3.1 Materials used

The elements listed in table 4.5 are required to build a gas leak detecting system .

Table 4.5: Detection of Gas Leakage .

Material	Characteristic	Number
ARDUINO UNO	Microcontroller board for programming	1
LED (Red and Green)	Light-emitting diodes in red and green	2
Gas Sensor MQ-2	Sensor for detecting various gases	1
RES 220 ohm	Resistor with resistance of 220 ohms	1
Source of Gas	Can detect H2, GPL, CH4, CO	//

4.2.3.2 Hardware cabling

The attachment procedure for connecting the component's wire to the Gas Leak Detection is depicted in Table 4.6.

Table 4.6: The wiring of the circuits .

System	Pin system	Arduino pin
MQ-2	Vcc	5v
	GND	GND
	DO	5
	AD	A2
LED RED	DATA	10
	GND	GND
LED GREEN	DATA	5v
	GND	GND

4.2.3.3 virtual simulation

Figure 4.7 depicts the simulation results for Proteus.

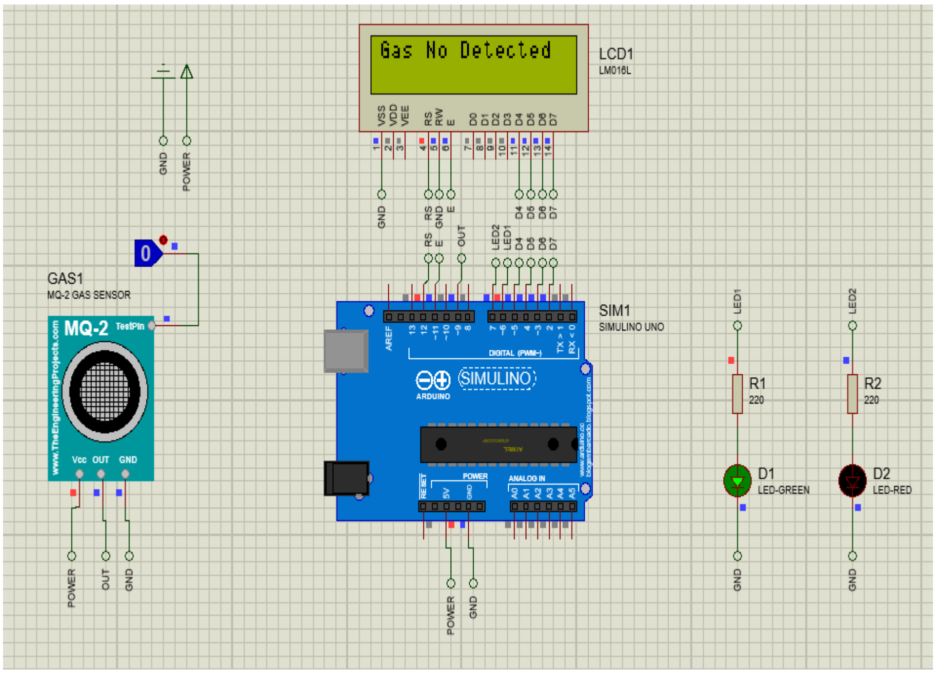

Figure 4.7: Gas no detected.

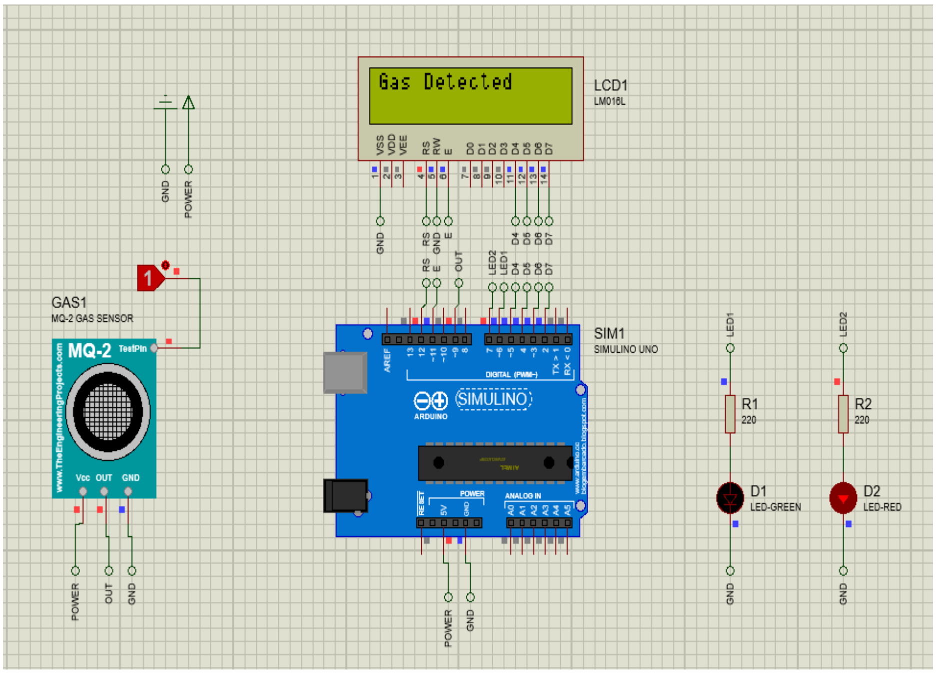

Figure 4.8: Gas detected .

4.2.3.4 realization

The first case, as depicted in Figure 4.9, represents the situation where there is no presence of gas.

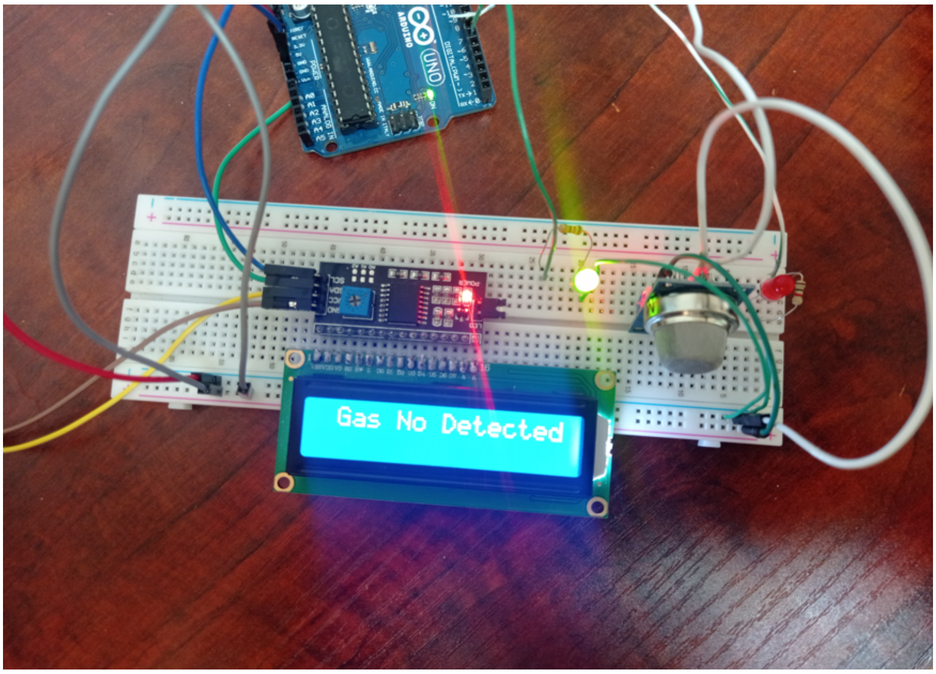

Figure 4.9: The case of gas absence .

The second case, as shown in figure 4.10, is where there is gas.

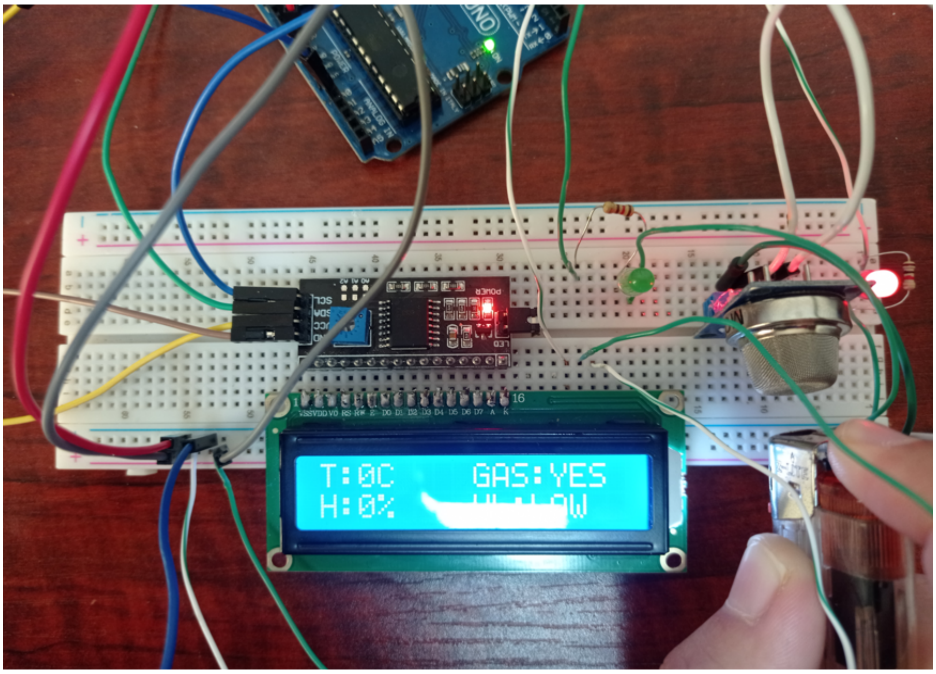

Figure 4.10: The case of gas leaks .

4.2.3.5 Comments

➢ The MQ-2 gas sensor is capable of detecting the following gases(Methane,Butane,smoke).

➢ In the event of a gas leak, our system allows for an alert to be sent through an buzzer bell and the illumination of a red LED

4.2.4 Task 4: Measuring Temperature and Humidity

In this step we stared to install DHT11 with Arduino Uno

4.2.4.1 Materials used

Here's a table 4.7 summarizing the materials used for measuring temperature and humidity using an DHT11 sensor

Table 4.7: Materials used for Automatic Door .

Material	Characteristic	Number
ARDUINO UNO	Microcontroller board for programming	1
DHT11	Temperature and Humidity sensor	1
LCD 16x2	16-character, 2-line liquid crystal display	1

4.2.4.2 Hardware cabling

The following table 4.8 displays the physical wiring needed to connect the Arduino Uno, DHT11 sensor, and LCD 16x2 display:

Table 4.8: The wiring of the circuits .

System	Pin system	Arduino pin
Module I2C	SCL	A5
	SDA	A4
	VCC	5v
	GND	GND
DHT11	DATA	2
	VCC	5v
	GND	GND

4.2.4.3 realization

In the initial case illustrated in Figure 4.11, temperature and humidity are measured under normal conditions.

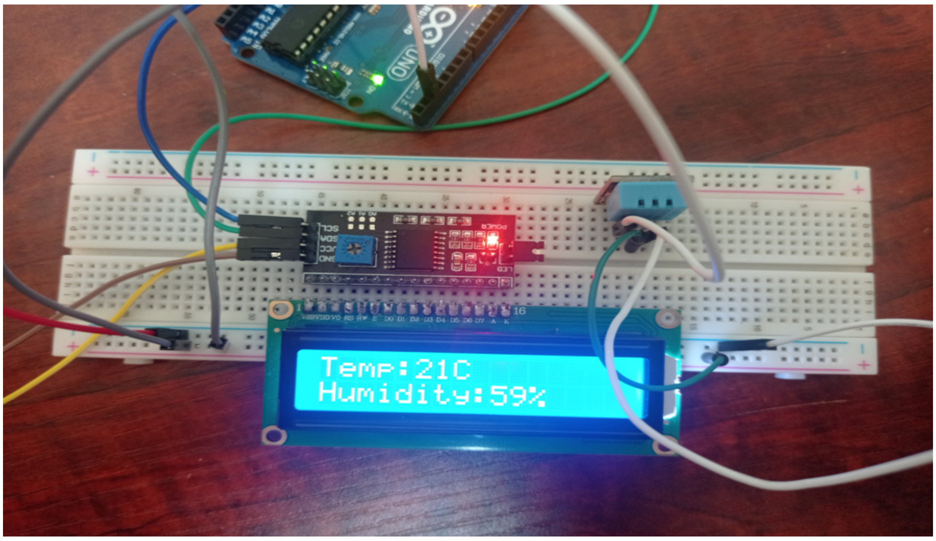

Figure 4.11: Temperature and Humidity in normal condition .

The second case, in which we raise the temperature and reassess the temperature and humidity, as shown in Figure 4.12.

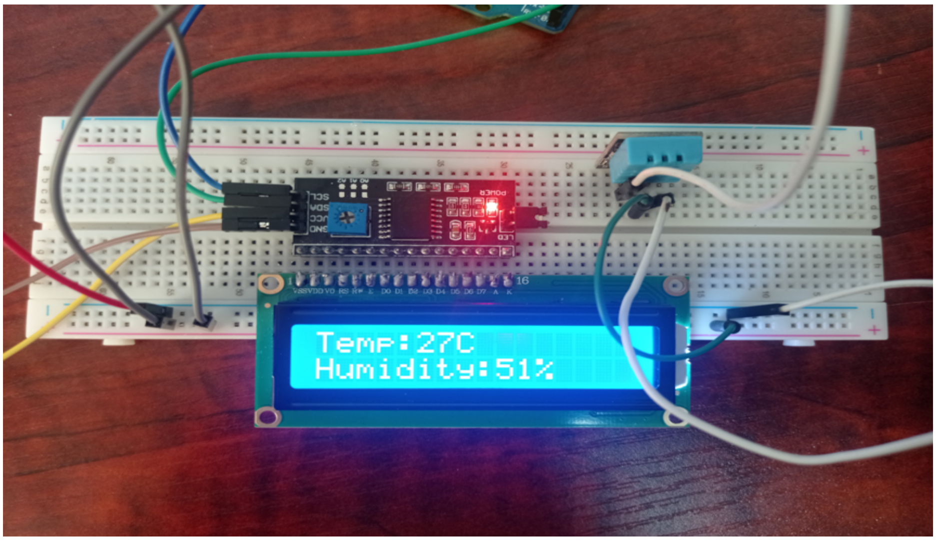

Figure 4.12: When changing the Temperature condition .

4.2.5 Task 5: Water Tank Monitoring

Monitoring water tanks is an important use for water sensors, particularly when it's crucial to ensure a sufficient supply of water or prevent overflow.

4.2.5.1 Materials used

The materials for monitoring water tanks are shown in table 4.9 below.

Table 4.9: Materials used Water Tank Monitoring .

Material	Characteristic	Number
ARDUINO UNO	Microcontroller board for programming	1
Water Level Sensor	Sensor for detecting water level	1
LCD 16x2	16-character, 2-line liquid crystal display	1

4.2.5.2 Hardware cabling

The attachment procedure for connecting the component's wire to the Water Tank Monitoring is depicted in Table 4.10.

Table 4.10: The wiring of the circuits .

System	Pin system	Arduino pin
Module I2C	SCL	A5
	SDA	A4
	VCC	5v
	GND	GND
Water Sensor	Signal	A0
	VCC (+)	5v
	GND (-)	GND

4.2.5.3 realization

❏ If the sensor is dry ❏ If the sensor is partially immersed in water ❏ If the sensor is fully immersed in water

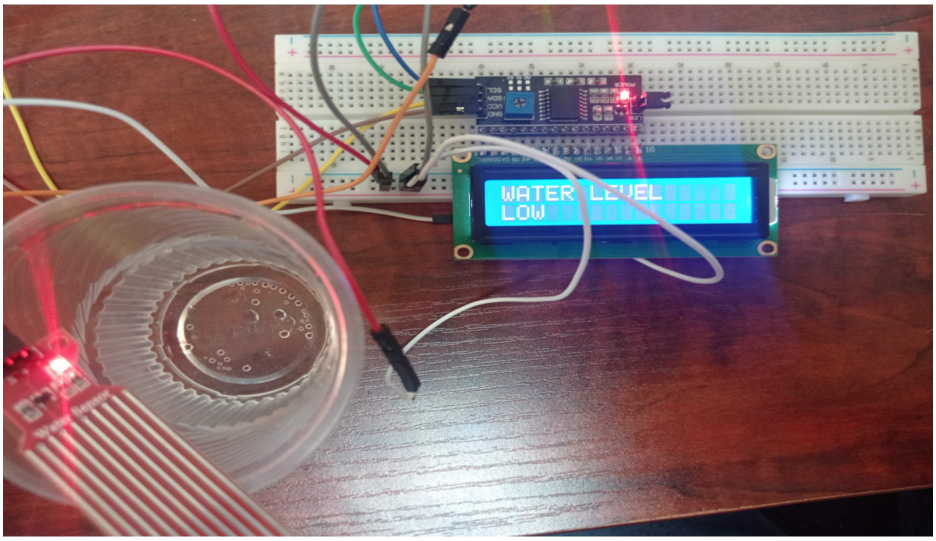

Figure 4.13: When the sensor is dry .

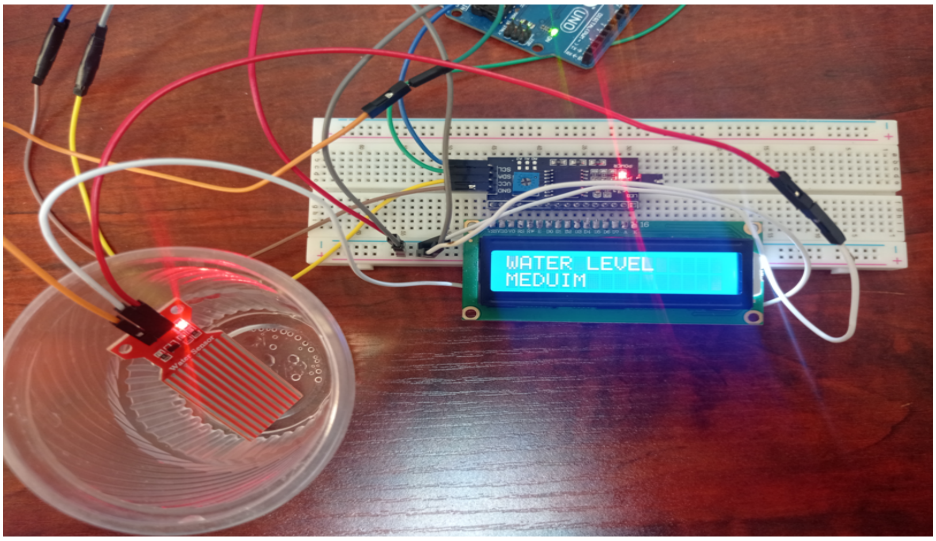

Figure 4.14: when the sensor is partially immersed in water .

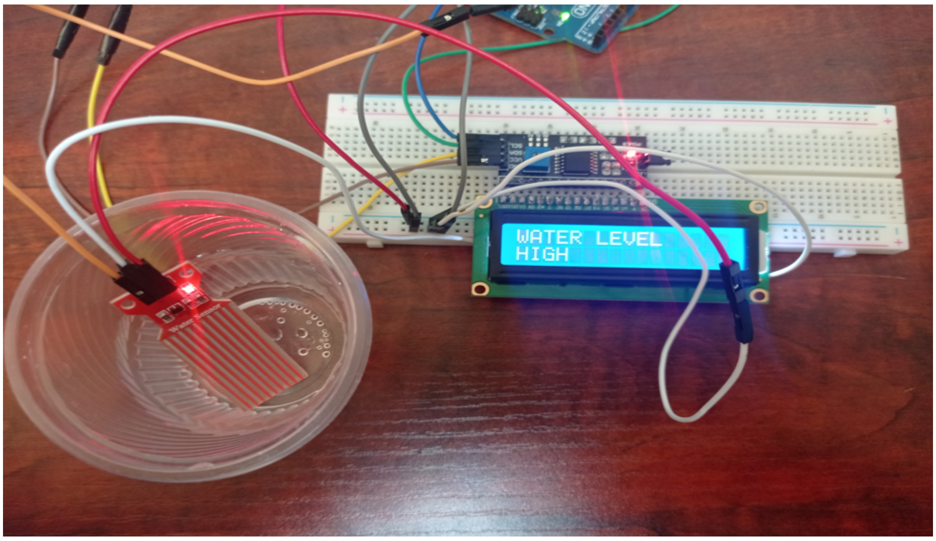

Figure 4.15: when the sensor is fully immersed in water .

GENERAL CONCLUSION

OUR project focuses on the concept of smart homes, which have been greatly influenced by advanced technology. These technological advancements have revolutionized the way we live, making our homes more secure, comfortable, and convenient than ever before. Our project aims to showcase the potential of home automation, with a specific emphasis on safety and comfort.

To accomplish this, we have explored the Internet of Things (IoT) and its historical background, applications, architectural engineering, and fundamental elements. The IoT plays a crucial role in enabling connectivity and communication among various devices and sensors within a smart home.

Additionally, we have examined the relationship between Artificial Intelligence (AI) and IoT in the development of technologically advanced residences. AI algorithms and machine learning techniques can analyze data collected by smart devices to provide personalized experiences and automate routine tasks, further enhancing the comfort and convenience of smart homes.

In our prototype, we have integrated various smart devices and sensors to create a connected and intelligent home environment. By leveraging mobile networks and IoT technologies, we have enabled seamless communication and control of different aspects of the home, including lighting, heating, security systems, and entertainment devices. This allows homeowners to remotely monitor and manage their homes, providing them with convenience and peace of mind.

Moreover, we have prioritized safety by integrating advanced security features into our prototype. Surveillance cameras, smart locks, and intrusion detection systems enhance the security of the property and give homeowners better control over their home's safety.

Looking ahead, we envision expanding our project to include additional features such as voice control, energy management systems, and integration with virtual assistants. By continually leveraging advancements in technology, we aim to create smarter and more efficient homes that enhance our daily lives.

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