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Présentée par :

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Thème

Design and Implementation of Smart Agriculture System Based on IoT

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بسم الله الرحمن الرحيم

ملخص

الهدف من هذا المشروع هو تسهيل عمل المزارع وإعطاء الزراعة الذكية لمسة تكنولوجية تسمح لها بالنمو بشكل عادل ودقيق . سيتم تجهيز الزراعة الذكية بنظام ري تلقائي وذكي . ستسمح لنا مستشعرات قياس رطوبة التربة بتشغيل الري الأرضي عند الحاجة وإيقاف الري عند الحاجة . سيتمكن المزارع من الحصول على درجة حرارة الدفيئة الخاصة به بفضل مستشعر درجة الحرارة الموجود بداخله يمكن تنظيم درجة الحرارة هذه بواسطة مروحة يتم تشغيلها فقط إذا كانت درجة الحرارة أقل أو أعلى اعتماداً على المزارع ، سيتم تشغيل الدفيئة الخاصة بنا بواسطة موزع كهربائي أو لوحة شمسية V220 والتي ستكون قادرة على تزويد الدفيئة باستمرار . سيتم توجيه كل هذه الوظائف من قبل مراقب التحكم الذي سيكون في حالتنا اردوينو سيتم إرسال إعدادات الزراعة الخاصة بنا في الوقت الفعلي إلى الهاتف الذكي للمزارع أو تخزينها مباشرة في تطبيقنا .

الكلمات المفتاحية : الدفيئة، ، الزراعة الذكية، المستشعرات .

Résumé

Le but de ce projet est de rendre les fermes plus faciles et de donner à la serre une touche technologique qui nous permet de cultiver juste et précis.

L'agriculture intelligente sera équipée d'un système d'arrosage automatique et intelligent. Les capteurs de mesure de l'humidité du sol nous permettront d'effectuer notre irrigation au sol au besoin et d'arrêter l'irrigation au besoin. L'agriculteur pourra obtenir sa propre température de serre grâce au capteur de température placé à l'intérieur! Cette température peut être régulée par un ventilateur qui ne fonctionne que si la température est inférieure ou supérieure selon le producteur, notre serre sera alimentée par un distributeur électrique ou panneau solaire 220V qui pourra alimenter la serre en continu. Toutes ces fonctions seront dirigées par un contrôleur qui sera dans notre cas le panneau Arduino ! Nos paramètres de serre seront envoyés en temps réel sur le smartphone de l'agriculteur ou stockés directement dans notre application.

Mots clés. L'agriculture intelligente, capteur, la serre

Abstract

The goal of this project is to make farms easier and give the greenhouse a technological touch that allows us to grow Fair and accurate.

Smart agriculture will be equipped with an automatic and intelligent watering system. Soil moisture measurement sensors will allow us to run our ground irrigation when needed and stop irrigation when needed. The farmer will be able to get his own greenhouse temperature thanks to the temperature sensor placed inside it! This temperature can be regulated by a fan that is operated only if the temperature is lower or higher depending on the farmer, our greenhouse will be powered by an electric dispenser or 220V solar panel which will be able to supply the greenhouse continuously. All these functions will be directed by a controller who will in our case be the Arduino panel! Our greenhouse settings will be sent in real time to the farmer smartphone or stored directly in our app.

Keywords. greenhouse, smart agriculture , Sensors

dedication

With my gratitude, I dedicate this humble act
to my mother and father, whatever Either the words I accepted will never be able to express my sincere love to them.
To my Mother, the one who showered me with tenderness and hope. For her help, her support and his encouragement during my journey. May this work be the fulfilment of your wishes the fruit of your countless sacrifices.
To my father, who was always pushing and motivating me in my studies. I hope this work is the fruit of your myriad sacrifices.
To my grandfather and grandmother I hoped that you would be here with me on this day God's mercy on you will remain in my memory.
To those I love very much and who have supported me throughout my life my brothers and my sisters Without forgetting my grandparents as well as all my dear family and friends.

abdelnacer *tissemsilt, in June 28, 2022.*

Appreciation

First of all we would like to thank God the Almighty for giving us courage, will and patience throughout our studies

Our special thanks go to our supervisor Dr. HAMDANI Mustapha for his great availability and wise advice during our preparation of this project.

Many thanks to all members of the jury for agreeing to review and evaluate our work.

We express our deep gratitude and thanks to our professors for the quality of the teacher they have given us during these five years spent at the university of Tissemsilt.
Thank you to all my colleagues from the Electronic section .

Finally we send our heartfelt thanks to our families, our friends for their support and encouragement throughout the realization of this work.

Abdelnacer *tissemsilt, in June 28, 2022.*

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General Introduction

Sommaire

1 Introduction

Agriculture is the foundation of human existence because it is the main source of food and food raw materials. Therefore, the development of the agricultural sector is imperative. Developing the country's economic situation. Unfortunately, many farmers still use traditional methods that lead to lower yields as the market becomes increasingly competitive, tomorrow's agriculture requires automation and based on the concept of smart farming, remote control standards need using the Internet of Things (IoT). To increase profitability, crops should be grown in the best environment.

2 Problematic

The purpose of this research is to develop an intelligent transplant system based on a factor-based structure to monitor air temperature and humidity are the most important control variables from the point of view of plant survival, growth and soil moisture less important for several hours, But it is less importantAn important variable to see if the plant can feed and plants have a constant need for light, so it is necessary to provide it whether the outdoor lighting is natural or industrial Each information has a set of straight values, for intelligent control: the system collects the necessary data from the plant's perimeter, diagnoses, then automatically resolves the problem and sends the required reports to the app to review all the data Smart agriculture relies on four types of sensors, heat and air moisture sensor, soil moisture sensor, and lighting sensor, as well as the Global System for Mobile communication (GSM) system for transmitting information and hazards. Finally, it stores the collected procedures in a database.

3 Contributions

In this project, we proposed a system for the realization of a smart agriculture. As part of this work, we developed a prototype consisting of a control board ARDUINO, based on microcontrollers with multiple output input ports. For Measuring and checking the bioclimatic parameters of smart agriculture, with sensors are used

- First, we drew up a blueprint for the project using the Proteus app
- The proposed algorithm is implemented with IDE under the results showing that the proposed algorithm is working and Give excellent results with existing approaches

4 Dissertation organization

We devote the first chapter to some definitions and generalities of the Internet of things (IoT).

In the second chapter's general study of smart agriculture, its interest, and its different types we present the ARDUINO type control board as the various sensors and actuators used in our system and their features.

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

5 Conferences

S. Ait Hamou, R. Dahou, A. Drizi, M. Hamdani and B. Nail, *'Design and Implementation of a Medical Tele-Monitoring System Based on IoT'*, First exhibition of innovative projects, Djelfa, Mai 19th, 20022.

A. Drizi, R. Dahou, S. Ait Hamou, M. Hamdani and B. Nail, *'Design and Implementation of Smart Agriculture System Based on IoT'*, First exhibition of innovative projects, Djelfa, Mai 19th, 20022.

CHAPTER 1

Internet of Things (IoT)

Sommaire

1.1 Introduction

INternet is one of the most significant inventions of the modern world, in its early days. It was primarily a protocol used to transmit messages from one point to another using computers. We have just made the transition from an Internet that connects people and computers to one that connects things and objects. This phenomenon is called the IoT which has been the subject of several advancements. Today, IoT is a gainful investment vehicle. It's a futuristic technology, which we will use in this chapter and provide a general overview of this new era.

In this Chapter, we will discuss the concept of IoT, explain its operation's principle and promote its components by citing examples such as communication protocols that are functional with it, platforms for its development and some application domains.

1.2 Definition

IoT is the network of things, with clear element identification, embedded with software intelligence, sensors, and ubiquitous connectivity to the Internet. IoT enables things or objects to exchange information with the manufacturer, operator, and/or other connected devices utilizing the telecommunications infrastructure of the Internet. It allows physical objects to be sensed (to provide specific information) and controlled remotely across the Internet, thereby creating opportunities for more direct integration between the physical world and computerbased systems and resulting in improved efficiency, accuracy, and economic benefit. Each thing is uniquely identifiable through its embedded computing system and is able to interoperate within the existing Internet infrastructure[1].

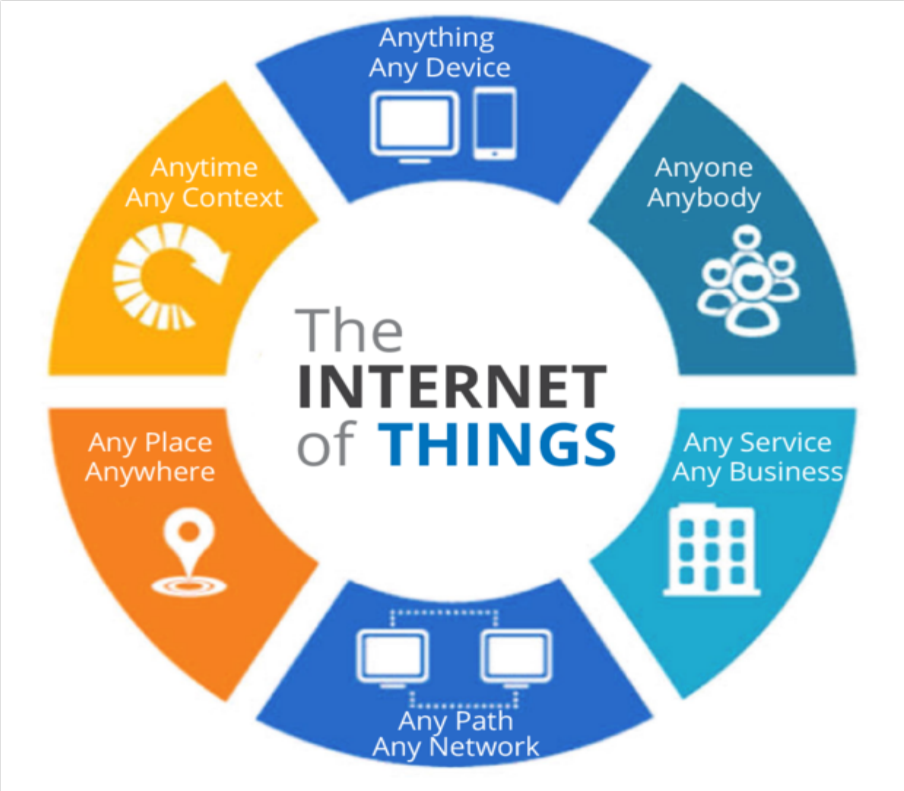

Figure 1.1: Figure IoT [2]

1.3 History of IoT

he term “Internet of Things” was coined by entrepreneur Kevin Ashton, one of the founders of the Auto-ID Center at MIT. Ashton was part of a team that discovered how to link objects to the internet through an Radio-frequency Identification (RFID) tag. He first used the phrase “Internet of Things” in a 1999 presentation – and it has stuck around ever since. Ashton may have been first to use the term Internet of Things, but the concept of connected devices – particularly connected machines – has been around for a long time. For example, machines have been communicating with each other since the first electric telegraphs were developed in the late 1830s. Other technologies that fed into IoT were radio voice transmissions, wireless (Wi-Fi) technologies and supervisory control and data acquisition (SCADA) software. Then in 1982, a modified Coke machine at Carnegie Mellon University became the first connected smart appliance. Using the university’s local ethernet or ARPANET – a precursor to today’s internet – students could find out which drinks were stocked, and whether they were cold. Today, we’re living in a world where there are more IoT connected devices than humans. These IoT connected devices and machines range from wearables like smartwatches to RFID inventory tracking chips. IoT connected devices communicate via networks or cloud-based platforms connected to the Internet of Things. The real-time insights gleaned from this IoT collected data fuel digital transformation. The Internet of Things promises many positive changes for health and safety, business operations, industrial performance, and global environmental and humanitarian issues [3].

1.4 Why IoT is so importent

Over the past few years, IoT has become one of the most important technologies of the 21st century. Now that we can connect everyday objects—kitchen appliances, cars, thermostats, baby monitors—to the internet via embedded devices, seamless communication is possible between people, processes, and things. Using low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention. In this hyperconnected world, digital systems can record, monitor, and adjust each interaction between connected things. The physical world meets the digital world—and they cooperate [4].

1.5 Eliment IoT

Knowing the basic IoT elements helps to better understand the real meaning and functionality of the IoT. IoT building block has six main elements to manage IoT activity and provide services as illustrated [5]

1.5.1 Identification

Identification of IoT object in term of name (ID) and address is very crucial. Object ID show the name of object and address refers its address with in computer network. Many identification methods are available for the IoT such as electronic product codes (EPC) and ubiquitous codes (uCode) In addition, IPv6 and IPv4 addressing methods are use for addressing [5].

1.5.2 Sensing

IoT sensor collects the data from devices and sends it back to database or cloud. For any service, data is analyzed and perform specific action. IoT sensor can be smart sensor or wearable sensing device. [5].

1.5.3 Communication

The IoT communication technology interlink different smart object to provide any specific serviced requested by user. Iot used efficient communication link for low power consumption .Id addition different protocol used for communication like are WiFi, Bluetooth. Some specific communication technologies are also in use like RFID, Near Field Communication **NFC!** (**NFC!**) and ultra-wide bandwidth (UWB). The first technology is RFID, used for M2M communication. FID has two basic components RFID tag and RFID reader. For unique identification a chip is attached with object represents as a RFID tag.ac RFID tags can be active, passive or semi-passive/active. Active tags are powered by battery while passive ones do not need battery. Semi-passive/active tags use board power when needed.RFID reader sends a signal to tag and receive response from tag and send to database. Database is connected to processing to identify the object [5].

1.5.4 Computation

Here all computing is done by processing unit and software application .Further many other software are usedfor effective computation. IoT applications to run on different hardware platforms were developed [5].

1.5.5 Services

IoT services can be categorized under four classes: Identity-related Services, Information Aggregation Services, Collaborative-Aware Services and Ubiquitous Services. First one is imperative services that are used in other types of services that wishes to carry real world things to the virtual world have to categorize those things. Second Services bring together and sum up unprocessed sensory measurements that require to be process and report to the IoT service. Third Services work on peak of Information Aggregation Services and utilize the obtained information to compose result and respond consequently. The main aim of fourth service is to provide Collaborative-Aware Services as per the need [5].

1.5.6 Semantics

This element has the ability to take out knowledge from different object smartly for required service. Knowledge extraction includes discovering and using resources and modeling information [5].

1.6 Architecture of IoT

A critical requirement of an IoT is that the things in the network must be connected to each other. IoT system architecture must guarantee the operations of IoT, which connects the physical and the virtual worlds. Design of IoT architecture involves many factors such as networking, communication, processes etc. In designing the architecture of IoT, the extensibility, scalability, and operability among devices should be taken into consideration. Due to the fact that things may move and need to interact with others in real-time mode, IoT architecture should be adaptive to make devices interact with other dynamically and support communication amongst them. In addition, IoT should possess the decentralized and heterogeneous nature [6].

1.6.1 Service oriented Architecture

A critical requirement of an IoT is that the things in the network must be interconnected. IoT system architecture must guarantee the operations of IoT, which bridges the gap between the physical and the virtual worlds. Design of IoT architecture involves many factors such as networking, communication, business models and processes, and security. In designing the architecture of IoT, the extensibility, scalability, and interoperability among heterogeneous devices and their models should be taken into consideration. Due to the fact that things may move physically and need to interact with each other in real-time mode, IoT architecture should be adaptive to make devices interact with other things dynamically and support unambiguous communication of events [6].

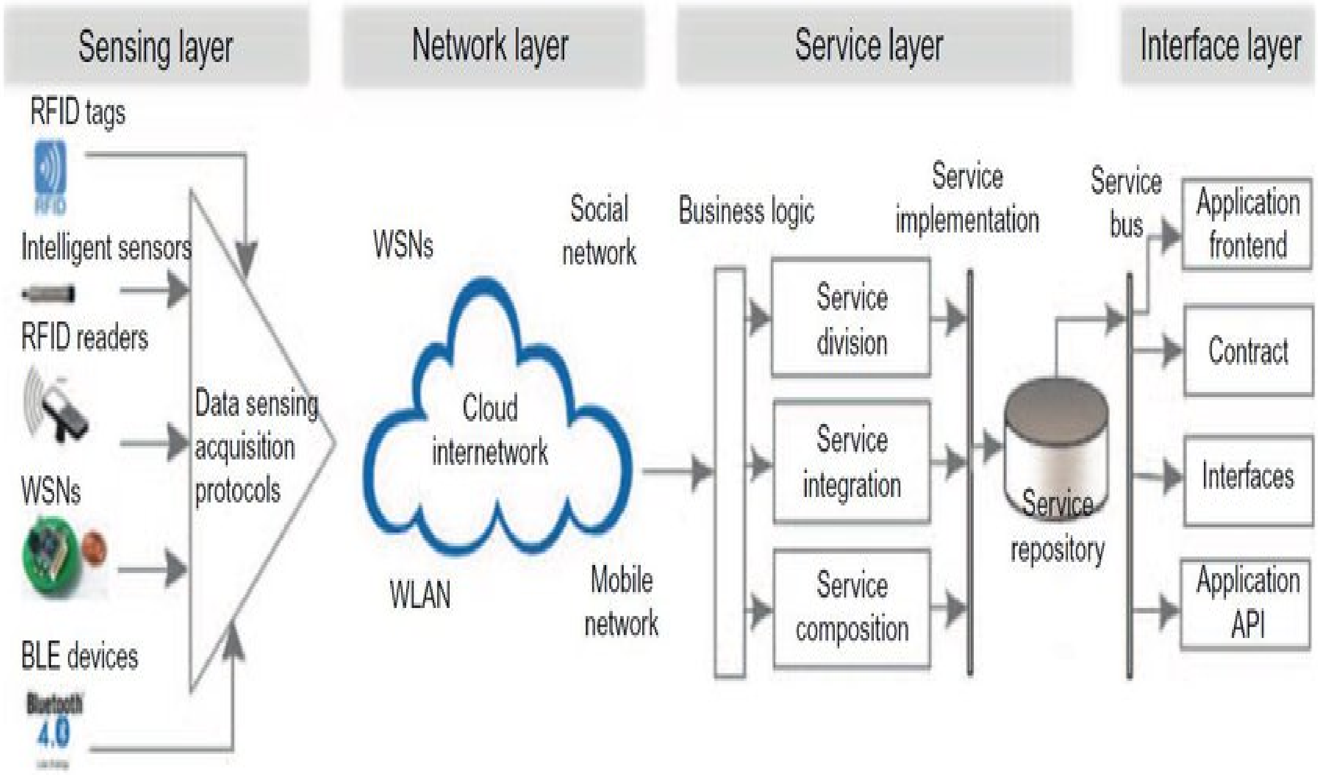

Figure 1.2: Architectural Layers of IoT [6]

The SoA treats a complex system as a set of well-defined simple objects or subsystems. Those objects or subsystems can be reused and are maintained individually; therefore, the software and hardware components in an IoT can be reused and upgraded efficiently. Due to these advantages, SoA has been widely applied as a mainstream architecture [6].

SoA, which consists of four layers with distinguished functionalities provide the interoperability among the devices in multiple ways .They are:

1.6.1.1 Sensing Layer

IoT is expected to be a wide spread physical inner-connected network, in which things are connected continuously and can be controlled from anywhere .In the sensing layer, the smart systems on tags or sensors are able to automatically sense the environment and exchange data among devices. Things can be uniquely identified and the surrounding environments can be monitored for various purposes and applications. Every object in IoT holds a digital identity and can be easily tracked in the digital domain. The technique of assigned unique identity to an object is called a universal unique identifier (UUID).The identifiers might contain names and addresses. A UUID is a 128-bit number used to uniquely identify some object or entity on the Internet [6].

In determining the sensing layer of an IoT, the following aspects should be taken into consideration:

- Cost, size, resource, and energy consumption: The things might be equipped with sensing devices such as RFID tags, sensor node. Due to a large number of sensors in applications, intelligent devices should be designed to minimize required resources as well as costs.
- Deployment: The sensing things (RFID tags, sensors etc.) can be deployed one-time, or incrementally, or randomly depending on the requirements.
- Communication. Sensors must be communicable to make things accessible and retrievable.
- Network. The things are organized as multi-hop, mesh or ad hoc networks.

1.6.1.2 Network layer

performs the following functions; Gateway – Routing & Addressing – Network Capabilities – Transport Capabilities – Error detection & Correction. Also, it takes care of message routing, publishing and subscribing. With demand needed to serve a wider range of IoT services and applications such as high speed transactional services, context-aware applications, etc, multiple networks with various technologies and access protocols are needed to work with each other in a heterogeneous configuration. These networks can be in the form of a private, public or hybrid models and are built to support the communication requirements for latency, bandwidth or security [7].

1.6.1.3 Services layer

performs the following functions; Service storage & orchestration – Service composition & organization – Virtual Entity resolution – IoT service – VE service – IoT service resolution – VE & IoT service monitoring. All decisions related to the monitoring, storage, organization and visualization of the received information, including resolving virtual entities created, are made [7].

1.6.1.4 Interface layer

In IoT, a large number of devices are connected; these devices belong to different people and hence do not always imply with the same standards. The compatibility issue among the things must be solved for the interaction among things. Compatibility involves in information exchanging, communication and events processing. There is a strong need for an effective interface mechanism to simplify the management and interconnection of things. Basically interface layer works in the application frontend or Application Program Interface (API) [6].

1.7 IoT platforms

There are several development environments and platforms are divided into two types for programming IoT systems, which can be used by designers for the development of IoT projects :

- IoT Hardware platforms/Boards:

  It refer to hardware devices/objects that are responsible to provide useful information and interact with other devices/objects and users by means of a communication medium. The communication can be deployed via Bluetooth Low Energy (IEEE 802.15.4), Wi-Fi (IEEE 802.11), Ethernet (IEEE 802.3), or other communication standards

- IoT Software Platforms:

  It is a software package that integrates devices, networks, and applications and hides implementation complexity from the user. Indeed, IoT software platforms support and enable IoT solutions by providing an ecosystem where things can be built upon .

1.8 IoT components

In IoT, there are four key components are used [8]:

1. Embedded low-power systems: Less battery usage and higher performance are inverse aspects that play a crucial role in electronic system design.

2. Cloud computing: IoT devices collect a large quantity of data, which must be stored on a trustworthy storage server. Here's where cloud computing comes into play. The information is examined and learned, allowing us to determine where electrical defects or mistakes may lie inside the system.

3. Big data availability: We all know that IoT is strongly reliant on sensors, particularly in real-time. As these electronic gadgets become more prevalent in many fields, their use will result in a vast flood of big data.

4. Networking connection: In a world where each physical thing is represented by an Internet protocol (IP) address, internet access is required to interact. According to IP naming, however, there are only a limited number of addresses accessible. As the number of devices grows, this way of naming will become outdated. As a result, scientists are seeking a new naming system to describe each physical thing.

1.9 Application domains

The Applications of the IoT are numerous and diversified in all areas of every-day life of people which broadly covers society, industries, and environment. All the IoT applications developed so far comes under these three broad areas as shown in Table 1. According to Internet of Things Strategic Research Agenda (SRA) during 2010, 6 or more application domains were identified that are smart energy, smart health, smart buildings, smart transport, smart living and smart cities. According to the survey that the IoT-I project ran during 2010 65 IoT application scenarios were identified and grouped in to 14 domains, which are Transportation, Smart Home, Smart City, Lifestyle, Retail, Agriculture, Smart Factory, Supply chain, Emergency, Health care, User interaction, Culture and tourism, Environment and Energy. Some of the IoT applications are briefly explained in next coming paragraphs [9].

Table 1.1: IoT Application [9]

Domain	Description	Applications
Society	Activities related to the betterment and development of society, cities and people	Smart Cities, Smart Animal Farming, Smart Agriculture, Healthcare, Domestic and Home automation, Independent Living, Telecommunications, Energy, Defense, Medical technology, Ticketing, Smart Buildings
Environment	Activities related to the protection, monitoring and development of all natural resources	Smart Environment, Smart Metering, Smart Water Recycling, Disaster Alerting
Industry	Activities related to financial, commercial transactions between companies, organizations and other entities	Retail, Logistics, Supply Chain Management Automotive, Industrial Control, Aerospace and Aviation

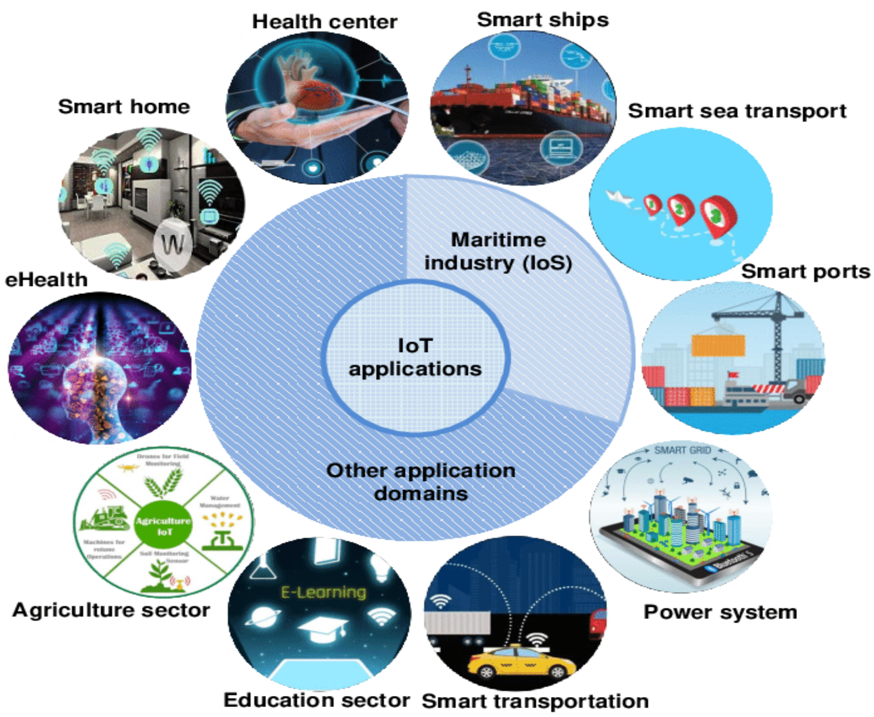

Figure 1.3: Application domains [10]

1.9.1 Smart Cities

The IoT play a vital role to improve the smartness of cities includes many applications to monitoring of parking spaces availability in the city, monitoring of vibrations and material conditions in buildings and bridges, sound monitoring in sensitive areas of cities, monitoring of vehicles and pedestrian levels, intelligent and weather adaptive lighting in street lights, detection of waste containers levels and trash collections, smart roads, intelligent highways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams. Some of IoT smart cities applications are smart parking, structural health, noise urban maps, traffic congestion, smart lightning, waste management, intelligent transportation systems and smart building. These smart cities IoT applications use RFID, Wireless Sensor Network and Single sensors as IoT elements and the bandwidth of these applications ranges from small to large. The already developed IoT applications reported on the literature are Awarehome, Smart Santander and city sense [9].

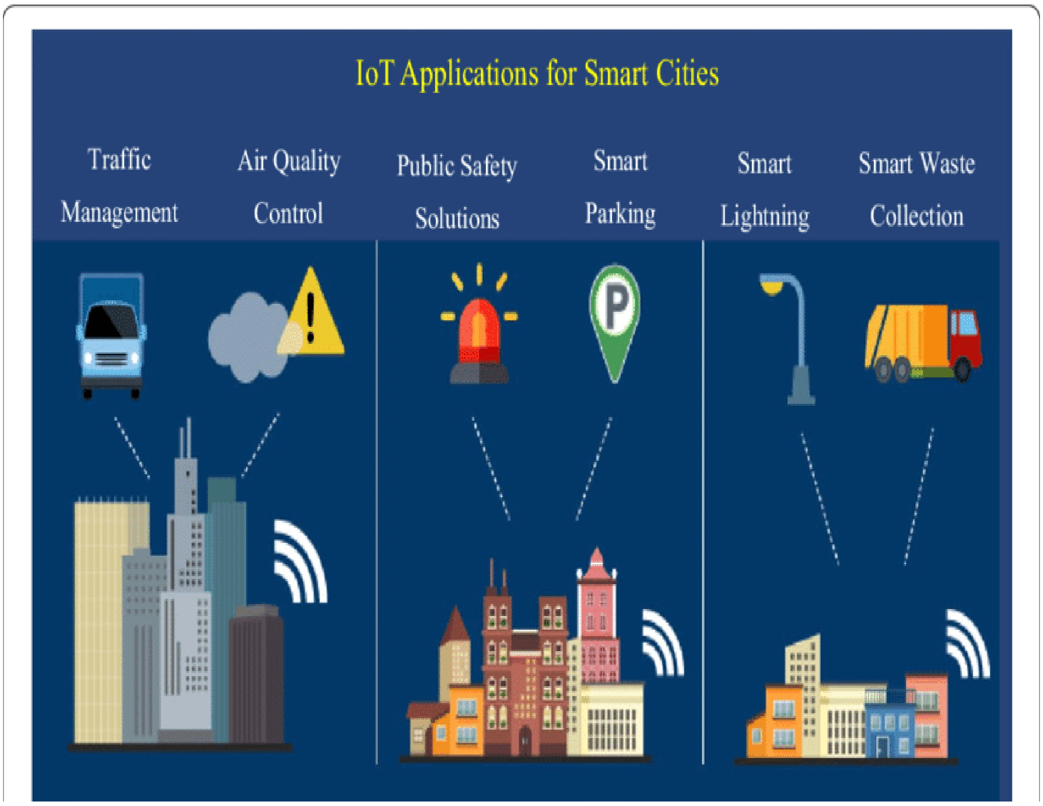

Figure 1.4: smart cities [11]

1.9.2 Smart Agriculture and Smart water

The IoT can help to improve and strengthen the agriculture work by monitoring soil moisture and trunk diameter in vineyards to control and maintain the amount of vitamins in agricultural products, control micro climate conditions to maximize the production of fruits and vegetables and its quality, study of weather conditions in fields to forecast ice information, rail, drought, snow or wind changes, control of humidity and temperature level to prevent fungus and other microbial contaminants. The role of IoT in water management includes study of water suitability in rivers and the sea for agriculture and drinkable use, detection of liquid presence outside tanks and pressure variations along pipes and monitoring of water level variations in rivers, dams and reservoirs. This kind of IoT applications use Wireless sensor network and single sensors as IoT elements and the bandwidth range as medium. The already reported IoT applications in this kind are SiSviA, GBROOS and SEMAT [9].

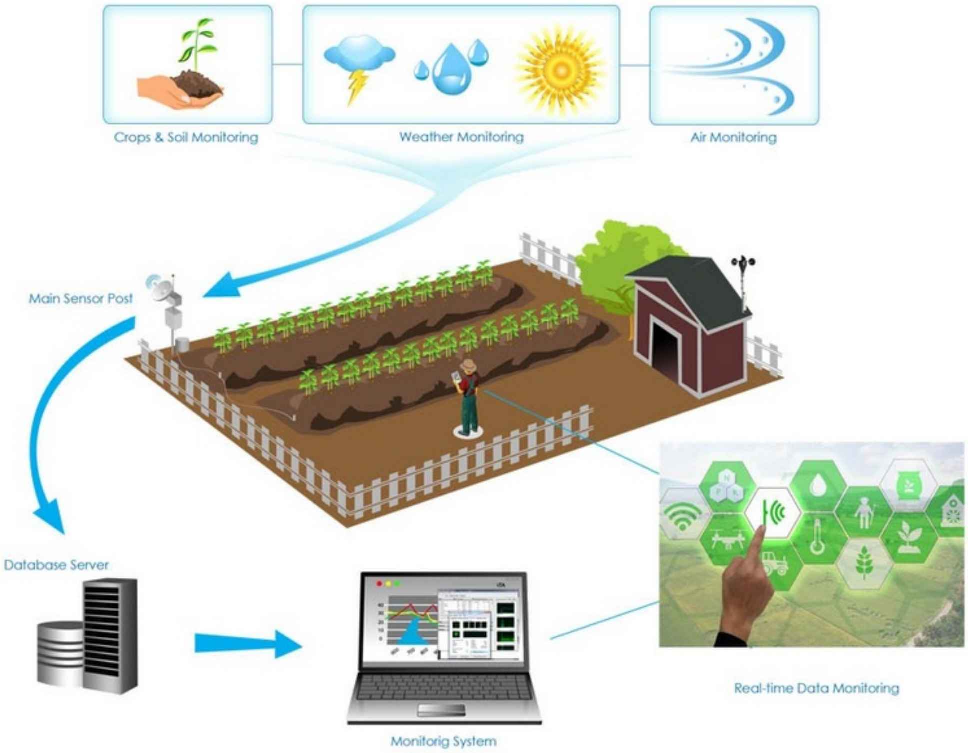

Figure 1.5: smart agriculture [12]

1.9.3 Home automatics

Home automation or smart building is called as domotics [16]. By using a centralized hub generally a smart phone (which contains sensors like accelerometer), the various things in the home can be controlled. That is, smart television, air conditioner, water heaters, lights, fans etc.. will be connected to the smart phone using NFC , Bluetooth, Zigbee or any other short range low power protocols [13].

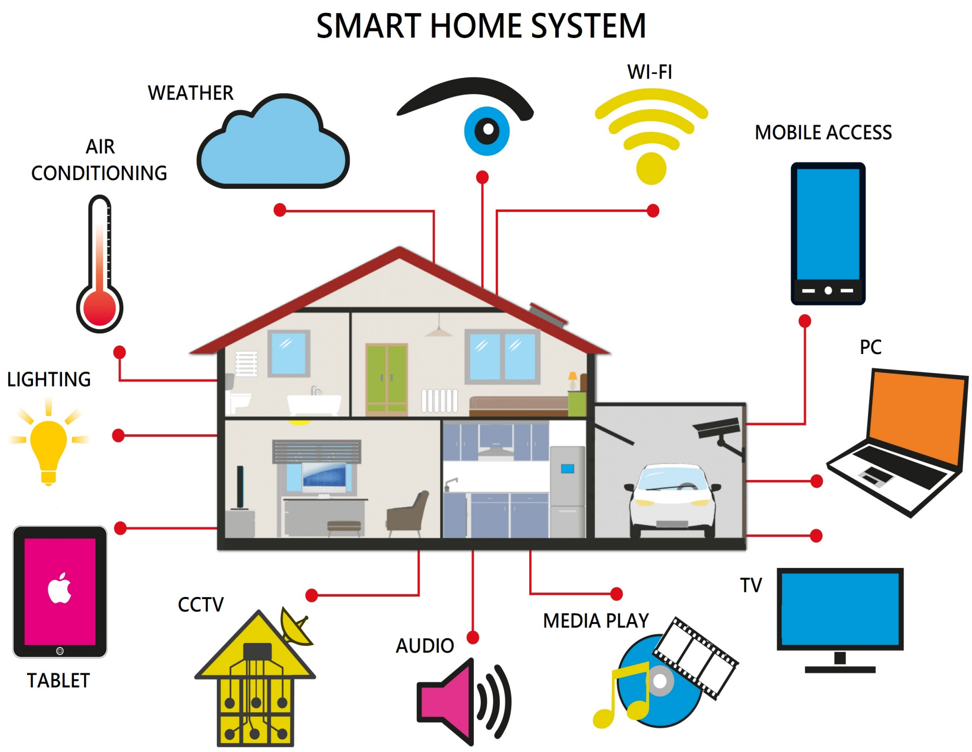

Figure 1.6: Smart Home [14]

1.9.4 A Smart Healthcare System

A smart healthcare system must provide a care to people in remote locations and monitoring systems that deliver a continuous data stream for better decisions. IoT revolutionizes a healthcare system by dramatically improving quality and IoT will accomplish a smart healthcare system to people. In this section, we describe blueprints of our proposal to a smart healthcare system iotHEALTHCARE and the logical architecture of IoT healthcare [15].

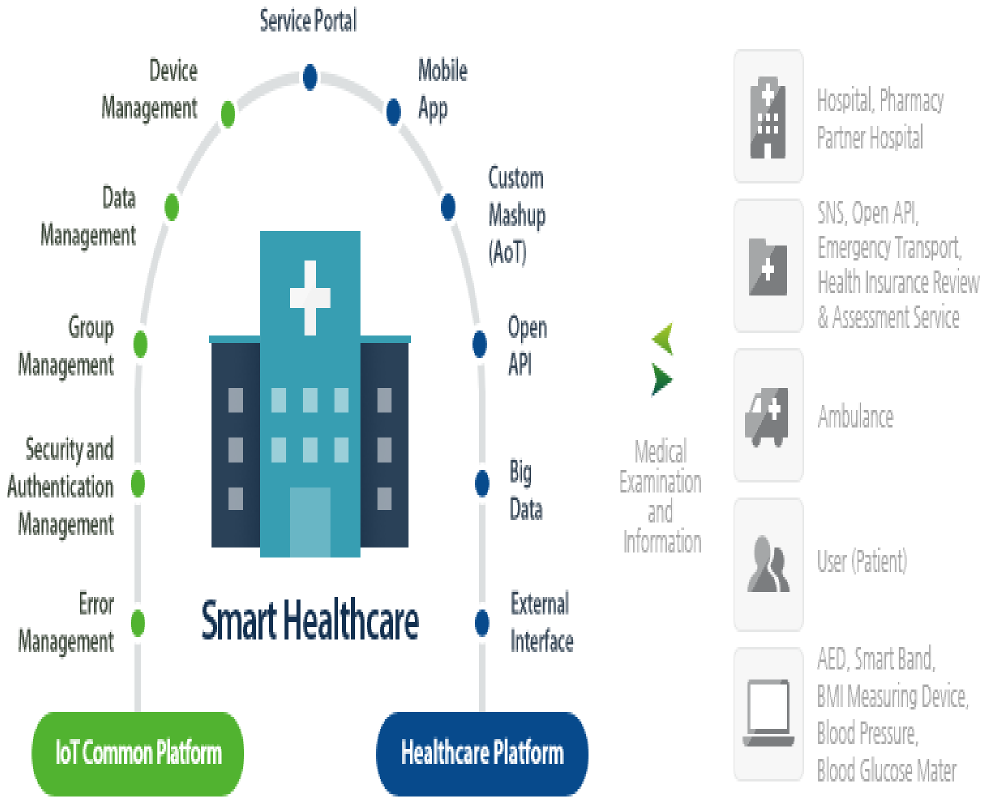

Figure 1.7: Smart healthcare [16]

1.10 Conclusion

The combination of computer concepts, sensors, monitoring networks, and equipment control has existed before, but in our time the main technology has launched the new reality of the Internet of Things, which revolutionized our world and the world has become fully connected, connecting things to their environment, things and people are becoming more intertwined, and they are occupying various fields, including smart agriculture.

CHAPTER 2

Smart agriculture

Sommaire

2.1 Introduction

AGriculture remains a vital sector for most countries. It presents the main source food for the world population. However, it faces a big challenge: to produce more and better while increasing sustainability with reasonable use of natural resources, reduce environmental degradation as well as adapt to climate change.

It is therefore extremely important to move from traditional agricultural methods to modern agriculture. Smart agriculture is one of the solutions to meet the growing demand for food while meeting sustainability requirements. It is embodied by the use different technologies such as the Internet of Things, artificial intelligence and data mining, sensors, robotics, etc.

This chapter is dedicated to the different smart farming technologies. These technologies cover automation and data acquisition technologies, data transmission, data processing technologies, RCSF, IoT.[17].

2.2 Smart agriculture

2.3 Definition

The concept of smart agriculture is not formally defined for all its aspects. Of Moreover, this concept can be defined in different ways, however we have retained the definitions following which seem to us to be the most appropriate:

- Smart agriculture is a modern concept in which information and communication technologies are used to manage all processes and activitiesrelated to agriculture [18].
- Smart agriculture is network-based agriculture. It is defined in as "a service that uses networks to actualize a convergence service in the agricultural field to cope with various problems, such as climate change, growing conditions of agricultural products and diseases using the technologies of information processing and autonomous control”. It should be considered on the basis interactions between

entities closely linked to the agricultural domain, i.e. the producers farmers, service providers, logistics agents, market distributors, customers and the telecommunications networks that interconnect them [19].

- Smart agriculture adopts a multidisciplinary approach, focused on new technologies. It integrates three different technological aspects which are biotechnology, nanotechnology and information and communication technologies [18].

2.4 Smart greenhouses of an agriculture

Smart greenhouses are greenhouses that are controlled and automated by a system intelligent. This makes it possible to ensure the monitoring and control of the environment and the microclimate of these greenhouses.

To control the greenhouse, different sensors (connected to the internet or not) are used to measure the environmental standards according to the requirements of each plant. This eliminates the need for static monitoring in greenhouses. These sensors provide information on light, pressure, humidity and temperature levels, which automatically control triggers to open the window, turn on the lights, 2D6control the heating and turn on the fan [20].

2.5 Materials used

2.5.1 Hardware side

2.5.1.1 Arduino

The Arduino system makes it possible to combine the performance of programming with that of electronics. Specifically, to program electronic systems. The big advantage of programmed electronics is that it greatly simplifies electronic diagrams and by therefore, the cost of the realization, but also the workload for the design of a map electronic.The Arduino system allows you to:

- control home appliances
- make your own robot

- make a light show
- communicate with the computer
- remote control a mobile device (model making)
- etc.

The Arduino system is made up of two main things: hardware and software [21].

2.5.1.2 Why Arduino

There are many electronic boards that have microcontroller-based platforms available for programmed electronics. All of these tools take the complicated details of programming and wrap them into an easy-to-use layout. In the same way, the ARDUINO system simplifies the way of working with microcontrollers while offering interested persons several advantages cited as follows:

- The price (discounted):

  ARDUINO boards are relatively inexpensive compared to other platforms. The cheapest version of the ARDUINO module can be assembled by hand, (pre-assembled ARDUINO boards cost less than 2500 DA).

- Multi-platform:

  The ARDUINO software, written in JAVA, runs under Windows, Macintosh and Linux operating systems. Most microcontroller systems are limited to Windows.

- A clear and simple programming environment:

  The ARDUINO programming environment (the Arduino IDE software) is easy to use for beginners, yet flexible enough for advanced users to take advantage of as well.

- Open Source and extensible software:

  The ARDUINO software and the ARDUINO language are released under an open source license, available to be completed by experienced programmers. The ARDUINO module programming software is a multi-platform JAVA application (running on any operating system), serving as a code editor and compiler, and which can transfer the program through the serial link (RS232, Bluetooth or USB depending on the module).

- Open source and extensible hardware:

  ARDUINO boards are based on Atmel ATMEGA8, ATMEGA168, ATMEGA 328 Microcontrollers. Module schematics are released under a Creative Commons License, and experienced circuit designers can make their own version of ARDUINO boards, complementing and improving them. . Even relatively inexperienced users can make the breadboard version of the ARDUINO board, the goal of which is to understand how it works to save the cost [22].

2.5.1.3 Different types of arduino

There are several types of arduino boards which differ from each other mainly by the type of microcontroller used, the number of inputs/outputs, the memory capacity and the operating speed. We can mention as an indication the Arduino UNO, Mega, Leonardo, Due, Pro mini, micro,... The most popular arduino boards for common applications are the UNO board and the mega card In the rest of this course we will only focus on the Arduino UNO board [22].

2.5.1.4 The Arduino UNO board

The Arduino Uno board is a microcontroller board built around the ATmega 328. It has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connector, a jack power supply, an ICSP socket, and an initialization button (reset). The Uno card contains everything necessary for the operation of the microcontroller. To use it, just connect to a computer with a USB cable, or to power it using a mains unit external or batteries. This card has several analog inputs, inputs and outputs digital. The analog-to-digital converter has 10 bits and its full voltage Scale defaults to 5V but can be set between 2 and 5V [22].

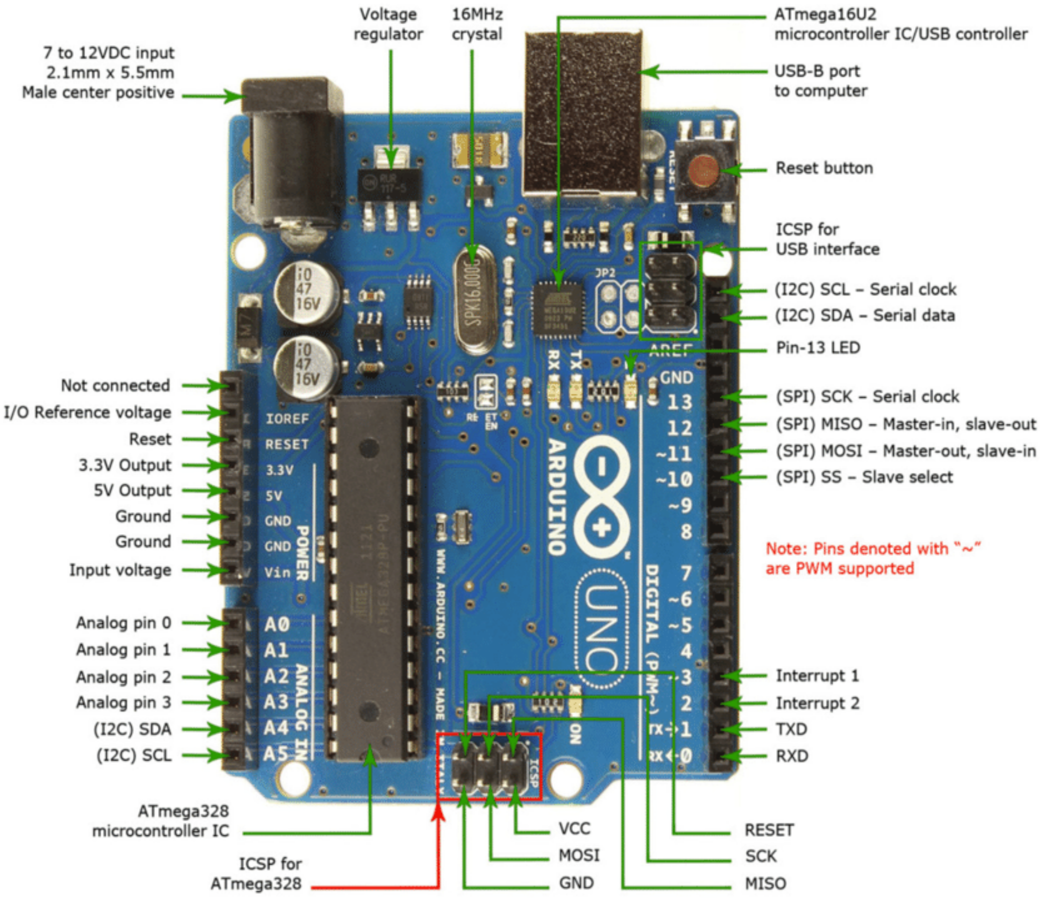

Figure 2.1: Arduino uno [23]

2.5.1.5 Caractéristiques techniques

- Atmega328 Microcontrôleur.
- 5-12 V entrées voltage.
- 14 Digital E/S pins.
- 6 PWM sorties.
- 6 entrées analogiques.
- 16 Mhz Clock Signal.
- 32 kB mémoire flash [24].

2.5.2 The sensors

2.5.2.1 Definition

A sensor is a device for collecting information which elaborates from a physical quantity, a usable quantity, such as an electric voltage, a height of mercury or an intensity. Sensors are the basic elements of data acquisition systems [25].

2.5.2.2 Sensor type

The sensors are classified according to their operating principle, there are two types:

2.5.2.3 Passive sensors

These are the sensors whose delivered electrical signal is an impedance variation. They are said to be passive because they require a source of electrical energy. They are classified according to their type of impedance [25].

A: Resistance (Ohms).

L: Inductance H (Henry).

C: Capacitance F (Farad).

2.5.2.4 Active sensors

Active sensors directly transform the measurement (m) into an electrical quantity [25].

q: Electric charge C (Coulomb).

i: Current A (Amps).

v: Potential difference (Volts)

2.5.3 Sensors used

2.5.3.1 DHT11 temperature and humidity sensor

The DHT11 sensor is a serial digital output temperature and humidity sensor that accepts a voltage of 3.3 to 5V. It is able to measure temperatures from 0 to +50°C with an accuracy of +/- 2°C and relative humidity levels from 0 to 90% with an accuracy of +/- 2% (+/- 5% at the extremes, at 20% and 96%). A measurement can be made every 500 milliseconds (i.e. twice per second) [26].

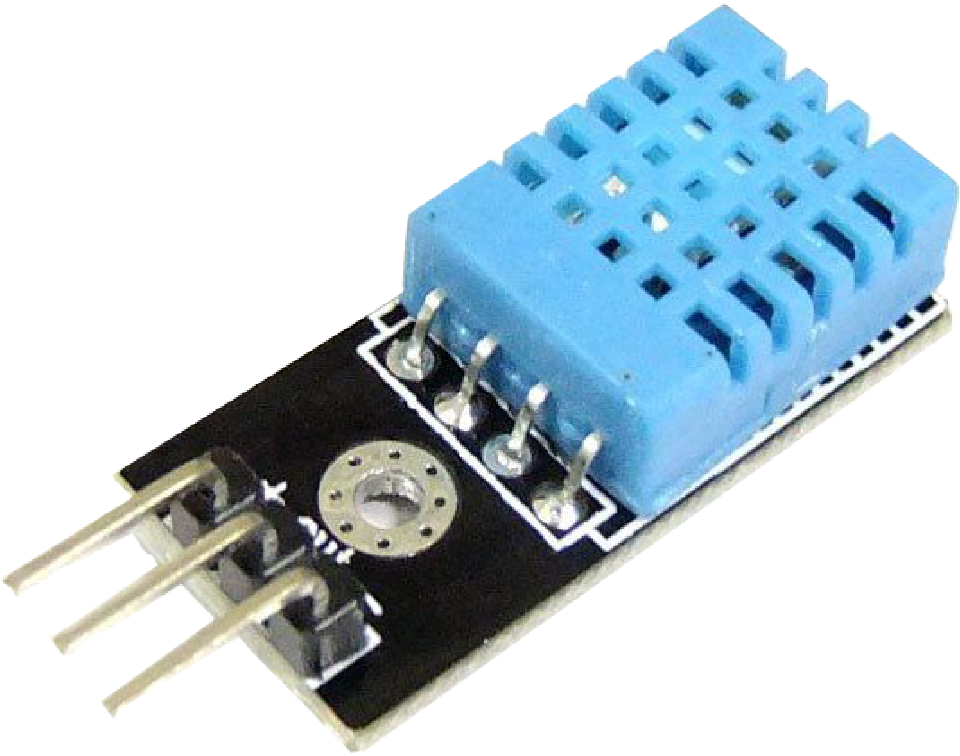

Figure 2.2: DHT11 sensor [27]

The sensor has 3 pins, used as follows:

- Pin1 is the power pin (5 volts or 3.3 volts).
- Pin2 is the communication pin.
- Pin3 is sensor ground (GND).

Table 2.1: Glossary of terms DHt11 [26].

Power supply	**WHO definition**
Power supply	+5V (3.5 – 5.5V)
Consumption	0.5 to 2.5 mA
Measuring range	- Temperature: 0 to 50°C - Humidity: 20 to 90% RH
Accuracy	- Temperature: ± 2°C - Humidity: ± 5% RH
Derivative	- Temperature: ± 0.1°C - Humidity: ± 5% RH
Size	32 x 22mm

2.5.3.2 Soil moisture sensor

The SparkFun Soil Moisture Sensor with Screw Terminals is a simple breakout board that measures moisture in soil and similar materials. The soil moisture sensor is relatively easy to use. It includes 2 large exposed pads, which function as probes for the sensor, acting as a variable resistor.

If the soil contains more water, it means there will be better conductivity between the pads, resulting in lower resistance and higher exterior signal (SIG). This version includes a 3-pin screw terminal pre-soldered to the board for ease of connection and installation [28].

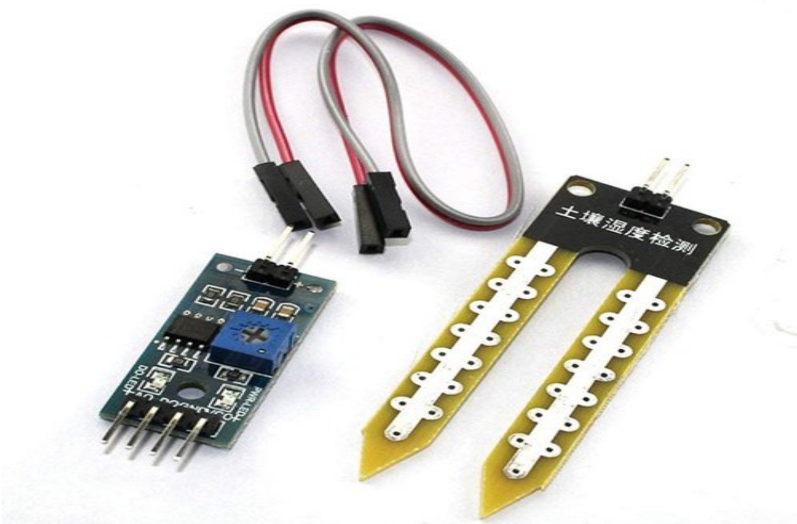

Figure 2.3: Sensor soil moisture [29]

The sensor has 3 terminals, used as follows:

- une borne reliée au 5 V de l'ARDUINO.
- une borne GND reliée à la masse.
- a SIG or A1 terminal connected to the ARDUINO analog input 1.

Table 2.2: Glossary of terms Soil moisture sensor [28].

Power supply	DC 3.3 - 5V
Voltage signal	0 4.2V
Fluent	35 Ma
LEDs	- Power indicator (red) - Digital output indicator (green)
Dimensions	60 x 20 x 5 mm

2.5.3.3 Light sensor LDR

A photoresistor (PhotoCells or CdS) is an electronic component whose resistance depends on the light flux to which it is exposed. They are also called LDR (Light Dependent Resistor) or photoconductive cells. They detect light. The photoresistor is mainly used to measure the light intensity, which is expressed in lux (illuminance). There are also other units to measure this type of data, such as the Candela (cd) which is used to calculate the luminance, expressed in cd/m² or the lumen noted lm, which measures the luminous flux. These sensors respond to light with wavelengths varying between 400nm (violet) and 600nm (orange), with a peak at around 520nm (green). They can therefore be used to capture visible light (whose wavelength is between 400 and 600 nm) [25].

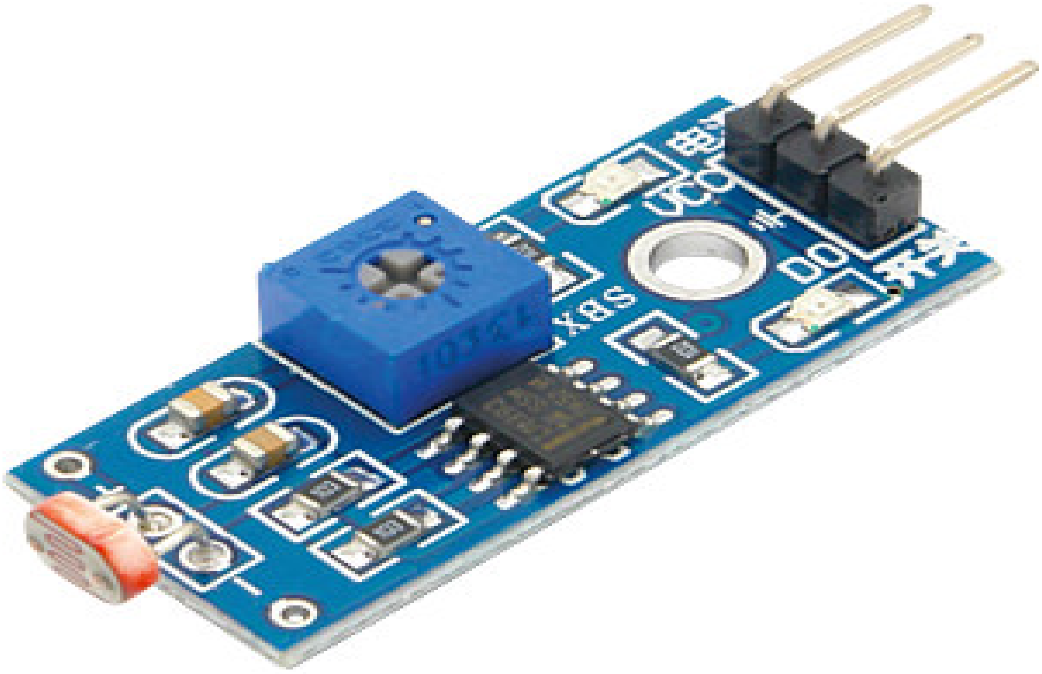

Figure 2.4: sensor LDR [30]

The sensor has 4 pins used as follows:

- A0 The analog output, reflecting the light intensity received by the LDR.
- D0 Digital output, changes to 1 (+3.3V or +5V) when the light intensity exceeds the threshold.
- GND Mass.
- Vdc Power supply +3.3V.

Table 2.3: Glossary of terms LDR sensor [25].

Power supply	DC 3.3 - 5V
screw hole	Fixed
Facility	Easy
Adjustable potentiometer	Adjust brightness and light
Dimensions	3.2 x 1.7cm

2.5.4 The actuators

An actuator is a device which transforms the energy delivered by the power interface, into energy usable by the process effectors. Electric motors, pneumatic cylinders as well as heating elements are typical examples of actuators used in industrial automation

2.5.4.1 The electric pump

It is a device allowing the circulation and acceleration of water in the irrigation pipes and the filling of the tank.

Figure 2.5: Electric pumpe [31]

Table 2.4: Glossary of terms the electric pump [31] .

Power supply	220-240 V
Frequency	50 Hz
Power	25 W
H/MAX	1.2 M
Q/MAX	1200L/H

2.5.4.2 Fan

It is a device that allows us to control the humidity and regulate the temperature in the greenhouse.

Figure 2.6: Fan [32]

Table 2.5: Glossary of terms FAN [32].

Tension	12V
Fluent	0.14A
Dimensions	120 x 120 x 38mm

2.5.4.3 LED

is an opto-electronic device capable of emitting light when an electric current passes through it. A light-emitting diode allows electric current to flow only in one direction and produces non-coherent monochromatic or polychromatic radiation by conversion of electrical energy when a current passes through it.

On the electronic diagrams, it can be identified thanks to its characteristic symbol: that of a classic diode surmounted by two arrows. These symbolize the emission of photons (of light). Some variations exist in this representation [33].

Figure 2.7: LED [33]

2.5.5 The rest of the equipment

Now we will present the suite of equipment used in our project.

2.5.5.1 GSM SIM900a

SIM900A GSM Module is the smallest and cheapest module for General Packet Radio Services (GPRS)/GSM communication. It is common with Arduino and microcontroller in most of embedded application. The module offers GPRS/GSM technology for communication with the uses of a mobile sim. It uses a 900 and 1800MHz frequency band and allows users to receive/send mobile calls and SMS. The keypad and display interface allows the developers to make the customize application with it. Furthermore, it also has modes, command mode and data mode. In every country the GPRS/GSM and different protocols/frequencies to operate. Command mode helps the developers to change the default setting according to their requirements [34].

Figure 2.8: Sim900A [35]

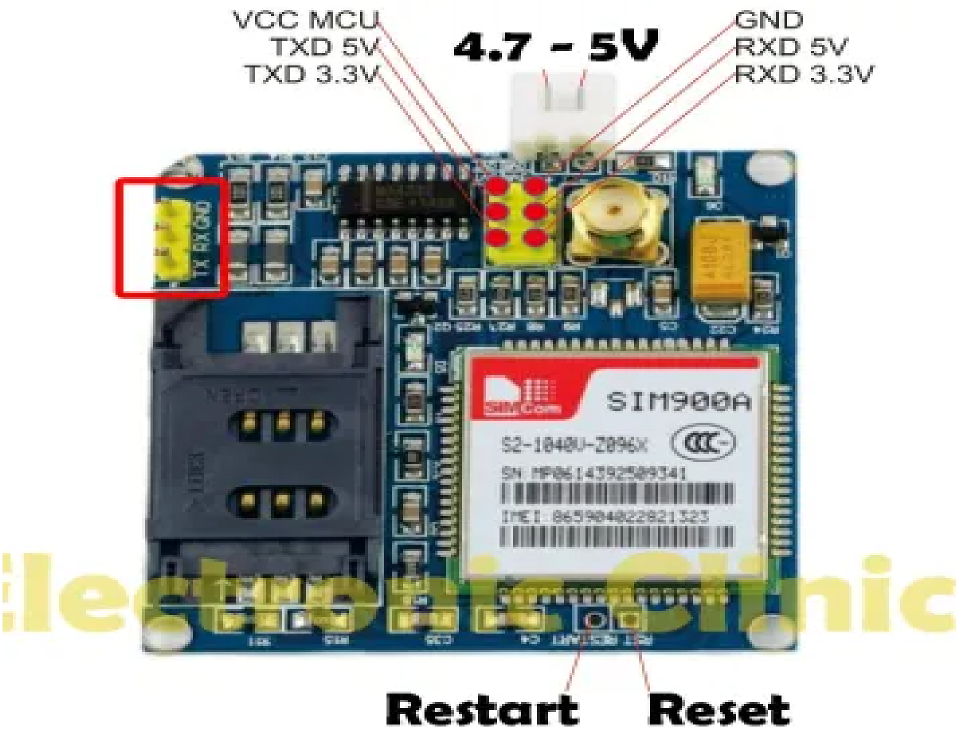

Figure 2.9: GSM Sim900A [36]

2.5.5.2 Relay

Relay is one kind of electro-mechanical component that functions as a switch. The relay coil is energized by DC so that contact switches can be opened or closed. A single channel 5V relay module generally includes a coil, and two contacts like normally open (NO) and normally closed (NC). This article discusses an overview of the 5V relay module & its working but before going to discuss what is relay module is, first we have to know what is relay and its pin configuration [37].

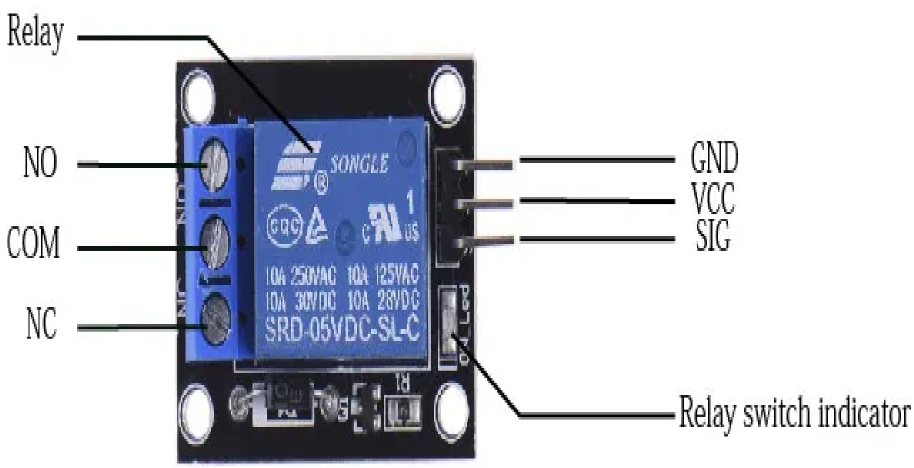

Figure 2.10: Shield relay 5v [38]

2.5.5.3 Breadboard

A test plate, also known as a breadboard or protoboard, is a array of electrically connected holes internally. On this plate it is possible to insert the electronic elements and the wires for the assembly and prototyping of electronic circuits. It is made of two materials, an insulator and a conductor that electrically connects the holes to each other and in a horizontal or vertical pattern. It is used to create and test prototypes of electronic circuits before arriving at the mechanical printing of the circuit in comercial production systems.

The objective is to be able to try our projects on it in a simple way being totally functional, and also to be able to easily modify them if it proves necessary [39].

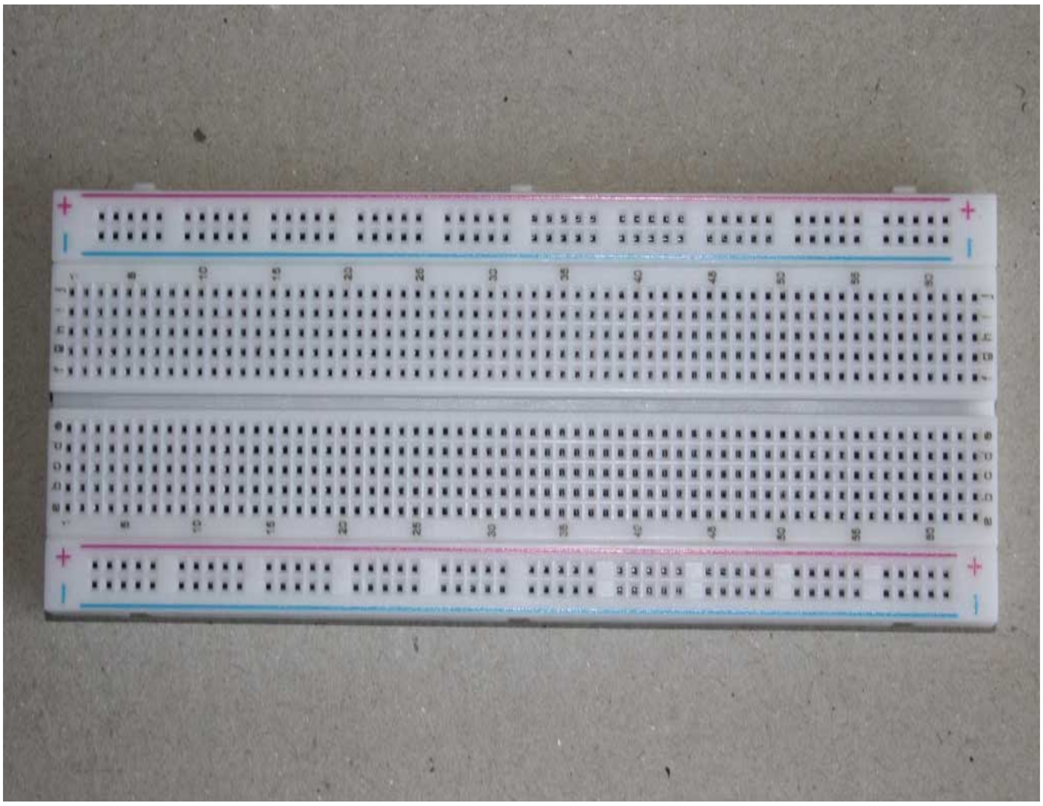

Figure 2.11: Breadboard

2.6 Conclusion

We presented in this chapter a survey on smart agriculture. Its applications are based on the Internet of Things, and the means used in smart farming such as green house, sensors and actuators to help farmers manage their farms more effectively and at the same time their income.

Finally, IoT is expected to help the agricultural sector to meet food demand.

CHAPTER 3

Simulation and Realization

Sommaire

3.1 Introduction

After explaining the theory and equipment needed for our project, we. We will begin this chapter with different stages of design and implementation from our system.

First, we separate the five services proposed Our system, with connected sensors and different catalysts. Then we offer the complete outline with the app Finally, we explain the results.

3.2 Simulate

3.2.1 Proteus

Proteus is a software suite for electronics. Developed by the company Labcenter Electronics, the software included in Proteus allows CAD in the electronic field. Two main programs make up this software suite: ISIS, ARES, PROSPICE and VSM.

This software suite is well known in the field of electronics. Many companies and training organizations (including high school and university) use this software suite. Besides the popularity of the tool, Proteus has other advantages

Package containing easy and fast software to understand and use The technical support is efficient Virtual prototype tool reduces hardware and software costs when designing a project [40].

3.2.2 Tinkercad

Tinkercad is a free online 3D modeling program that runs in a web browser, known for its simplicity and ease of use. Since it was published in 2011, it has become a popular platform for creating models for 3D printing as well as for teaching solid geometry in schools [41].

3.2.3 Step 1

In the first step, we drew up a scheme using Proteus program for arduino uno and dht11 sensor with lcd screen 16*2.

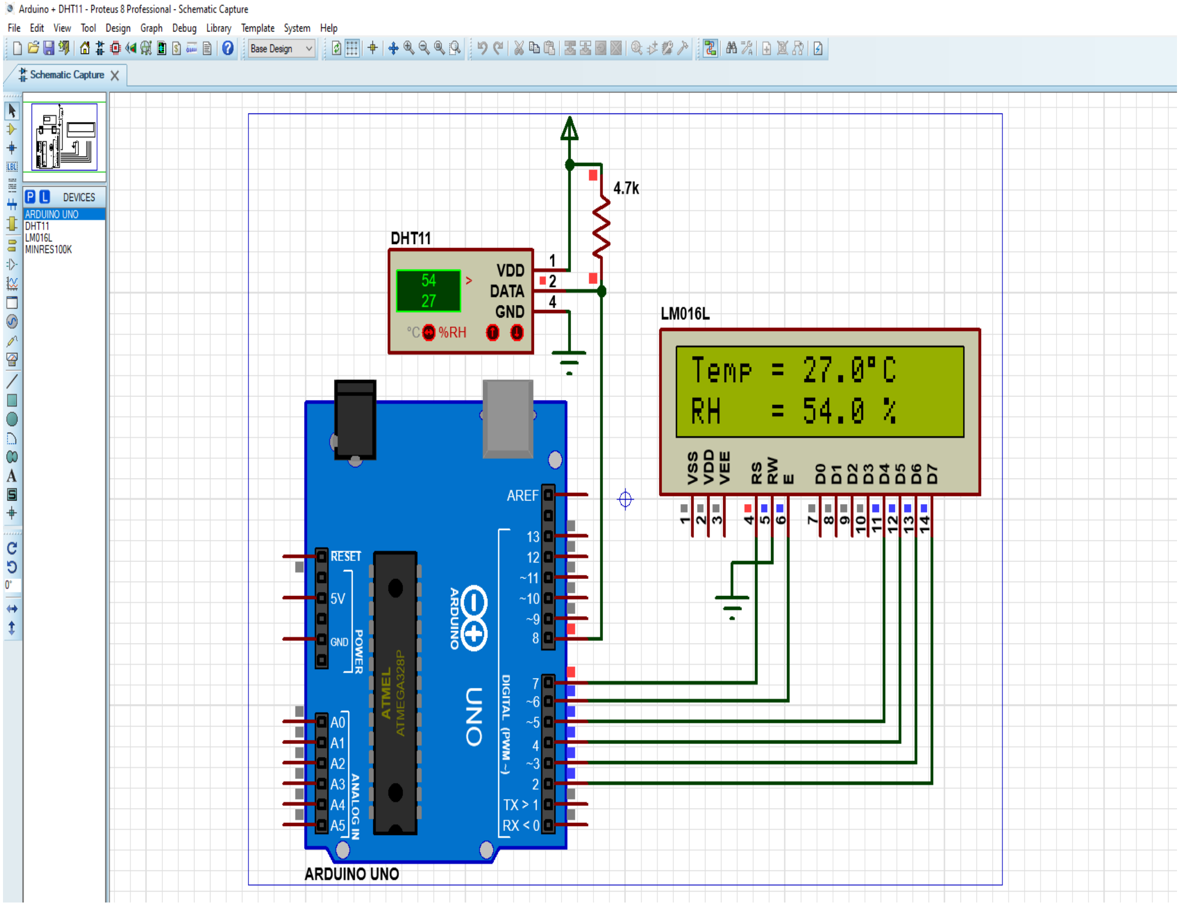

Figure 3.1: Simulate dht11

Table 3.1: The different DHT11 and LCD connections and circuit pin numbers

System	Pin system	Arduino pin
DHT11	Data	8
	Vcc	5v
	GND	GND
LCD 16*2	VDD	5V
	RS	7
	RW	GND
	E	6
	D4	5
	D5	4
	D6	3
	D7	2

3.2.4 Step 2

in the second step we drew up a scheme using Proteus program for arduino uno and soil moistuse sensor with lcd screen 16*2.

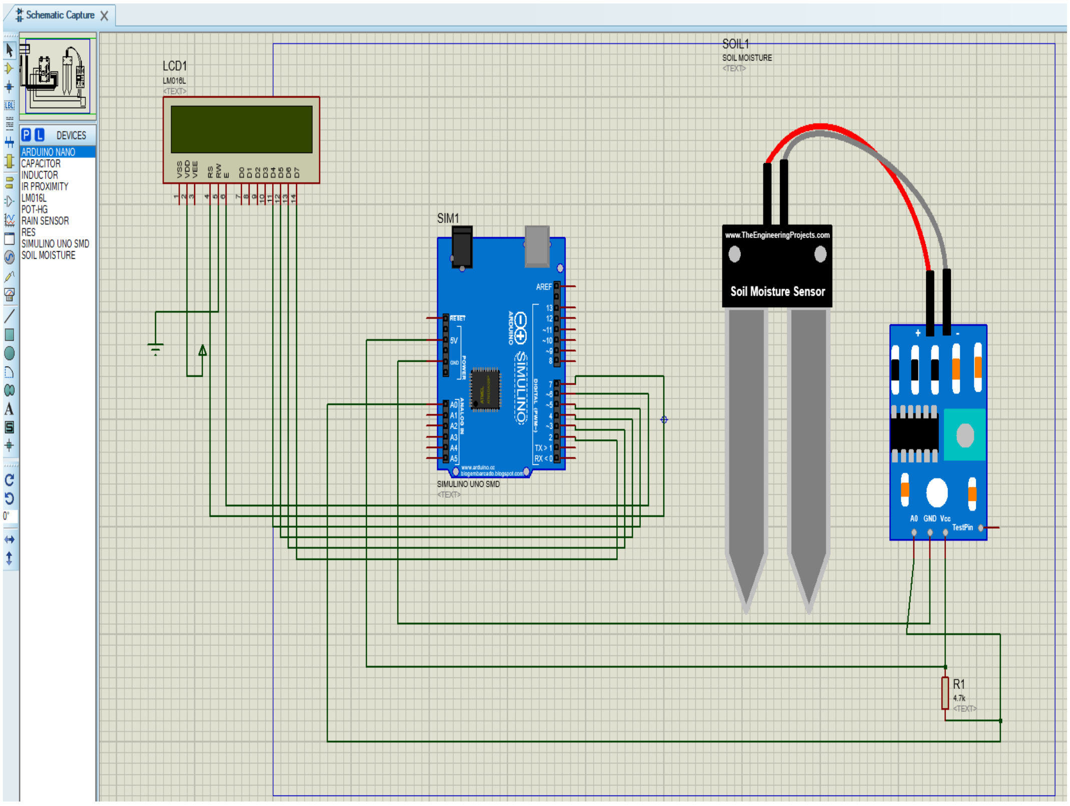

Figure 3.2: Simulate soil moisture

Table 3.2: The different Soil moisture and LCD connections and circuit pin numbers

System	Pin system	Arduino pin
DHT11	Data	8
	Vcc	5v
	GND	GND
LCD 16*2	VDD	5V
	RS	7
	RW	GND
	E	6
	D4	5
	D5	4
	D6	3
	D7	2

3.2.5 Step 3

in the third step we drew up a scheme using Tinkercad program for arduino uno and LDR sensor with LED.

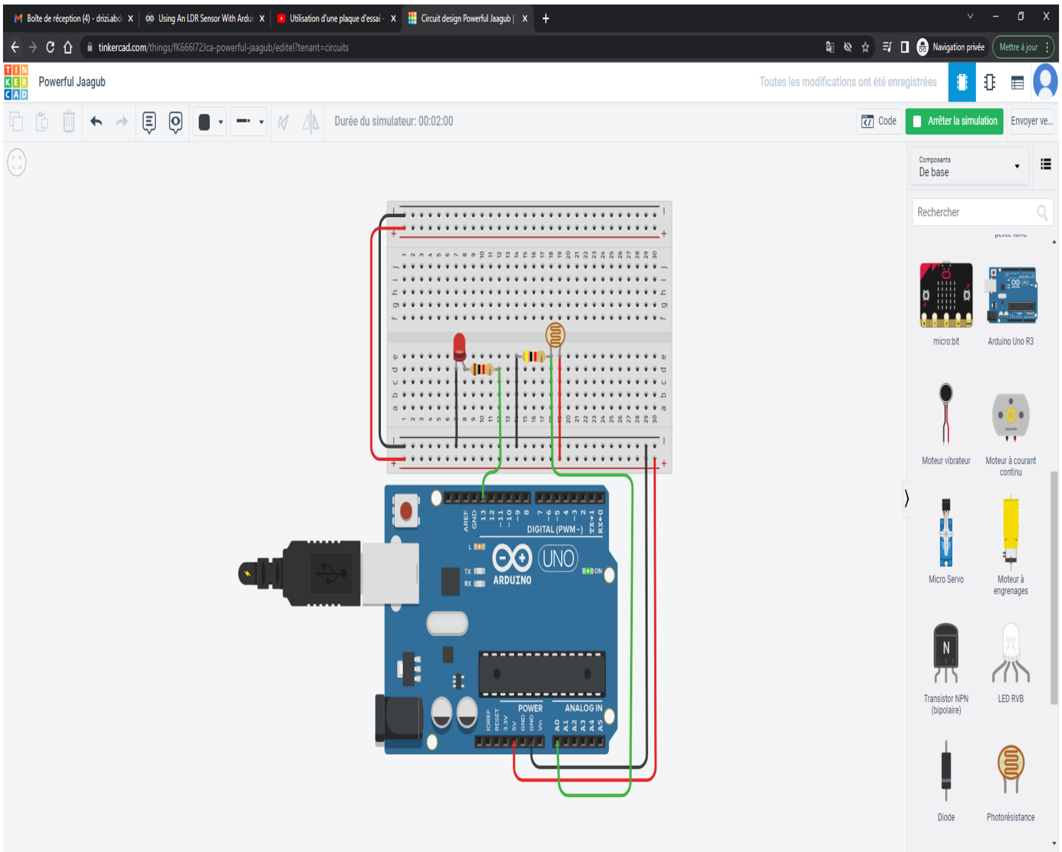

Figure 3.3: Simulate LDR

Table 3.3: The different LDR and LED connections and circuit pin numbers

System	Pin system	Arduino pin
LDR	Data	A0
	Vcc	5v
	GND	GND
LED	Data	13
	GND	GND

3.2.6 Step 4

In Step 4 we drew scheme using proteus program for arduino uno and GSM Sim900D

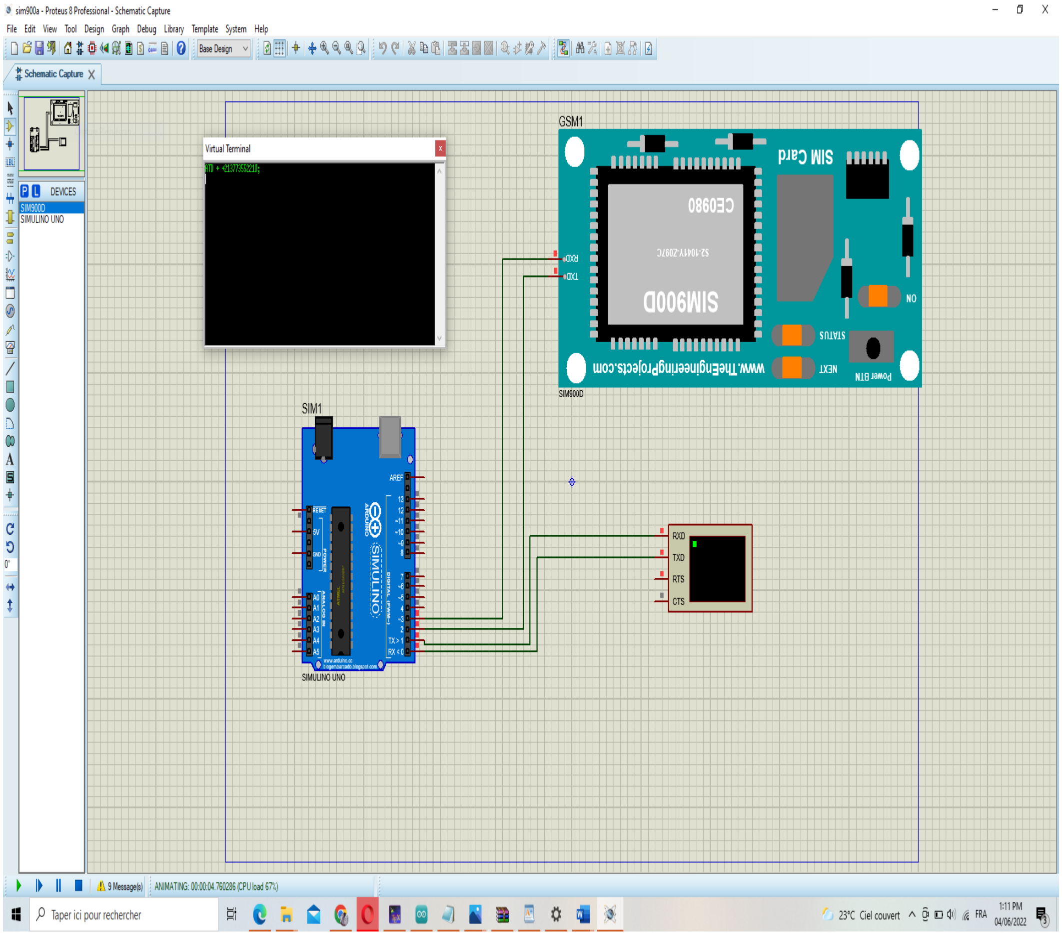

Figure 3.4: Simulate GSM sim900A

Table 3.4: The different Sim900A connections and circuit pin numbers

System	Pin system	Arduino pin
GSM Sim900A	Rx	2
	Tx	3
	Vcc	5v
	GND	GND

3.2.7 Final step

In the last step, we have developed the final outline of all sensors and some actuators including lighting, cooling chopper and water pump using Proteus program.

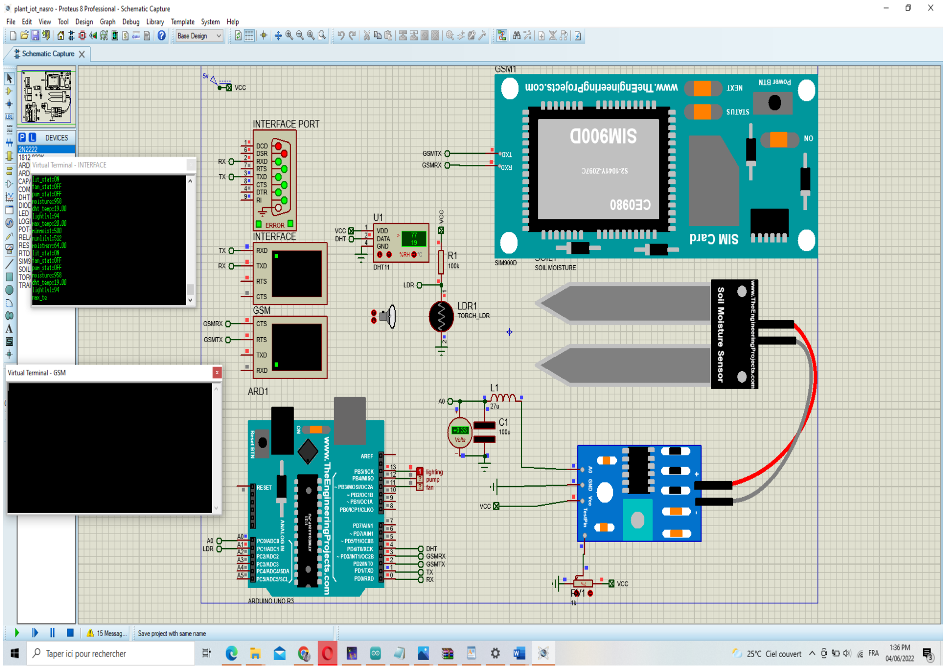

Figure 3.5: Final simulate

Table 3.5: The different Sensors and actuators connections and circuit pin numbers

System	Pin system	Arduino pin
DHT11	Data	4
	Vcc	5v
	GND	GND
Fan	Data	11
	Vcc	12v
	GND	GND
Soil moisture	Data	A0
	Vcc	5v
	GND	GND
Water pump	Data	12
	Vcc	5v
	GND	GND
LDR	Data	A1
	Vcc	5v
	GND	GND
LED	Data	13
	GND	GND
GSM Sim900A	GSMRX	2
	GSMTX	3
Vertual terminal	Rx	Tx
	Tx	Rx
Interface port	Rx	Rx
	Tx	Tx

3.3 Realization

3.3.1 Step 1

First step we started to install dht11 sensor and lcd 16 * 2 with arduino and add dht11 program to arduino using computer.

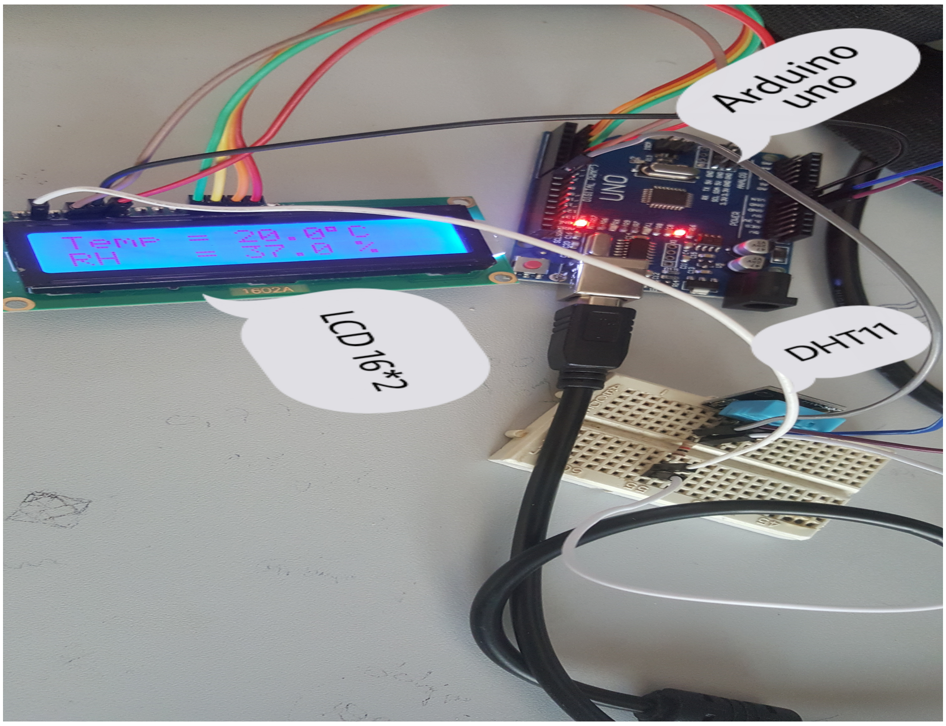

Figure 3.6: Realization DHT11 with LCD screen

Table 3.6: The different DHT11 and LCD 16*2 connections and circuit pin numbers

System	Pin system	Arduino pin
DHT11	DATA	8
	VCC	5V
	GND	GND
LCD 16*2	VDD	5V
	RS	7
	RW	GND
	E	6
	D4	5
	D5	4
	D6	3
	D7	2

3.3.2 Step 2

First step we started to install soil moisture sensor and lcd 16 * 2 with arduino and add soil moisture program to arduino using computer.

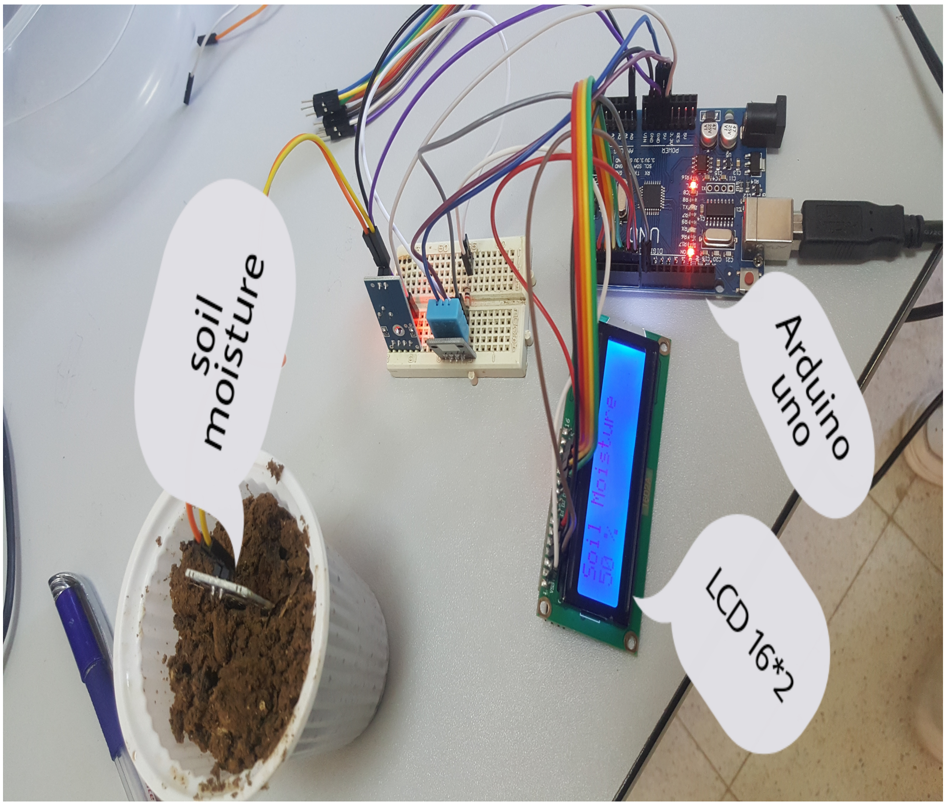

Figure 3.7: Realization soil moisture with LCD screen

Table 3.7: The different Soil moisture and LCD 16*2 connections and circuit pin numbers

System	Pin system	Arduino pin
soil moisture	DATA	A0
	VCC	5V
	GND	GND
LCD 16*2	VDD	5V
	RS	7
	RW	GND
	E	6
	D4	5
	D5	4
	D6	3
	D7	2

3.3.3 Step 3

in the third step we started to install LDR sensor and LED with arduino and add LDR program to arduino using computer.

Figure 3.8: The different LDR sensor and LED connections and circuit pin numbers

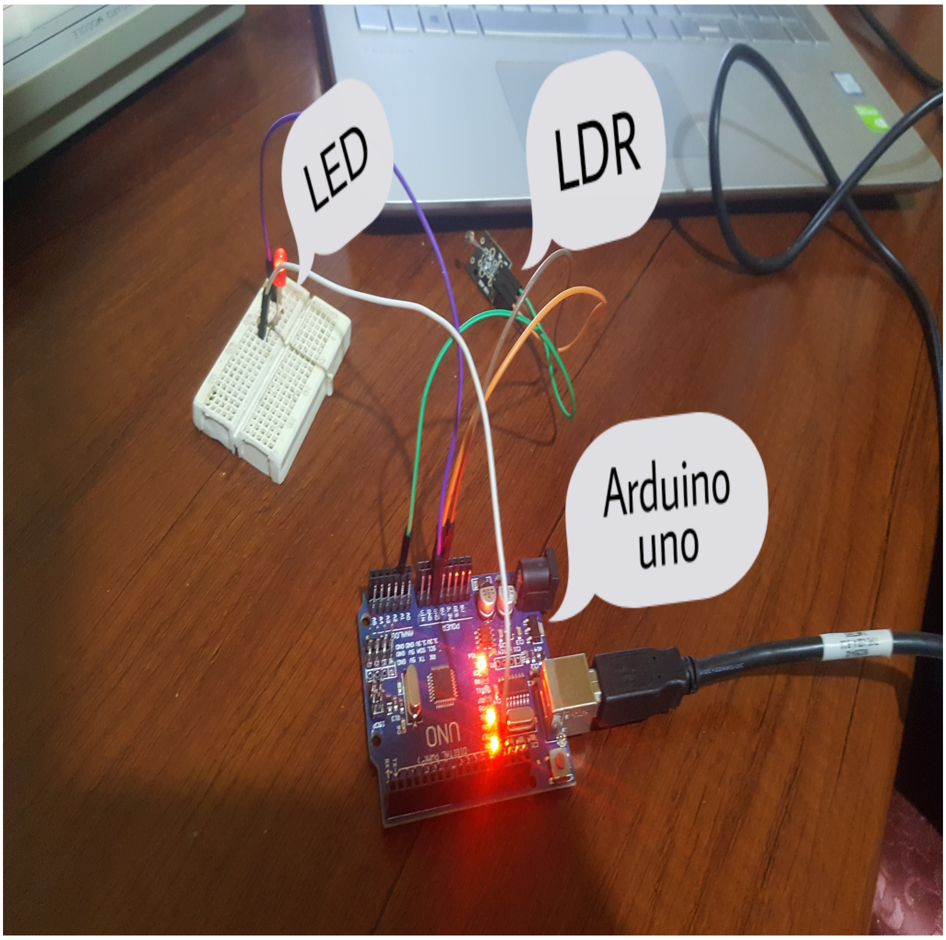

Figure 3.9: Realization LDR sensor

3.3.4 Step 4

In Step 4 we started to install GSM Sim900A with arduino and add GSM program to arduino using computer.

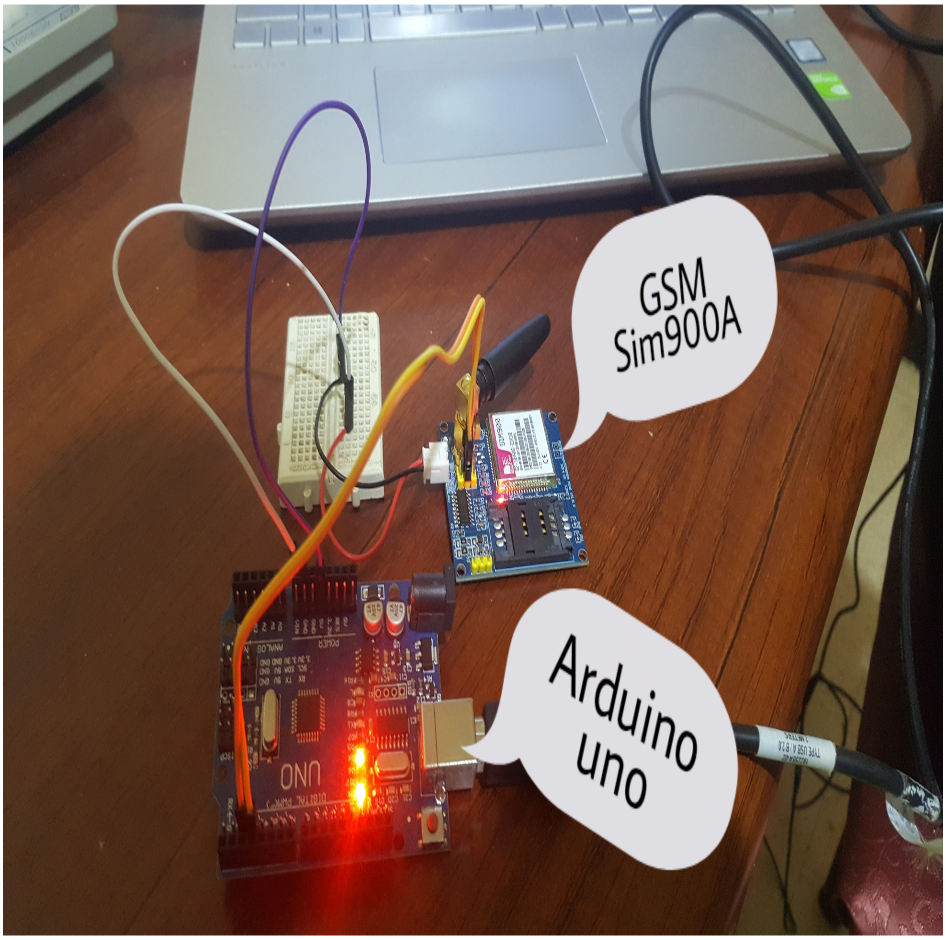

Figure 3.10: Realization GSM Sim900A

Table 3.8: The different GSM Sim900A connections and circuit pin numbers

System	Pin system	Arduino pin
GSM Sim900A	RX	2
	TX	3
	VCC	5V
	GND	GND

3.3.5 Final Step

In the last step we completed the final plan by installing all sensors and actuators inside the Greenhouse.

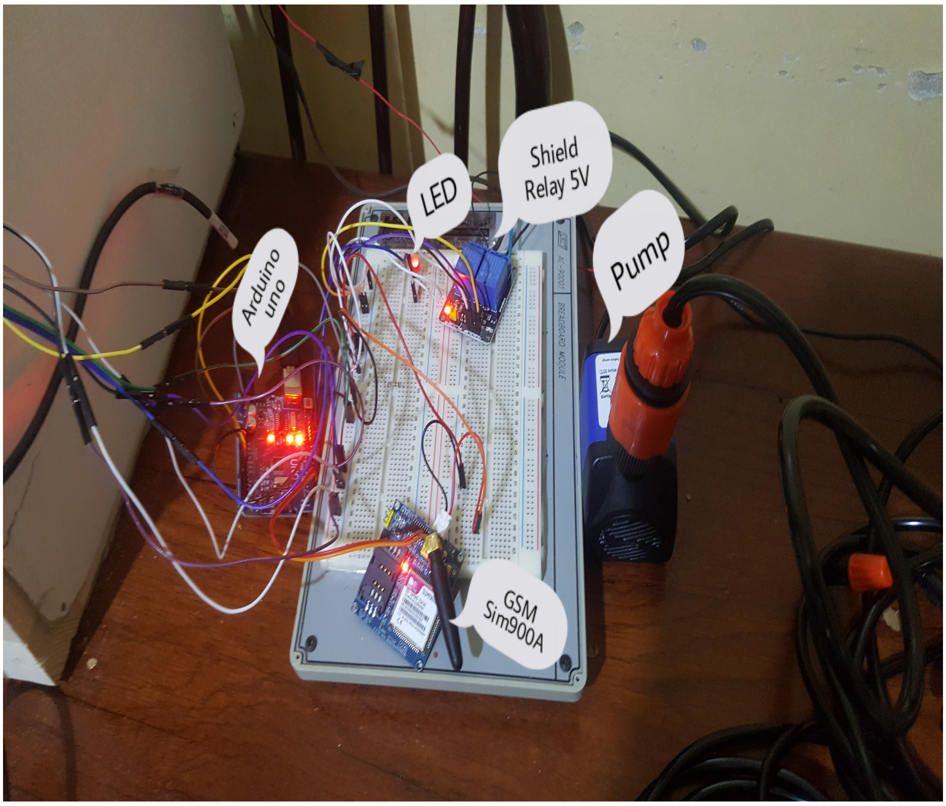

Figure 3.11: Final realization

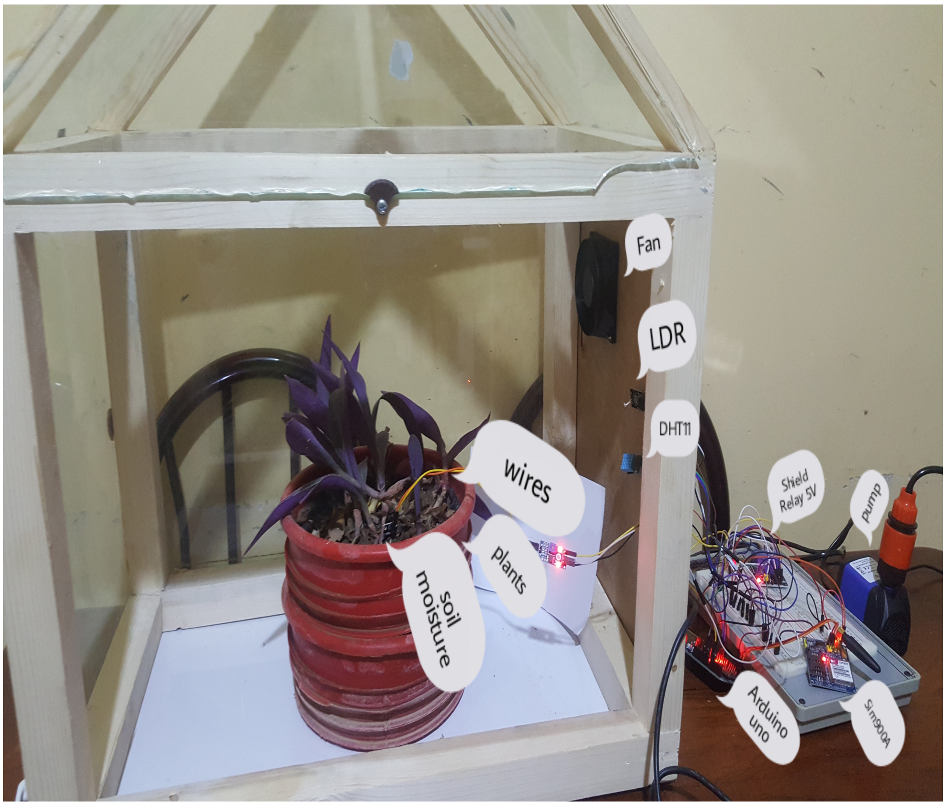

Figure 3.12: Final realization with greenhouse

Table 3.9: The different Sensors and actuators connections and circuit pin numbers

system	pin system	arduino pin
LDR	DATA VCC GND	A1 5V GND
LED	DATA GND	13 GND
DHT11	DATA VCC GND	4 5V GND
Fan	DATA VCC	12 12V
Soil moisture	DATA VCC GND	A0 5V GND
Water pomp	DATA VCC	11 220V
GSM Sim900A	RX TX VCC GND	2 3 5V GND
Relay	VCC GND	5V GND

3.4 Software

In our project we needed several programs to run and control Arduino and interface to see the results close or remotely Using computer or phone.

3.4.1 Program arduino

3.4.1.1 Integrated Development Environment (IDE)

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them [42].

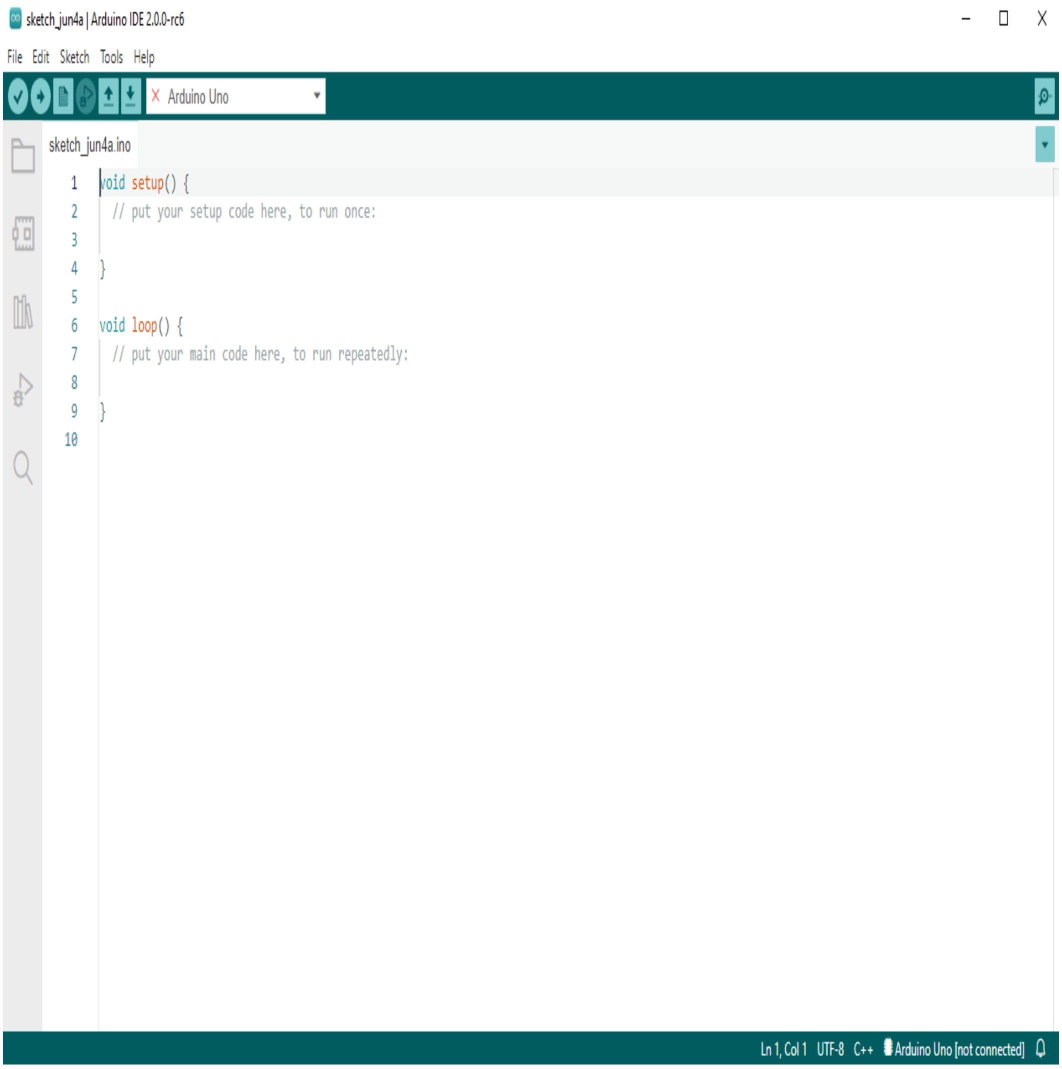

Figure 3.13: Arduino IDE

3.4.2 Interface

3.4.2.1 Processing

Processing is a flexible software sketchbook and a language for learning how to code within the context of the visual arts. Since 2001, Processing has promoted software literacy within the visual arts and visual literacy within technology. There are tens of thousands of students, artists, designers, researchers, and hobbyists who use Processing for learning and prototyping [43].

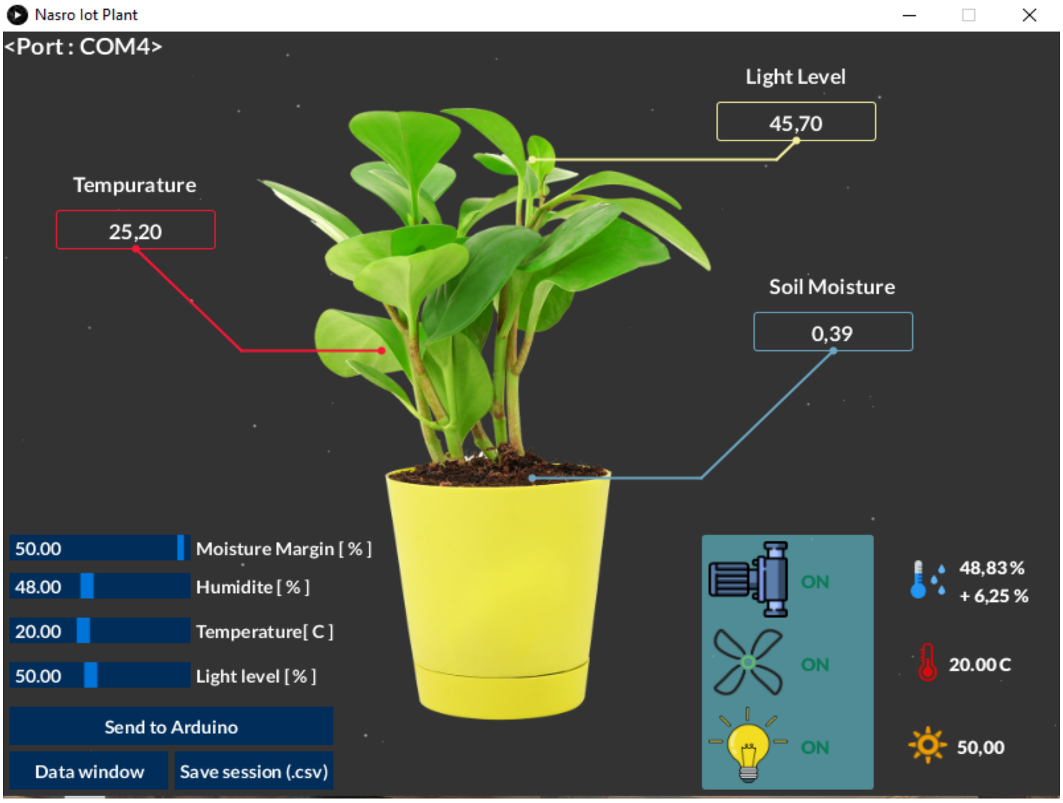

Figure 3.14: Interface smart agriculture

data Table

date et heure	temperature souhaitee	temperature	ventilateur	humidite	humidite de sol souhaitee	humidite de sol	pompe d'eau	niveau de luminosite	LDR	lampe
2022/06/06 02:30:09	0.0	0.0	0	null	0.0	3.0	0	0.0	0.0	0
2022/06/06 02:30:10	0.0	0.0	0	null	0.0	8.0	0	0.0	0.0	0
2022/06/06 02:30:10	0.0	0.0	0	null	0.0	8.0	0	512.0	0.0	0
2022/06/06 02:30:10	0.0	0.0	0	null	0.0	4.0	0	512.0	0.0	0
2022/06/06 02:30:10	20.0	0.0	0	null	0.0	4.0	0	512.0	0.0	0
2022/06/06 02:30:10	20.0	0.0	0	null	0.0	4.0	0	512.0	0.0	ON
2022/06/06 02:30:10	20.0	25.2	0	null	0.0	4.0	0	512.0	0.0	ON
2022/06/06 02:30:10	20.0	25.2	0	null	500.0	4.0	0	512.0	0.0	ON
2022/06/06 02:30:10	20.0	25.2	ON	null	500.0	4.0	0	512.0	0.0	ON
2022/06/06 02:30:10	20.0	25.2	ON	null	500.0	4.0	0	512.0	476.0	ON
2022/06/06 02:30:10	20.0	25.2	ON	null	500.0	4.0	ON	512.0	476.0	ON

Figure 3.15: Table save data

3.5 Conclusion

In this proposed smart farming system, automatic mode of operation is designed for farming purposes. With this type of device, no additional help is needed. it's working Ideally in the absence of the owner by detecting soil moisture through the humidity sensor and temperature through the heat sensor and lighting condition through the light sensor and these sensors work automatically with actuators, a water pump to reduce soil moisture and a fan to reduce the increasing temperature and Automatic lighting according to the light sensor. All this is managed by the Arduino program according to the owner. They can also be sent Alert messages to the farm owner's phone via a SIM card. All these settings can be seen through a dedicated interface via the computer.

General conclusion

OUR project is to build "smart" automated farming for them Agricultural Production. This project allowed us to deepen our theoretical knowledge and Some practical implementation experience.

We also have the opportunity to learn Design and use a variety of hardware and software. We start our work with an overview of the Internet of Things (definition of the Internet of Things, its architecture, different application areas) and then we introduce the concept of smart agriculture Agriculture (its interests, its different types). Then we introduce the devices used in hardware: the different types ARDUINO boards and basic equipment in our project and their characteristics and their connections. On the software side, we have software (IDE FRITZING and processing and proteus).

Finally, we start the different phases of the project implementation Operates the four services provided by our system (temperature and humidity control, automatic watering and lighting) then we have The results obtained after each test provided are explained. Over the next few years, we hope that investor confidence will increase A Connected Smart Agriculture Project That Meets Nationwide Coverage Needs food needs of the country.

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