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Design of An IOT Platform Based on Sensor-Actuator Networks for System Automation.

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Dedicate

I dedicate this piece of work to my supportive and outrageously one. my uncle Mancer Mokhtar, who paved me the path to further my studies and to complete my master degrees. You make known to me the path of life, I am really clear about what my life mission is now and all these were not possible without supports of you. Dear uncle, I just thought I'd drop you a line and tell you how much you mean to me. Thanks, for doing all the right things at the right time and most of all... for being MY "KHALOU".

Ahlem.

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Last, but not the least, I thank my loving family, they are the recipients of my heartfelt gratitude for their continuous devotion during the entire period of my life and my studies. Their unfailing support constitutes the basis of my success. Further, I would like to acknowledge my lovely sister Feriel AZIZ for her endless support. She reminds me always that my research should be useful and serve good purposes for human kind, also she has provided me invaluable lessons and values that have created my passion for sustainability.

Sincerely;

Ahlem Aziz

Abstract

In recent times, the internet has grown considerably, in our day the use of the internet is not limited to the management of networks, but also has extended to the management of things, or so-called Internet of Things. Home automation is considered one of the most prominent fields that use this new technology, now it's called Smart Home. In fact, the smart home market is expected to grow in demand, due to the availability of comfort and protection equipment, as well as the decreasing of energy costs. Within the framework of this research project, we aim to integrate Internet of Things technology into a smart home, using open source hardware and software, and focusing on four interdependent elements, namely:

- Central Organ.
- Sensors scattered in the house.
- Actuators.
- Command interface.

These four elements could make the house smart.

Keywords: Smart Home, Internet ofThings, Raspberry Pi, Arduino, Home Automation, Sensor, Actuator, Command Interface.

Resume

Nowadays, the smart city is a topic that has attracted the attention of many researchers and engineers due to its pervasive and vast effect on everyday life. My end-of-study project consists of an Internet-based control device for a smart home, called the Internet of Things. i have linked three distinct devices with a different programming language in this project to have the user interface, the top-level unit is the smartphone / computer / tablet. On the other hand, the second host computer is the Raspberry pi 3, which links the user via the Internet, using a server (server / client), to different devices in the home. The third and final level is the Arduino which receives orders from the user through the internet to the user through the Raspberry pi.

Summary

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List of Abbreviations

List ofAbbreviations

APL	**A**pplication **L**ayer
ADC	**A**nalog-**T**o-**D**igital **C**onverter
DSSS	**D**irect **S**equence **S**pread **S**pectrum
FFD	**F**ull-**F**unction **D**evice
FHSS	**F**requency **H**opping **S**pread **S**pectrum
H A	**H**ome **A**utomation
HAN	**H**ome **A**rea **N**etwork
HTML	**H**ypertext **M**arkup **L**anguage
HTTP	**H**ypertext **T**ransfer **P**rotocol
HVAC	**H**eating, **V**entilation **A**nd **A**ir **C**onditioning
IDE	**I**ntegrated **D**evelopment **E**nvironment
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers
IOT	**I**nternet **O**f **T**hings
ISM	**I**ndustrial, **S**cientific, **A**nd **M**edical
IP	**I**nternet **P**rotocol
LR-WPAN	**L**ow-**R**ate **W**ireless **P**ersonal **A**rea **N**etwork
M2M	**M**achine - **T**o - **M**achine **C**ommunication
MAC	**M**edium **A**ccess **C**ontrol
MEMS	**M**icro **E**lectro **M**echanical **S**ystems
NWK	**N**etwork **L**ayer
OSI	**O**pen **S**ystems **I**nterconnection
PC	**P**ersonal **C**omputer
PHY	**P**hysical **L**ayer
PIN	**P**ersonal **I**dentification **N**umber

QoS **Q**uality **O**f **S**ervice

RF **R**adio **F**requency

RFD **R**educed **F**unction **D**evice

RFID **R**adio **F**requency **I**dentification

RX **R**eceiver

S H **S**mart **H**ome

TRX **T**ransceiver

TX **T**ransmitter

UART **U**niversal **A**synchronous **R**eceiver/**T**ransmitter

USB **U**niversal **S**erial **B**us

WEP **W**ireless **E**quivalent **P**rivacy

Wi-Fi **W**ireless **F**idelity

WLAN **W**ireless **L**ocal **A**rea **N**etwork

WPAN **W**ireless **P**ersonal **A**rea **N**etwork

WSAN **W**ireless **S**ensor **A**nd **A**ctuator **N**etwork

WSN **W**ireless **S**ensor **N**etwork

ZDO **Z**igBee **D**evice **O**bject

DHT11 **D**igital **H**umidity **A**nd **T**emperature **S**ensor.

FTDI **F**utur **T**echnology **D**evices **I**nternational

Ido **I**nternet **D**es **O**bjets

LED **L**ight **E**mitting **D**iode

LDR **L**ight **D**ependent **R**esistor

General Introduction

General Introduction

Smart homes have the ability to increase the comfort of the inhabitant through interfaces to control light, temperature or various electronic devices. It is possible to put the heating devices on standby when residents are away or adapt automatically the use of electrical resources according to the needs of residents in order to save energy resources. In addition, the application aspect of new communication and information such as Android applications, emails, etc., the security aspect is all the more important in the daily life of individuals. This is made possible by systems capable of anticipating potentially dangerous situations or of reacting to events involving endangering the integrity of people**.**

Problematic:

The home is a particularly important place for everyone, etymologically it is from where you stay, where you come back, from the place of sedentarization. The majority of individuals, and more particularly the elderly, spend a lot of their time at home, hence the influence considerable habitat on the quality of life. Improving the feeling of security and comfort in the habitat therefore appears to be an element of vital importance. These last years, it has been applied in the creation of smart homes with the aim of improving living conditions of people when they are at home. A smart home is defined as a residence equipped with ambient computer technologies which aims to assist the resident in the various situations of domestic life.According to an article titled (Word Population Prospect 2017) that in 2017, approximately 962 million people are aged 60 and over, representing 13% of the world's population. This rate increases by about 3% per year and by 2050 are in need of house applications smart homes that simple homes can't.

- The lack of security, the difficulty of controlling all the needs of the house at the same time.

Objective:

One of the main goals for this project is to make a prototype of a smart home that is well secured and easy to control anytime and anywhere, control will be remoted by web page guaranteeing a rapid response to user needs.The writing is divided into four main chapters:

The IoT and its various aspects are defined in chapter one.In the second chapter, i gave the general aspects of a smart home as well as its advantages and impact on people's lives. i have also introduced the different concepts related to research areas, home automation in general.chapter three is devoted to the project description of these essential elements, as well as the various electronic components used and reserved for the hardware and software part of this work.Chapter four is dedicated to the creation of the command interface, the web page.

I will end this dissertation with a general conclusion and perspectives.

Chapter I:
Internet of Things (IOT)

Abstract:

The advancement in technology has depreciated the size of the gadget by leaps and bounds during the last few decades. The usage and dependence of human beings on electronic gadgets has grown exponentially with the passage of time. The substantial scaling of such kind of devices gave birth to a new technology called 'Internet of Things' (IoT) in the year 1999. The concept of IoT adheres to the need of round the clock and ubiquitous connectivity. This allows for the establishment of Interconnectivity and interactions among those devices. IoT has carved out the path for new innovations leading to novel type of communication among humans and things. The interactions would enable the realization of services utilizing these resources for improving the quality of life. This chapter is an attempt in this direction with the basic introduction of IoT, basic architectures, challenges and the plethora of services provided by IoT.

1.1 Introduction

The modern living trends of the society have turned out to be addictive to 24 × 7 connectivity. In order to provide this round, the clock connectivity, the notion of 'Internet of Things (IoT)' came into existence after a gap of almost four decades following the invention of Internet. Internet can be defined as a massive pool of applications and protocols built on top of network of computers. In today's era, ubiquitous computing and seamless connectivity is no more a challenge. Earlier the concept of connectivity was restricted to the interactions between humans and machines. But gradually with the advancement in technology of connectivity, today one can relate connectivity between anything as in IoT. The most important feature of IoT is that it can transform an object into smart object by providing sensing, actuating, computing and communicating capability to the object the huge workspace for IoT is fueled by the smooth integration of the technologies like digital electronics, microelectromechanical system and nanotechnology etc. The functionality of the objects and technologies together provide an environment where the sharing of the information can be carried out across the varied platforms. IoT is carving out its path in all the domains and is on the verge of becoming Internet of Everything.The term "Internet of Things" was first coined by Kevin Ashton with contextual reference to supply chain management in the year 1999. The term was further redefined by various researchers to include applications like transport, mining, healthcare, and utilities etc.

The tenure which marks the emergence of IoT is stated to be during 2008–2009. In this period, the human populace began to be eclipsed by network allied devices.

With the passage of time the number of linked "things", which included human and gadgets showed exponential escalation. This carved out the necessity for "Internet of Things". IoT can be defined as the usage of internet that bridges the gap between varied services and things including humans. As per the conceptual framework of 2020, IoT can be expressed in terms of mathematical language as:

IoT = Sensor + Network + Data Services

IoT can be treated as the extension of the contemporary internet services to enclose each existing object. These objects can be living or nonliving thing which can appeal for a service or offer a service. This global connectivity has been possible by embedding sensors, actuators, microcontrollers etc. in the things, which facilitates the Internet to become more persistent. The miniaturization and advancements in the field of electronics and computers has made the materialization of IoT visible in many fields during the last few years. Some major applications of IoT are depicted in Fig. 1.1.

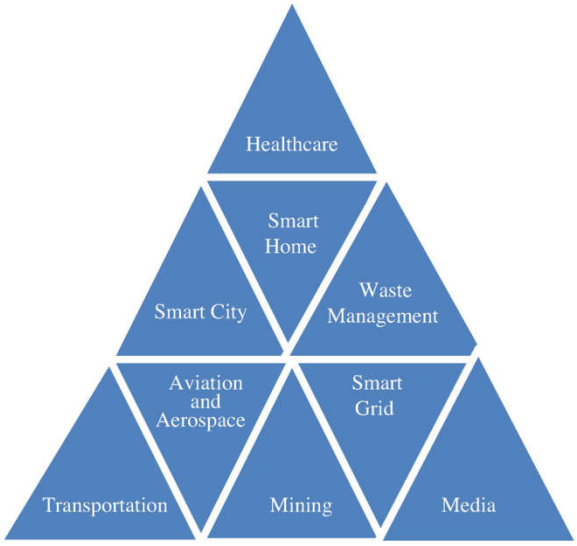


Fig. 1.1 Domains supported by IoT. (Alhafidh and Allen 2016).

1.2 Historical Development:

Communication has been an integral part of our day to day life. It can be defined as the transmission of information from one entity or object (sender) to another entity or object (receiver) with the help of some medium. In the early age, smoke signals, drum beats, chirping

of birds, waving of handkerchiefs or flags were used as means of communication. Some other modes of communication were pigeons, hydraulic semaphore system, chain of beacons at the hilltops etc. Later electric telegraph came into existence in 1816 followed by the communication of audio messages using telephone in 1870s. In order to improve the range of communication, the invention of radio waves was made in 1880s. With the novel inventions of different modes of communication, the use of radio and televisions for communication was termed as 'Telecommunication' (Cohen-Almagor 2011; Leiner et al. 2009). The word telecommunication consists of two words, tele means 'from far distances' and communication means 'to share information'. In other words it means communication at a distance. The next innovation in this field highlighted in the late 1890s in the form of Fax (facsimile). This mode of communication helped in the transmission of scanned printed material over the telephone connected to printers or some other input device. This was also called telecopying. It worked by scanning the original document with the fax machine. The machine processed the contents of both image and text in the form of a single fixed graphic image. This image was converted into a bitmap and transmitted in the form of audio-frequency tones through the telephone system. The receiving fax machine interpreted the tone and reconstructed the image by printing it on the paper. In 1940, the concept of a better mode of communication came into existence, where some calculations were done on one computer and the result was displayed on the other remote computer. This concept of a main computer and the other connected remote computers became popular in 1950s. Later in 1960s, researchers were on toes and investigated a new technology called packet switching. Packet switching breaks the data into small chunks and sends it to different computers. This differed from the previous means of communication as it would not pass the data through a centralized mainframe system. However, it was not until the personal motive of Department of Defense's Advanced Research Projects Agency (ARPAnet) that the concept of 'networking' came into existence (Leiner et al. 2009). In this project, a network of military computers was formed for communication in order to survive a disastrous nuclear attack. This small network of defense computers laid the first stone of the world of INTERNET. In the next phase of development around 1970s, protocols were designed to connect devices to the network of computers. This protocol was termed as the Transmission Control Protocol and Internet Protocol (TCP/IP).

offered standards stating how the transmission could be carried out in a network of computers. The paradigm then shifted towards the concept of network of networks. Finally, the term 'Internet' was coined by Vinton Cerf, Yogen Dalal and Carl Sunshine in 1974 (Cohen-Almagor

2011). Internet can be interpreted as a union of two terms 'Inter' and 'net', meaning network between devices.

Internet can be defined as the global connection of computer networks that transmits data using TCP/IP. The popularity of internet grew slowly and steadily as its digitized access, digitized business, digitized world and finally is digitizing everything including people, process and things as shown in Fig. 1.2.

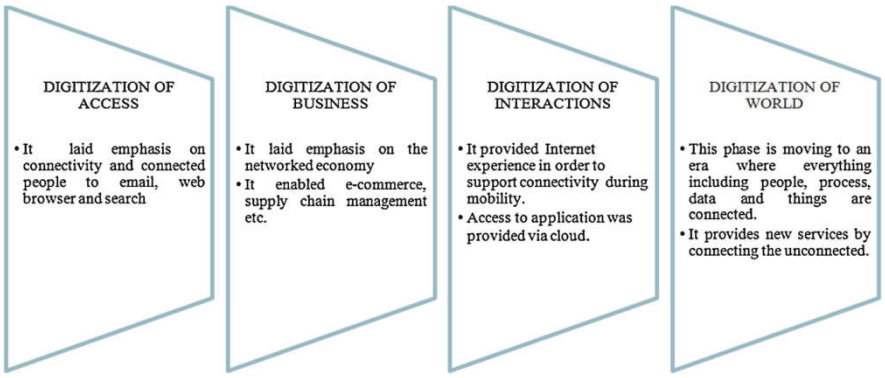


Fig. 1.2 Evolutionary phases of the internet. (Perera et al. 2014).

1.3 Internet of Things (IoT) :

Internet of Things endeavors to provide an epoch wherein digital and physical entities will be able to seamlessly communicate to provide a new domain of applications and services. Many applications and features we use these days prove as an ascending wave in the computing era. In the imminent time, the Internet will have its existence as flawless connection of objects and network. IoT can well be explained by a Venn diagram as shown in Fig. 1.3, where two different sets namely Information Technology (IT) and Operational Technology (OT) unite to form Internet of Things. The IT domain consists of 'things 'like servers, databases and applications. These 'things' run on the network and are controlled by IT. IT assists secure connectivity of the data and gadgets for smooth flow within the vicinity of an organization. On the other hand, OT is generally concerned with the industrial work and contains 'things' like sensors and devices connected to the machines or some other equipment. It supervises devices and processes on physical systems (Perera et al. 2014). These systems incorporate industries, roadways systems, production services etc. Prior to the existence of IoT, the concept of IT and OT were considered to be poles apart that worked independently and had little requirement to interact with each other. IoT has changed this paradigm to some extent and is still working in order to collaborate IT and OT into a single concept. The concept of IoT focuses on an interconnected world in which every "thing" is connected to any "thing".

The obligatory part of IoT is to provide smart association with the in-use network and context-aware computations using network assets (Singh et al. 2014). Some requisites for achieving the stated motives are: (a) a mutual discernment of the circumstances of the gadgets and their associated users, (b) the investigative tools that seek for autonomous and smart actions, and (c) software architectures and pervasive communication networks to process and convey the contextual information to where it is relevant.

Internet is the actual backbone that has carved out the path for ubiquitous computing. It enables inter device communication across the globe. The two basic pillars for the growth of ubiquitous computing are: Internet of Things and Cloud Computing. Cloud computing provides reliable service by providing virtual storage and computing zone for processing. On the other hand, Internet of Things provides a seamless connectivity between objects using RFID, which provides a unique code to each and every object (Chemudupati et al. 2012). All the work carried out in the background of IoT and cloud computing are completely hidden from the user. The smart environment consisting of the sensor-actuator-internet framework has given rise to a common operating picture (COP), where the generated data and information is efficiently shared across varied platforms and applications. Internet of Things is a shift towards ubiquitous computing evolved due to the presence of Wi-Fi and ad hoc wireless networking. However, for the successful and widespread use of Internet of Things, networking exemplar has to step out of its boundary of mobile computing. There are ample of technologies that exist and some that are about to spring up to interconnect the devices. The foremost goal of Internet of things is to make the environment intelligent. The existence and functioning of IoT environment is possible due to the concept of digital electronics, microelectromechanical system and nanotechnology etc. All the said technologies converge to provide the ability of INTERNET OF THINGS (IoT) INFORMATION TECHNOLOGY OPERATIONAL TECHNOLOGY Fig. 1.3 Venn diagram 1 Foundation of IoT: An Overview 8 capturing data, providing connectivity, computing and storing data for usage. The sensors, actuators, RFID, Bluetooth and Wireless Sensor Network etc. are embedded into physical items to turn them into ‘SMART’ objects thus leveraging the connectivity amongst the actual and implicit realms (Yassein et al. 2017). Context related computations and well-tuned connectivity with existing networks are the prime requisites for the IoT. As humans use Internet to communicate, the “smart things” use the Internet of things to communicate. Eventually, the quantity and quality of data collected and analyzed to land up to a solution determine the smartness of the object.

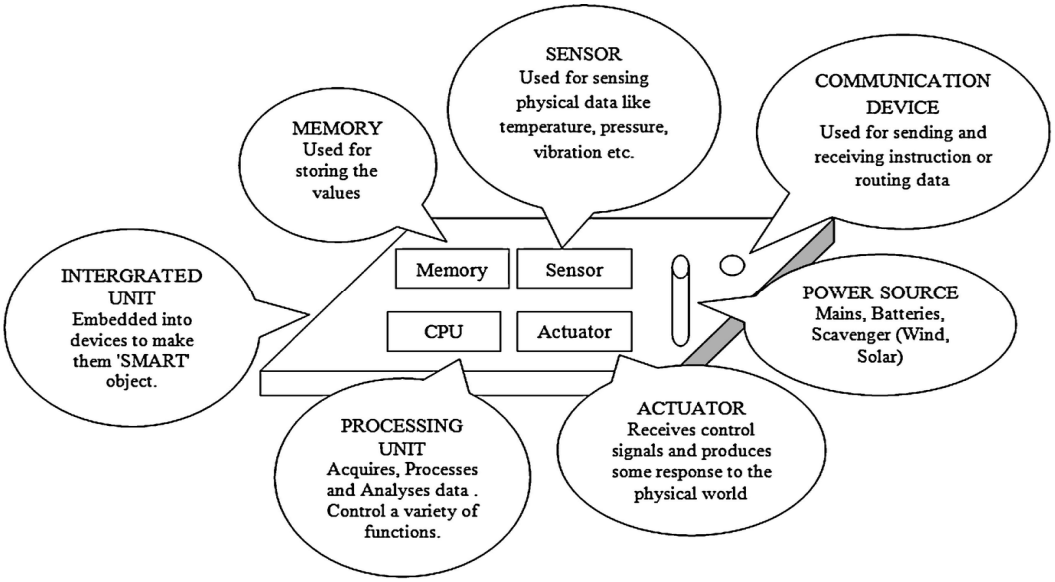


Fig. 1.3 Components of a Smart Object.

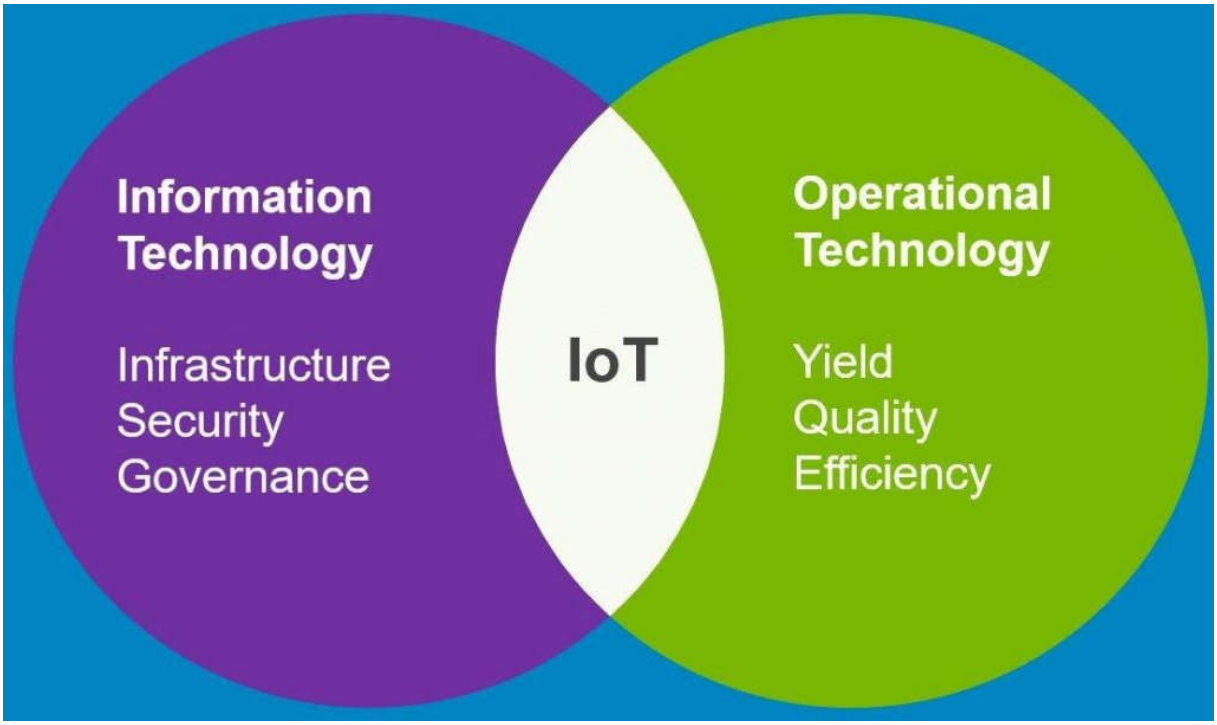


Fig. 1.4 Venn Diagram.

1.4 Smart Object :

In the late 1980s, tremendous efforts were made by the researchers to use technology as a bridge for human-to-human communication. As a result, the concept of ubiquitous computing came into existence.

The major motive of ubiquitous computing was to embed technology in order to cater the everyday needs of public. In today's era of smart phones and other handheld or pocket devices, the environment has turned out to be more interactive and informative. The focus of the interaction has shifted to smart communication. A communication is smart if it is between anything that is capable of judging its context and state. Smart communication is only possible if the environment is also smart. According to Mark Weiser, smart environment is an environment containing heterogeneous combination of objects embedded with sensors, actuators, computational capability, display area which are seamlessly connected through a network (Mühlhäuser and Gurevych 2010; Bohn et al. 2003). The implications that came out from the early studies conducted by Weiser were that any physical object is smart if it acts as the source of digital information. Marcelo Kallman and Daniel Thalmann introduced the concept of smart object (Kallmann and Thalmann 1999). They termed an object as smart object if it is capable of describing its own possible interactions. These objects have the ability of sensing, computing and communicating wirelessly both in short distance and long distance. The resemblance of smart objects and IoT can be understood by the fact that the basic building block of human body is cell. Each cell performs its operation and assists in the good functioning of the body. In a similar manner, smart objects act as the basic building block of IoT which combine to form a smart network. Each smart object assists in the formation of a network where a lot of data or information can be gathered, processed and analyzed. With strong affirmation it can be said that the real strength of IoT comes from the transformation of an isolated ordinary object into interactive smart object. The synonyms widely used for smart object are IoT device, smart device, intelligent device, intelligent node etc.

1.4.1 Characteristics of Smart Object

Any object or device can be categorized as smart object if it possesses certain characteristics. The Smart Object consists of Sensors/Actuators, Memory, Communication Device, Power Source, and Processing Unit as shown in Fig. 1.4. The detailed description of each component is given below:

1.Sensors: As the name implies, sensors are used for sensing. A human body has five sense organs. The sense organs are responsible for interacting with the environment. The sensing performed by sense organs may be visual sensing, physical sensing or audio sensing. As soon as something is sensed, a message is sent to the brain which in turn takes some decisions.

In a similar manner, sensors embedded in the device helps the smart object in sensing and measuring the changes in the environment. This physical quantity when measured is converted into digital representation. This digital representation is then passed onto some other computational unit where the transformation of data is done so that it can be used by other devices or humans as shown in Fig. 1.5 (El Jai and Pritchard 2007; Lannacci 2018; Pinelis 2017). A lot of sensors are available to measure various quantity and quality of the physical and virtual things in the environment.

2. Actuators: The sensors are used for sensing data. The data is collected from various sources and devices. This data is then processed, analyzed and needs to be used to produce some productive result. This sensed data now triggers the actuators. The actuators are complements to sensors as shown in Fig. 1.5. It receives control signal and produces some response to the physical world (Anjanappa et al. 2002). In short we can say that sensors sense and send whereas actuators act and activate. A smart object may either have sensor or actuator or both and their number can vary from zero to multiple values depending on the requirement. The relationship between sensors and actuators can be understood with a simple example. Suppose there is a water tank marked with a level. The water pump should be switched on as soon as the water reaches below the marked level. In order to design such a system both sensor and actuator will be employed. Sensor will sense the level of water in the tank. When the water level reaches the marked level, a notification message will be sent to the controller embedded into the system. At this point of time the controller will trigger the actuator to turn on the water pump. In short we can say that actuators are triggering device that converts energy into motions (Alhafidh and Allen 2016; El Jai and Pritchard 2007; Lannacci 2018). Actuators can generate rotary, linear or oscillatory motion. The actuators can be classified on the basis of various parameters. In the context of IoT, switching on and off another device or equipment by the application of force is handled by actuator. IoT is an amalgamation of not only sensing and processing the data but also triggering varied devices into operation on the basis of the dynamics of data. Sensors and actuators that complement each other in terms of functionality work in collaboration to attain the maximum benefit from Internet of Things.

3. Memory: The interaction of smart object is not only limited to physical world objects but it also includes interaction with the virtual objects. A smart object Fig. 1.5 Relationship between sensor and actuator Zaheeruddin and H. Gupta 11 may have a physical existence and physical properties such as size, shape etc.

or a virtual existence in the form of software objects. In both the cases, the smart objects should have a unique identifier. This identifier would be an address which would play a huge role in sending and receiving data. The existence of the smart objects also demands a possession of minimum communication and computation capability. This includes the ability to be discovered, accepting the incoming message and replying to them, discovering services and performing the tasks related to network management. All the above stated functions require a memory range from a few Kilobytes to Gigabytes as per the need. The memory helps in the storage of data. This data is then used for analysis, computations and

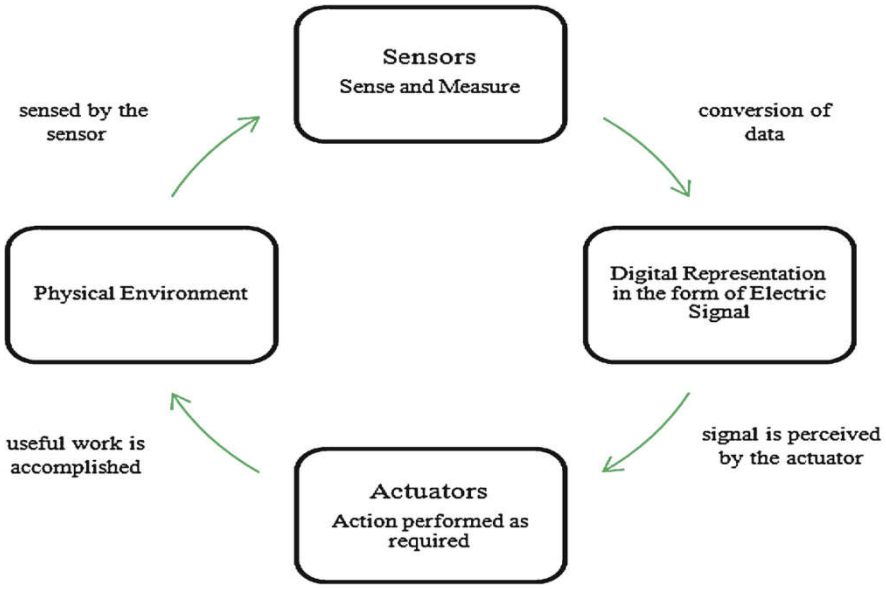


Fig. 1.5 Relationship between sensor and actuatordecision making.

4. Processing unit: A smart object has a processing unit for gathering, processing and analyzing the data acquired from the sensors. The computations done call for control signals that prompt the actuator according to the need. Various functions of the smart object are controlled by the processing unit like communication and power system. The type of processing unit to be used can vary according to the needs and kind of processing to be used by the applications. Microcontroller is the most widely used processing unit due to its small size, simplicity of programming, less power consumption, flexibility and low cost.

5. Communication unit: All the smart objects need to communicate to each other for the sharing of information. This communication may take place between two or more smart objects or to the outside world through network. The communication is only possible if the smart object has a unit meant for communicating over a wire or wirelessly.

The wireless connectivity is preferred more over the wired connectivity for various reasons like cost, ease of deployment and limitations associated with the infrastructure. The communicating unit follows a set of rules, generally termed as protocols to share the information across the network.

6. Power source: There are various components in a smart object. These components need power to operate. The different sources from which power can be attained are batteries, solar power, wind power, main supply etc. Communicating unit of a smart object accounts for the maximum power consumption. The requirements of power consumption vary greatly according to the scenarios like the area of deployment, switching between the active and sleep mode, accessibility, the power source being used (battery, solar or wind etc.), area of application, criticality of the information etc. The different combination of scenarios or conditions calls for different selection of power source.

1.4.2 Trends in Smart Object:

1. Decrease in size: The size of the sensors is decreasing day by day;the process of miniaturization has excelled so much that in some cases the sensors are not visible from the naked eyes. A trend can be seen in the decrease in the size of the sensors. In general, the smart objects are embedded into everyday objects. The smaller size of the smart objects makes the process of embedding easier.

2. Increase in the processing power: With the passage of time the potential of processors has risen continuously and the size has reduced to a large extent. This advancement in the smart objects have made them more complex and connected.

3. Declination in the power consumed: A smart object comprises of different parts. These parts continuously consume power. The sensors may be active or passive. These days sensors are turning out to be completely passive having no requirement of the external power supply. On the contrary the battery powered sensors are also being designed in such a manner that they are able to last for many years without any need of replacement

4. Improvement in the communication capabilities:

A great improvement can be seen in the speed and range of communication provided by the wireless technologies.

With the growth in the use of IoT network, more and more specialized communication protocols are being developed to support various applications and environments.

The stated trends in smart object provide ground for the development of sophisticated devices that are capable of performing complex task with increased efficiency. These trends have resulted due to improved inter-object and inter-system communication. The actual power of IoT is visible only when the smart objects are allied collectively in the network of sensors and actuators.

1.5 IoT as an Industrial Commodity:

Although the concept of IoT is not new, its perception and handling vary from industry to industry. The efficiency of every company is analyzed by their new products in the market. In order to develop the product, projects are undertaken by the industries. In different phases of the project, knowledge, skills, tools and techniques are applied to accomplish the goals in well-defined tenure. In case of an IoT project, the completion of such project comprises of effective handling of data and keeping a tab on the scope of high complex systems. The complexity of system is expressed in terms of number of things, velocity of the generation of data, volume of the data generated, geography, diversified manufacturers and analytics. It is observed from the literature survey that no two implementations of the IoT project are same. The reason for this discrepancy lies in different architectures of IoT that are used by the industries. The basic five steps required in any IoT project are shown in Fig. 1.6.

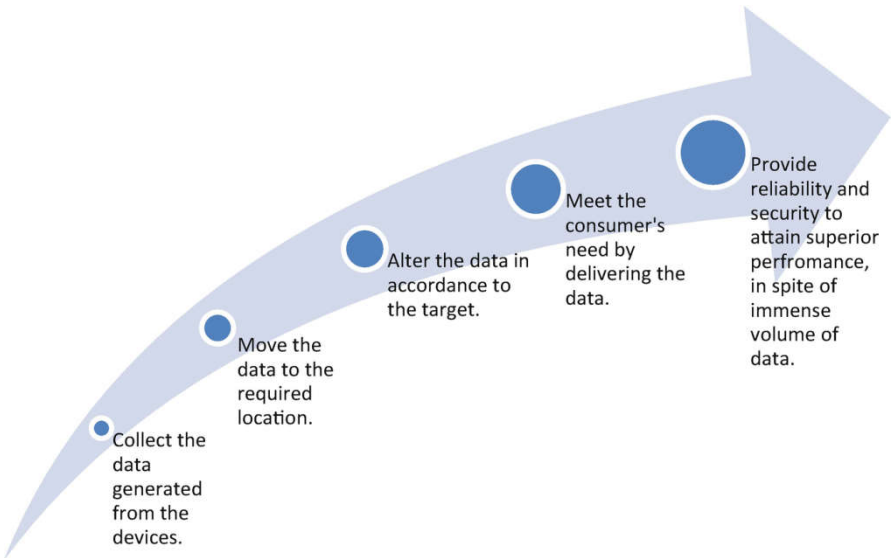


Fig. 1.6 Steps in an IoT project.

1. Linkage of Objects: The first essence of an IoT system is to connect to different objects such as devices, machines or sensors. On the establishment of connection, the generated data can be collected. The generation of data can vary from application to application. Data may be generated at every small change or event, or periodically. The tenure in which the data is collected will influence the volume of data gathered.

2. Collection of data: The second essence in the project is to capture the generated data. The data collected in the previous stage is required to be sent to the next stage comprising of centralized data centre or cloud. Immediate or predictive Collect the data generated from the devices. Move the data to the required loca on. Alter the data in accordance to the target. Meet the consumer's need by delivering the data. Provide reliability and security to aain superior perfromance, in spite of immense volume of data. Fig. 1.6 Steps in an IoT project Zaheeruddin and H. Gupta 17 analysis of data can be carried out at the cloud. If required, data may be ported to the main application for further analysis. 3. Transformation of data: As the data is in progression in the third stage, normalization and modification is performed on the data. This modification is done to customize the data as per the application. Various operations that take place in this stage are buffering of data, filtering of data, aggregation and compression of the data. The reduced and useful data is now sent to the next stage of delivery. 4. Delivery of data: The reduced and transformed data is ready for delivery at this stage. Delivery of data is made to the target end points, applications and analytics platform. The prime requisite for delivery is to eradicate any loss of data. Any three mechanisms namely request-reply, message based or publish-subscribe can be used for delivering the data. Transmission Control Protocol (TCP), Hyper Text Transfer Protocol (HTTP) or Web Sockets can be used as transport interfaces by the message routers. The transport interfaces can provide messaging infrastructure for communication. 5. Management of data: The data obtained from the above said stages can now be consumed by the companies. This transformed and reduced data can help the companies to increase their efficiency, reduce risk, predict services and support that they can provide. The data across the IoT system is needed to be controlled and synchronized reliably. This would incorporate managing the network, connectivity of the devices, application provisioning and automation (Khan et al. 2015). A huge volume of data will flow amongst the devices thus having the need for high security. Therefore, every enterprise would need to adhere to the strict rules and regulations in this regard.

1.6 Applications:

A lot of potential is hidden in the network of IoT which makes the development of numerous applications possible. Many applications can be developed and deployed on the basis of IoT. As the saying goes 'Rome was not built in a day', similarly advancements take time. It is step by step process in which development plans can be easily made but the deployment of it takes time (Agarwal and Alam 2018). In this section many applications of IoT have been highlighted. Some common and significant applications of the IoT are briefly discussed below:

1. **Aerospace and aviation industry**:

Counterfeit products and elements can easily be identified with the help of IoT. This can improvise the safety and security of products as well as services. For instance, the industry of aviation is susceptible to the issue of the unapproved part of aircraft that is commonly known as Suspected Unapproved Parts (SUP) (Sletten 2000). There is no assurance of the fact that SUP copes up to the necessities of a standard aircraft part and may lack behind in confirming the stringent limitations of quality of the aviation industry. Thus, security standards with respect to the aircraft are seriously violated 1 Foundation of IoT: An Overview 18 by the SUPs. The authentication and security of the aircraft parts can be easily be infringed by forging the documents. Solution to this problem is to introduce electronic pedigrees. These electronic pedigrees will work for a limited group of aircraft parts. In order to improve the safety and operational reliability of aircrafts, the aircraft parts in their lifecycle, will make a record of their origin and critical security related events. These pedigrees will then be stored and secured within RFID tags and a decentralized database. The RFID tags will be attached to the parts. Whenever a new aircraft part has to be installed in the aircraft authentication can easily be done by verifying the digital signatures and comparing the RFID tags pedigree with the database. These steps can upgrade the safety and operational reliability of the aircrafts.

2. **Automotive industry:**

A lot of up gradation can be seen in the automotive industry as generally all the means of transport are getting equipped with sensors, actuators etc. The installed sensors and actuators are known for their increased processing power (Szmelter 2017). Smart things are used for building and implementing the applications in the automobiles. The applications may monitor and report various parameters of the automobiles like proximity of the other vehicles, pressure in tyres etc.

The RFID technology is being used to rationalize the production of vehicles, to improvise logistics, to enhance the quality control and improve customer services. The real time data in the manufacturing process and maintenance operations is provided by the RFID technology. This provides effective assistance in managing the product and the automobiles. In order to achieve high bit rate and reduction in the interference with the other equipment, Dedicated Short Range Communication (DSRC) is employed.

The applications of the Intelligent Transportation System (ITS) which include traffic management and safety services of vehicle can fully be incorporated in the IoT infrastructure by using communications like Vehicle-tovehicle (V2V) and vehicle-to-infrastructure (V2I) communication.

3. Telecommunications industry:

The alliance between dissimilar technologies can be made possible with the help of IoT. This will work as the foundation for creating new services. An illustrative scenario for the above alliance is the mutual use of GSM, Bluetooth, Near Field Communication (NFC), Wireless Local Area Network (WLAN), Global Positioning System (GPS), multi-hop networks and sensor network with Subscriber Identity Module (SIM)-card technology (Deshpande et al. 2017). The different technologies stated above have significant features which help in the implementation of the services. In these services or applications, the SIM-card is attached to the mobile phone. The mobile phone has the reader (i.e. tag) and different applications share the SIM-card. A secure and simple communication among objects can be enabled by the use of NFC. This is achieved by placing the objects in the vicinity of each other. In this scenario the mobile phone can read all the data by imitating as a NFC-reader. This data is then transmitted to a central server. The SIM-card in the mobile plays an important role by storing the authentication credentials like ID information, ticket numbers etc. and NFC data. For specialized purposes the robustness of the communication channel and networks can be Zaheeruddin and H. Gupta 19 increased by facilitating peer-to-peer communication. In order to achieve it the ‘things can connect to form a network. An ad-hoc peer-to-peer network can also be formed to handle the situation of disaster or a condition of telecommunication infrastructure failures.

4. Medical and healthcare industry:

There are many applications in the healthcare sector that can be framed by using the features of IoT.

Monitoring the medical parameters and tracking the delivery of drugs can easily be done by using cell phones with RFID-sensor capabilities. Some of the advantages that can be achieved by using the said feature are: (a) monitoring of diseases can be made easy, (b) ad-hoc diagnosis can be done, and (c) instant medical aid can be provided in case of accidents. Health records can be saved and secured by using implantable and wireless devices. These health records can be used to save patient's life and special treatment can be given to people in emergency situation especially those suffering from heart disease, cancer, diabetes, stroke, cognitive impairments, Alzheimer's etc. Guided action on a body can be taken by introducing biodegradable chips into the human body (Machorro-Cano et al. 2017). Muscular stimuli can be delivered to paraplegic persons for restoring the movement functions. This can be attained by implanting a smart thingcontrolled electrical simulation system.

5. Pharmaceutical industry:

Safety and security of the pharmaceutical products are the prime requirements that need to be fulfilled for the effective use of the drug. Using the technique of IoT smart labels can be attached to the drugs. These smart labels enable the tracking and monitoring of the drug in the supply chain management. The status of the drug can be monitored providing many potential benefits. For instance, many products of pharmacy like vaccines and some drugs are required to be stored at a cool temperature. An appropriate maintenance of the cool chain can be monitored with the help of IoT. In case, if the required cool temperature is not maintained during storage or transportation, then the product can be discarded. The developing countries are affected by counterfeiting of the drugs. Drug tracking and e-pedigrees can be used in order to eradicate fraudsters and detect the counterfeit products (Fantana et al. 2013).

6. Retail, logistics and supply chain management:

The operations of retailing and supply chain management (SCM) can benefit from IoT. Many applications can be optimized by the retailer by implanting RFID chips to the products and using smart ledges to follow up the availability of items in real time. For instance, automatic inspection of goods receipt, tracking the goods that are out of stocks, real time monitoring of the stocks and many such activities can be done by the retailer. It has been found that loss in sales is also detected when the customer does not find the required product in the shelves and returns back without the product. This loss of the retail store can be reduced with the help of IoT.

Moreover, the logistics of the whole supply chain management can be optimized by providing the availability of data from the retail store. The availability of stock and sales data from the retailers will help the manufacturers to produce and dispatch the appropriate amounts of product. This will in turn 1 Foundation of IoT: An Overview 20 avoid the situation of over production or under production. The exchange of RFID data can prove beneficial to several sectors of industry by improvising the supply chain incorporating the logistic processes (Da Xu and He 2014).

7. Environment monitoring:

Environmental monitoring and conservation can be considered as one of the booming segment in the market in the coming future. Identifiable wireless devices can be utilized for efficient monitoring of the environment. The monitoring may include scrutinizing of the weather condition, level of humidity, level of pollution etc.

8. Transportation industry:

IoT has the capability of providing many solutions for improving the transportation industry. It can provide solutions for automatic toll and fare collection, thus reducing the traffic and waiting queues on road. With the help of IoT, the transportation system can be modified by the deployment of Intelligent Transportation System (ITS). ITS will help in the commuting of people and goods efficiently. It will monitor traffic jams and provide free pathways to emergency vehicles. It can also provide support and improve the security policies across the globe by providing means for the automatic screening of commuters and their baggage's boarding the cargo system (Skabardonis 2008).

9. Agriculture and breeding:

A technology like IoT can be used to regulate the traceability of animals used for agriculture purpose. This can assist the detection of animals in real time especially during the eruption of infectious syndrome. In many countries farmers and shepherds are given subsidies as per the basis of the number of animals like cattle, goat, sheep etc. People can do fraud with the government by misleading them with the count of animals. The detection of such deceptions is a difficult task. Therefore, IoT can be employed to reduce the fraud as it can provide appropriate methods of identifications. Many other applications like conducting survey, controlling and prevention of diseases can easily be done by using varied features of IoT.

IoT can be used to accurately identify the different specimens of blood and tissues and provide certification regarding the health status of animals in a region. The concept of IoT will also benefit the farmers as they can have a direct contact with the consumers. The farmers can then make direct deliveries of crop to not only smaller regions but also wide area markets. This will provide new way of supply chain and prove beneficial both for the producers and consumers (Maple 2017).

10. Media, entertainment industry:

Online videos and news have become very common now days. An enhancement that IoT technology can show in this area is to deploy multimedia devices at different locations. Using these devices ad hoc news can be gathered on the basis of the location of the users. Financial offers can be provided to the people at these locations for collecting the footages. More information can be congregated by affixing the NFC tags to the posters. The tag readers are connected to a URI address possessing exhaustive details about the poster.

11. Insurance industry:

The privacy of an individual is very important but IoT technology is considered as a serious hinder in maintaining it. But in order to avail the monetary benefits people are willing to compromise with their privacy. Zaheeruddin and H. Gupta 21 Let's take an example of vehicle insurance which has been equipped with electronic recorders with the permission of their owners. The advantage of this recorder is that it can record dangerous driving pattern and communicate this information to the car owner or insurer. Similarly in case of house insurance, in-home sensors can monitor the water and fire damage and inform the insurer. The advantage of this kind of insurance is that the insurer can be informed of the imminent damages and can trigger the best possible economic action. Same kind of insurances can be provided on different assets like machinery, factories etc. The innovation provides cushion for maintenance at cheaper rates before the occurrence of the incident.

12. Home Automation:

These days' people rely more on technology to address concerns regarding lifestyle led by them and security of their homes. The advancements in the technology of sensors, actuators and wireless sensor network are the main pillars behind the popularity of converting homes to smart homes.

In smart homes, intelligent and automated services are provided to the user by the deployment of sensors at different locations. The smart sensors not only automate the day to day tasks of an individual but also help in energy conservation by switching off the electronic gadgets like fans, lights etc. when not in use. Energy conservation in smart homes is made possible by the use of sensors and the concept of context awareness. Different data like (temperature, light, humidity, fire event, gas etc.) are collected by the heterogeneous sensors and fed to the context aggregator. The aggregator passes on the collected data to the context aware service engine. On the contextual basis, different services are selected and the required task is achieved (Pal et al. 2018). For instance, an increase in the humidity level will switch on the AC automatically. A lot of modification in smart homes can be done as and when required.

1.7 Conclusion:

The living standard in the modern society has moved to a different level by the emergence of Internet of Things. The Internet of Things has enabled communication amongst smart objects, contradicting the previous definition of interaction that was confined to the interactions amongst human and machines. In the present scenario, the term interaction encompasses communication between ‘anything’ irrespective of location, time and type of communication. This chapter introduces IoT as a combination of Information Technology and Operational Technology. IT supports protected connectivity of the data and gadgets within an organization whereas OT administers devices and processes on physical system. The new paradigm of IoT has shown an immense progress in digitization and has framed an aura where everything including people, process, data and things are connected. In order to assist the global connectivity of things new features have to be added to the existing objects and internet. The ordinary objects are upgraded to the smart object by integrating 1 Foundation of IoT: An Overview 22 communication and computation capability. The characteristics, trends and features of IoT objects have been covered in detail in the chapter. Various types of project can be undertaken by IoT involving different inputs, attributes and solutions. Each project can follow a different architecture as per the requirement. In this chapter, two basic possible architectures namely oneM2M and IoT World Forum Architecture have been illustrated. The perception and handling of IoT can vary from industry to industry. Therefore, any IoT project should progress in a sequence employing and modifying the architecture as per the requirement.Each commodity provided by the industry will pave the path for new applications. Upcoming developments and growth in IoT will also optimize the flow of information thus revolutionizing private and business communications.

The various applications of IoT are described in the last section of the chapter. With firm determination it can be said that a lot good can be achieved in the field of IoT if the networking and communication research are carried out together in the laboratories of industries and academic institutions complementing each other.

Chapter II :
Smart Home

Abstract:

In an ageing world, maintaining good health and independence for as long as possible is essential. Instead of hospitalization or institutionalization, the elderly and disabled can be assisted in their own environment 24 h a day with numerous ‘smart’ devices. The concept of the smart home is a promising and cost-effective way of improving home care for the elderly and the disabled in a non-obtrusive way, allowing greater independence, maintaining good health and preventing social isolation. Smart homes are equipped with sensors, actuators, and/or biomedical monitors. The devices operate in a network connected to a remote centre for data collection and processing. The remote centre diagnoses the ongoing situation and initiates assistance procedures as required. The technology can be extended to wearable and *in vivo* implantable devices to monitor people 24 h a day both inside and outside the house. This review describes a selection of projects in developed countries on smart homes examining the various technologies available. Advantages and disadvantages, as well as the impact on modern society, are discussed. Finally, future perspectives on smart homes as part of a home-based health care network are presented.

Introduction:

A “smart home” can be defined as a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond. The full-blown concept of the smart home is the acme of domestic technology we can envisage at present. The concept, at one time only encountered in science fiction, has moved closer to realization over the last ten years. Although the gap between reality and fantasy is still wide, it is important that we start to give proper consideration to the implications this technology holds for the way we will live in our homes in the future.

Literature review:

the smart home concept is the integration of different services within a home by using a common communication system. It assures an economic, secure and comfortable operation of the home and includes a high degree of intelligent functionality and flexibility.”

The definition is influenced by home automation terminology and does not mention anything about home intelligence (According to Lutolf).The Adaptive Control of Home Environment (ACHE) system was developed by Mozer in the USA. ACHE monitors the device usage pattern of residents, utilizing different types of sensors, and builds the adaptive inferential engine of a neural network to control temperature, heating, and lighting. ACHE can control three main components of a house while maximizing user comfort and conserving energy (M.C. Mozer, 1998). Nikolaidis et al. proposed a solution to combine CWMP (CPE Wide area network Management Protocol) with UPnP following DSL forum standardization. The authors discussed a method that sends UPnP information to a CWMP client. The CWMP client transfers this information to a UPnP control point. The UPnP control point undertakes the configuration and management of the UPnP network. This architecture presents a remote diagnostic solution to the service provider. Their future works include security and multi-provider access to the home network. (A.E Nikolaidis,. S. Papastefanos, G. A. Doumenis, G.I. Stassinopoulos and M.P.K. Drakos,2007). Casattenta is an ambient intelligent system developed by Farella et al. in Italy. The authors used a wireless sensor network (WSN) to monitor elderly inhabitants for recognizing activity disorders such as falls, immobility, reaction incapacity etc. The proposed system used wearable kits to gather information from the user. For this purpose, Tiny OS-based motes were employed in a TmoteSky platform. The system can only identify motion-based changes. The acquisition of such physiological data as body temperature, heartbeat rate, and blood pressure has yet to be demonstrated.(E.Farella,M.Falavigna,B.Ricco,2009).CarerNet is an architectural model of an integrated and intelligent telecare system proposed by Williams et al. Its core components are a sensor set, a sensor bus, an intelligent monitoring system, and a control unit. The authors use ECG, PPG, spirometer, temperature, galvanic skin response, colorimeter, and pulse measurement tools to collect physiological data. The communication network is an integration of HomeLAN and Body Area Network (BAN), which is responsible for recording real-time data, event data, and command and control data. It has a distributed intelligent system in the form of smart sensors, smart therapy units, body hub, Local Intelligence Unit (LIU), and Client's Healthcare Record (CHR). The system provides an emergency alarm, health information, and ambulatory monitoring services (G. Williams, K. Doughty, D.A. Bradley, 1998.). Vaidya et al. proposed an authentication mechanism to secure remote access to a smart home network.

The system uses a HMAC-based One Time Password (HOTP), a hash chaining technique, and smart cards based on strong password approach. It consists of an Integrated Authentication Server (IAS), which is located outside the home network, to provide authentication, authorization, and accounting (AAA) services. At the initial registration phase, the user chooses an ID and password, which are used by the IAS server to generate a smart card. This smart card, along with the coded information, is used to implement secure access in smart homes. It requires higher computational overhead than that used in the previous schemes.(B. Vaidya, J. H. Park, S.-S. Yeo, J. J. P.C. Rodrigues, 2011.).

Background :

Smart home projects have been conducted over the last several decades; they convey different ideas, functions, and utilities. Smart homes are extending into different branches of specialization focusing on the interests of researchers and user requirements and expectations. This section presents a study of smart home projects according to research objectives and desired services. Smart homes provide comfort, healthcare, and security services to their inhabitants. Comfort and healthcare services can be provided locally as well as remotely. Security measures not only provide authentication services to the user but also restrict unauthorized access to the household devices.

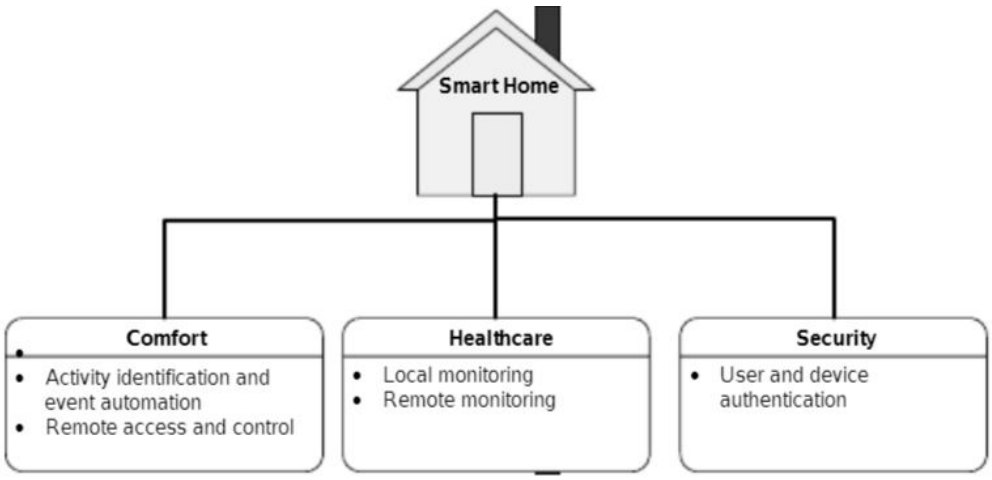


Fig. 2.1 presents the categorization of smart home projects according to the intended services.

A. Comfort :

One of the main objectives of smart home research is to ease daily life by increasing user comfort. This is achievautomation in local environments. The other is remote home management from distant locations. The following smart home projects aim to automate home appliances using knowledge of human activity and behavior. These assistive services sometimes optimize energy usage because the house is intelligent enough to reduce energy use by controlling unattended home appliances.

1) Activity identification and event automation:

Context awareness is an important prerequisite to employ intelligence in smart homes. A context-aware smart home can distinguish location, identity, activity, and time.The projects discussed in this category can learn user behavior, track user location, identify the user, and automate tasks to optimize comfort in the localenvironment.The MavHome (Managing an Adaptive Versatile Home) project at the University of Texas at Arlington was first introduced by Das et al. MavHome uses a combination of multidisciplinary technologies: artificial intelligence, multimedia technology, mobile computing, and robotics. Its architecture is divided into four abstract layers: physical, communication, information, and decision.

Fig 2.2: The MavHome Project.

The X10 protocol is used to control and monitor more than 60 X10 devices plugged into the home electric wiring system. An active LeZi (ALZ) algorithm is implemented, which makes a decision tree based on a finite-order Markov model.

ALZ predicts the future actions, calculating the probability of all previous actions by applying prediction by partial matching (PPM) method. Although MavHome utilizes AI algorithms to make accurate predictions and decisions, it can only predict the behavior of a single inhabitant.A snow-flake data model was designed by Zhang et al. to represent residents' activity in smart homes [19]. They used a homeML (an XML based schema to represent the information of smart homes) structure to store sensory information. A novel prediction algorithm is proposed to classify the activities of daily life (ADL) from the observed episodes and time information. The learning output is a joint probability distribution. The distribution can also be measured by the distance to the true underlying probability distribution using the Euclidean metric. Smaller distance implies a better learned model when compared to the true situation. The algorithm is based on a probabilistic distribution and is able to predict the ADL of more than one inhabitant. The system cannot correct itself in cases of false classification and can identify only one task.The Controlling System and Status Retaining System (CSnSRS) was proposed by Kumar et al. to automate home appliances. The system features a computer as the controlling device and uses the X10 protocol to control home appliances. The researchers used a device called a "Safe Mode" panel to retain the status of home appliances in case of a power outage. A power-saving mode was also proposed to turn off the controlling device when the status of the appliances is not changing. The authors did not implement the CSnSRS.

Fig 2.3: KNX Protocol.

Another important contribution of the research is the application of the KNX protocol, which seems to be expandable based on user requirements.

The proposed methodology is not suitable for real-time analysis because the IRIS method is only applicable to offline processing.

Rashidi et al. developed CASAS at Washington State University. CASAS is an adaptive smart home that uses machine learning techniques to discover user behavior patterns and automatically mimic these patterns. The user can modify the automation policies, provide feedback on the proposed automation activities, and introduce new requests. CASAS can automatically identify changes in resident behavior. The Frequent and Periodic Activity Miner (FPAM) algorithm identifies frequent and periodic activity patterns after processing activity information.

The patterns are modeled by a Hierarchal Activity Model (HAM) for a satisfactory automation policy utilizing temporal and structural regularities. The authors are planning to add a voice recognition system, which is an efficient tool in creating a robust and interactive smart home. The CASAS project has benefited from the aid of researchers who previously worked on the MavHome smart home.

2) Remote acces and control :

These projects enable the user to remotely access, monitor, and control their home environment. The internet is the most common and widely used technology that provides bidirectional communication between the home and the user. Sometimes, telecommunication infrastructure is used for this purpose. The following projects enable users to control and monitor home appliances from remote locations by direct interaction. In these cases, the home does not possess intelligence; it only creates a platform for remote access and control.Perumal et al. from the Institute of Advanced Technology of University Putra Malaysia (UPM) presented a design and implementation of Simple Object Access Protocol (SOAP) based smart homes. They designed a SOAP-based control module to allow for the interoperation of home appliances in smart homes. Fifteen web-based feedback control channels were designed within a residential management system. If the server goes down, the system can also be controlled remotely via an SMS module. It offers a complete, bi-directional Realtime smart home control and monitoring system. This system has been implemented using relay-based switches, which do not follow any standard communication protocols.Yong ping et al. developed an embedded web server to control equipment’s employing the Zigbee protocol. For this purpose, they used a S3C2410 microprocessor, which was programmed with Linux 2.6 kernel.

To provide online access, a small web server (only 60 KB) named Boa was installed. The authors have designed an interface to communicate with the Zigbee module (MC13192). This is a remote home automation project. The system does not possess any type of intelligence.

Fig 2.4 : ZigBee Protocol.

B. Healthcare :

Smart homes provide healthcare facilities for patients, elderly people, and healthy people. Healthcare services can be implemented on-site as stand-alone solutions to generate health reports locally. Another effective way is to use remote healthcare service providers for emergency support. The projects in this category present effective ways to provide healthcare support in smart homes.

Fig 2.5: Healthcare Services.

Local monitoring:

Smart homes provide patient-monitoring services in the home environment to identify health conditions, ensure assistive services, and generate local warnings or alarms if required. A home can produce long-term trends of user health, which can be analyzed by a medical office or by the user. The projects discussed here present the methodologies used to implement healthcare support in the home environment.A Health Integrated Smart Home Information System (HIS) is an experimental platform for home-based monitoring. IR sensors and contact switches are used to track inhabitant activities, and information is transmitted via a Controller Area Network (CAN) to a local computer. The CAN also acquires physiological data, e.g., blood pressure, heart rate, weight, and SaO2 information. The proposed methodology is based on a 24-hour circadian cycle, which is subdivided hourly for activity monitoring. Statistical mean and deviation measurement methods are applied to this hourly information to alert in an abnormal situation. This research is limited to single-inhabitant monitoring. The presented results are based on a simulated design in LabVIEW (a tool from National Instruments). However, the hourly summarization method is not efficient with respect to the detection of long-term deviations such as weight changes or sleeping disorders.The ENABLE project evaluates the impact of assistive technologies on patients suffering from mild or moderate dementia. The researchers installed two devices (cooker and night light) in the apartments of several patients in different locations to estimate the efficiency of the system. The proposed project places a greater emphasis on psychological impact rather than on technical development. The researchers have found that a good relationship (consistent communication and presentation) between the caregivers, evaluators and project staff is essential for long-term evaluation. The authors concluded that to evaluate the current technology, the researchers should have patience and a better understanding of people with dementia. The scope of this research was limited to only two household devices. To satisfy this type of patient, there should be more assistive services, which were not considered in this design.At the Tampere University of Technology, Vainio et al. developed a proactive fuzzy home control system. An adaptive fuzzy logic algorithm is applied to evaluate the test on the obtained results. The goal of this research is to assist the elderly to live independently at home. The developed system can recognize routines and deviations from routines. It can provide residents' information to caregivers with respect to daily rhythm, sleeping disorders, and medicine taking. It Workssensible for Lightning control.

Remote monitoring:

Fig 2.6: Remote Monitoring.

Remote monitoring employs specialized healthcare service providers to deliver instant medical support in emergency situations. The house monitors the patient using physiological sensors and contacts the caregiver automatically if any vital sign is found. Normal sensors along with information processing systems are used to observe the elderly which generates an alarm in remote healthcare center in case of user inactivity. The following projects discussed smart homes that aim at providing remote patient-monitoring services. These projects require real-time human intervention from remote locations.

Barnes et al. evaluated the life-style monitoring data of elderly using the infrastructure of British Telecom and Anchor Trust in England. The system detects the inhabitant's movement using IR sensors and magnetic contacts at the entrance of the household doors. It uses a temperature sensor in the main living area to measure the current temperature. An alarm activation system is implemented, which detects abnormal behavior and communicates to a remote telecare control center, the clients, and their caregivers. The researchers presented a low-cost solution to implementing a smart telecare system. It is limited to detecting abnormal sleeping duration, unexpected inactivity, uncomfortable home temperature, and fridge usage disorder. Moreover, it uses a special new telecom protocol called "No Ring Calling," which requires the service providers to modify the existing telecom protocols.

A No Ring Calling is a phone call that occurs without ringing. It provides a lower-cost solution to collecting data from the client's home using existing telephone line. Its priority is less than that of a normal phone call so that any incoming or outgoing call can override it.

Raad et al. developed a cost-effective user-friendly telemedicine system to serve the elderly and disabled. It consists of physiological sensors (pulse oximeter sensor and the blood pressure sensor) and general-purpose sensors (weight sensors, motion detectors, and light sensors). The physiological sensors are attached to a wheelchair, which can communicate to a database server through a PDA or laptop. The doctor can analyze the patient's health condition from the database remotely. Other sensors are used to track the location and detect the activities of the residents. It automatically contacts the doctor through SMS via a GSM modem if any abnormal vital sign is detected. It cannot detect health conditions by analyzing real-time data from physiological equipment's. It still depends on human interaction for medical report analysis.

C. Security :

Fig 2.7: Home Security System.

Smart homes are vulnerable to security threats. Most security problems are related to weak user- and device-authentication schemes. Security attacks may be generated locally or remotely. The projects that deal with security issues in smart homes are discussed next. From this review, it is obvious that most security mechanisms are adopted from existing techniques of computer security. Pishva et al. proposed a product-based security model for smart home appliances. The model suggested the involvement of a third-party network operator to implement security measures that are related to multivendor products.

It uses a home gateway as the key component to impose security features. The main purpose of the gateway is to implement a user-authentication scheme. It can log user access and billing information based on authorized access control.

It is equipped with a firewall and virus-protection software. Another important part of this paper is the presentation of a taxonomy of common security threads according to product functionality. The assumptions are actually based on previous experiences regarding computer network security such as user impersonation, device impersonation, service interruption, data alteration, worm/virus, phishing, data wiretapping, firmware alteration, and OS/software vulnerability. The authors categorized the common threats into several difficulty levels and proposed solutions to prevent these security problems. The authors assume that all the smart appliances function using internet technology. Therefore, the security threats and the model discussed here are only applicable in computer networks. The security issues related to other coexisting protocols, e.g., Zigbee, X10, KNX, etc., are not included.

Result and Discussion:

The design of a smart home depends on user requirements and user living styles. Generally, smart homes offer comfort, safety, security, remote control, and energy conservation. Smart homes provide healthcare support to the elderly and disabled. These patients normally suffer from long-term diseases, which do not require critical medical support. It is not efficient to provide healthcare support to these patients in a traditional medical center for an uncertain period of time. Some elderly people are not alert and suffer memory problems, and many of them cannot even make their way to a hospital. They require safety, security, and immediate health support in case of emergency. Smart homes can support the disabled, e.g., patients with bone fractures, hearing problems, blindness, and mental disorders. These consumer groups require continuous monitoring in an intelligent environment. Smart homes transfer medical facilities to citizens' dwelling places.

Conclusion:

The Smart Home is a fundamental enlargement chance for most of the actors in which the telecom operators are significant, all is attributable to the positive societal tendency, improved need and quickening in advancemet strategic assets including the access to the internet, customer association management, strength of support and sales, telecom operators played their due role in extracting value from Smart Home services. Smart home technology is a

favorable selection for individuals that are concerned about their safety, ease and cost-containment.

The paper explored a smart home power management technique on the basis of sensors. The technique revealed cost-containment in terms of power and user habits' adaptation. However, in few cases a smart home technology is complex for deployment due to an extensive preliminary cost and also senior citizens are highly unwilling to attempt innovated applications or transition their manner of approaching things as they feel danger of losing solitude due to continuous monitoring.

Chapter III:
Implementation Of The IOT Application.

Introduction:

In addition to simplifying life, a smart home becomes comfortable, connected, scalable, autonomous, safe and economical. My mission is to realize a smart home by implementing home automation functions such as lighting management, opening and closing window shutters, the acquisition of temperature inside and outside the habitat and the control of ventilation, the toxic gas leak detection.In this chapter, i will describe the process of realizing my system which is nothing more than the implementation of what has been stated in the previous chapter.

2. Problematic:

The majority of brains connected home systems also called box-home automation are proprietary. They are reserved for their builders, as a result a lot of problems arise, among them i can quote:

- Incompatibility between proprietary protocols.
- The cost of a complete home automation system is expensive.
- Limited choice of sensors.
- Control interfaces are not ergonomic.

3.Objective:

The objective in this project is to create a connected home system by exploiting open-hardware technology, this system will be accessible and controllable in real time via a web server and expandable by actuators and sensors that the administrator can configure in related to their needs.

4. Development of the home automation system

The process to follow for the realization of my project is as follows:

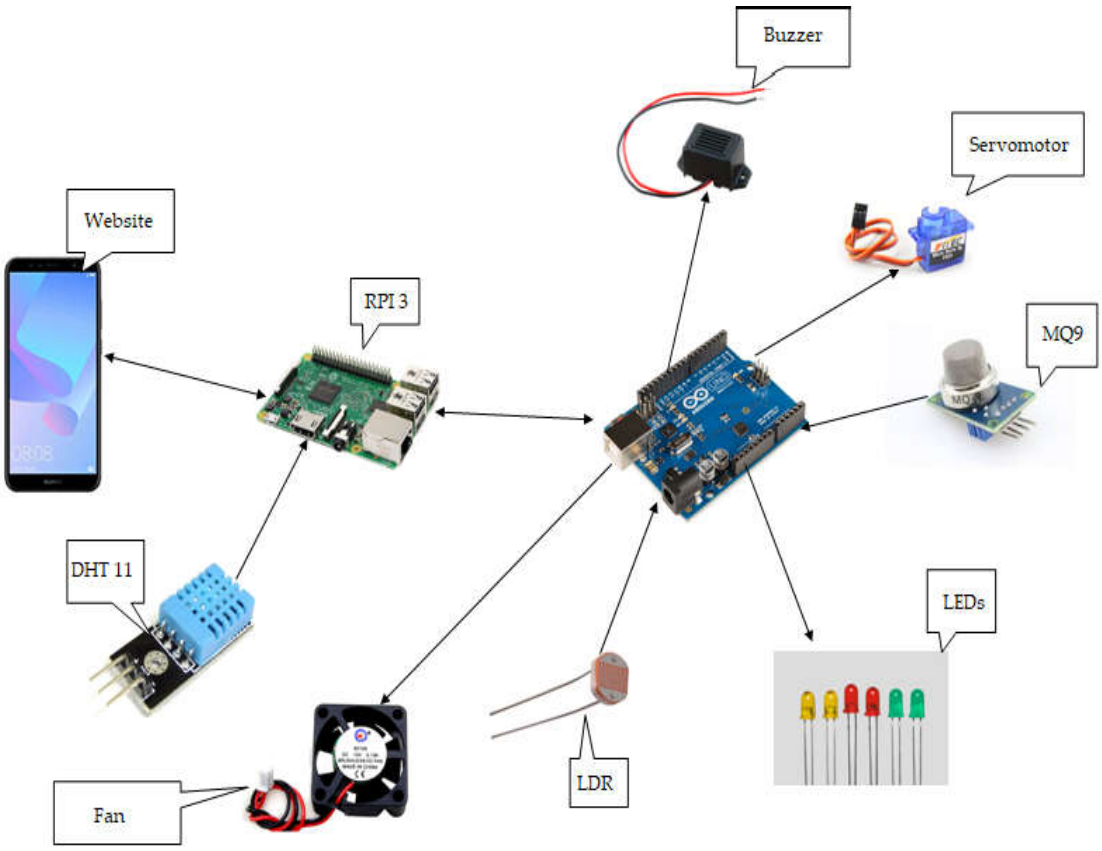
- Assemble the various components, namely the sensors, actuators.
- Create the web interface on which to control the home automation system
- Make a prototype of a smart wooden house.

5. Project specifications:

I have defined my project specifications, which will cover the following points:First, I must establish the following functions of home automation:

- Lighting management by LEDs.
- Curtain opening/closing management with step-by-step motors.
- Toxic gas management.
- Temperature and humidity acquisition by a DHT11 sensor to control ventilation.

The following synoptic diagram will allow us to better understand the overall functioning of



the studied system:

Figure 3.1 Block diagram of our project.

6. Definition of fonctions :

Fonction	Entitled
F1	Lightning control
F2	Gas management
F3	Ventilator
F4	Curtain opening management

Table 3.1 the functions used in the project.

7. Lighting management function:

This function allows users to manage lighting for the purpose of saving electrical energy.

Fig 3.2: Lighting Management System.

Gas leak detection function:

This function allows the detection of gas leaks via an MQ-9 gas sensor. It is able to detect LPG, butane, propane, methane, alcohol, hydrogen, smoke. The windows are opened in the event of a gas leak. An alarm was subsequently added to inform the user in case of danger.

Fig 3.3: MQ9 Gas Sensor.

Temperature acquisition and ventilation function:The temperature is acquired via a DHT11 sensor to control the climate inside the habitat with ventilation.

6.1 Lighting Management Function:

In this function one has the external and internal brightness that is to say one uses an external LED and the other the interior one.The external LED is able to turn on automatically in case of low lighting and conversely to turn off if the lighting level is sufficient, for this we used a charged photoresistor (LDR) to measure the ambient lighting level. the LED of the inside to light up manually, you just need to press the ON icon on the interface. Resistors have been added as each LED needs a resistor to limit the current through it. Resistors are used to control the electric current in a circuit in order to protect the LEDs against destruction that would result from a very strong current.

6.1.1 Materials:

A. LDR.

B. Des LEDS.

C. Arduino UNO.

D. Resistor.

A: Light dependent resistor, LDR or photoresistor:

A photoresistor or light dependent resistor is a component that is sensitive to light. When light falls upon it then the resistance changes.

Values of the resistance of the LDR may change over many orders of magnitude the value of the resistance falling as the level of light increases.It is not uncommon for the values of resistance of an LDR or photoresistor to be several megohms in darkness and then to fall to a few hundred ohms in bright light. With such a wide variation in resistance, LDRs are easy to use and there are many LDR circuits available. The sensitivity of light dependent resistors or photoresistors also varies with the wavelength of the incident light. LDRs are made from semiconductor materials to enable them to have their light sensitive properties. Many materials can be used, but one popular material for these photoresistors is cadmium sulphone, CDs, although the use of these cells is now restricted in Europe because of environmental issues with the use of cadmium. Similarly, cadmium CdSe is also restricted. Other materials that can be used include lead sulphide, PBSs and indium antimonide.

Fig3.4: LDR.

A typical light dependent resistor, LDR / photoresistor specification may be:

EXAMPLE PHOTORESISTOR SPECIFICATIONS

PARAMETER	EXAMPLE FIGURES
Max power dissipation	200mW
Max voltage @ 0 lux	200V
Peak wavelength	600nm
Min. resistance @ 10lux	1.8kΩ
Max. resistance @ 10lux	4.5kΩ
Typ. Resistance @ 100lux	0.7kΩ
Dark resistance after 1 sec	0.03MΩ
Dark resistance after 5 sec	0.25MΩ

Table. 3.2. Photoresistor parameter-example.

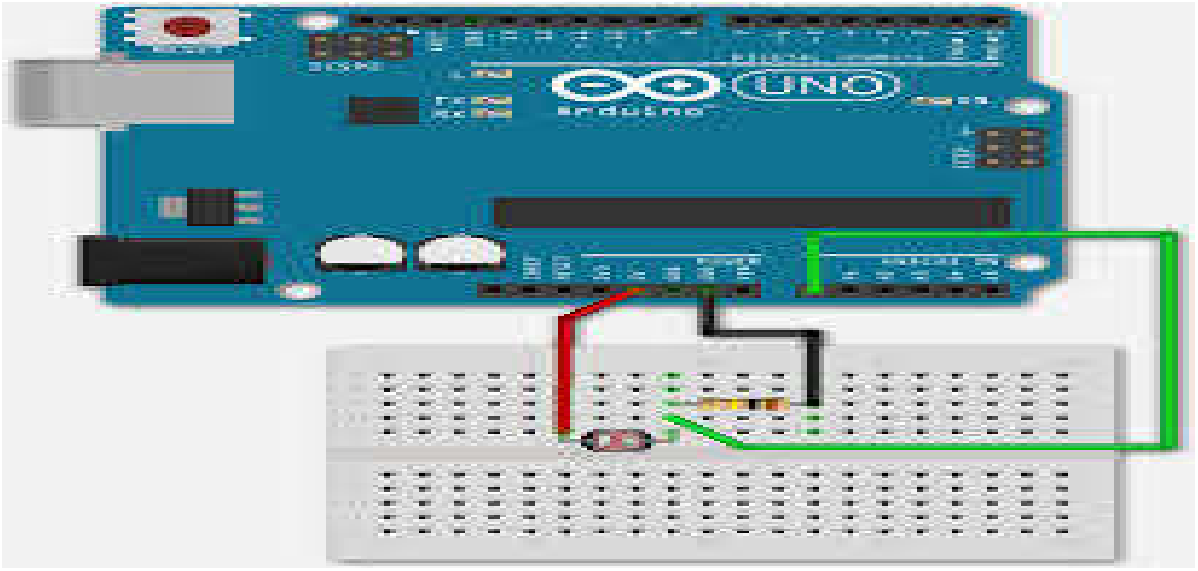


Fig 3.5: Connecting an LDR with Arduino.

B. LEDS:

A **light-emitting diode** (**LED**) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons.The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. [White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

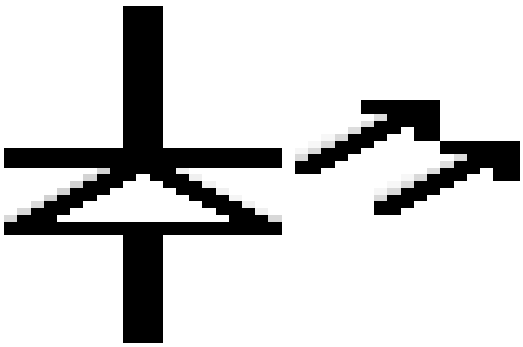


Fig 3.6: LED.

Connection of an LED with Arduino:

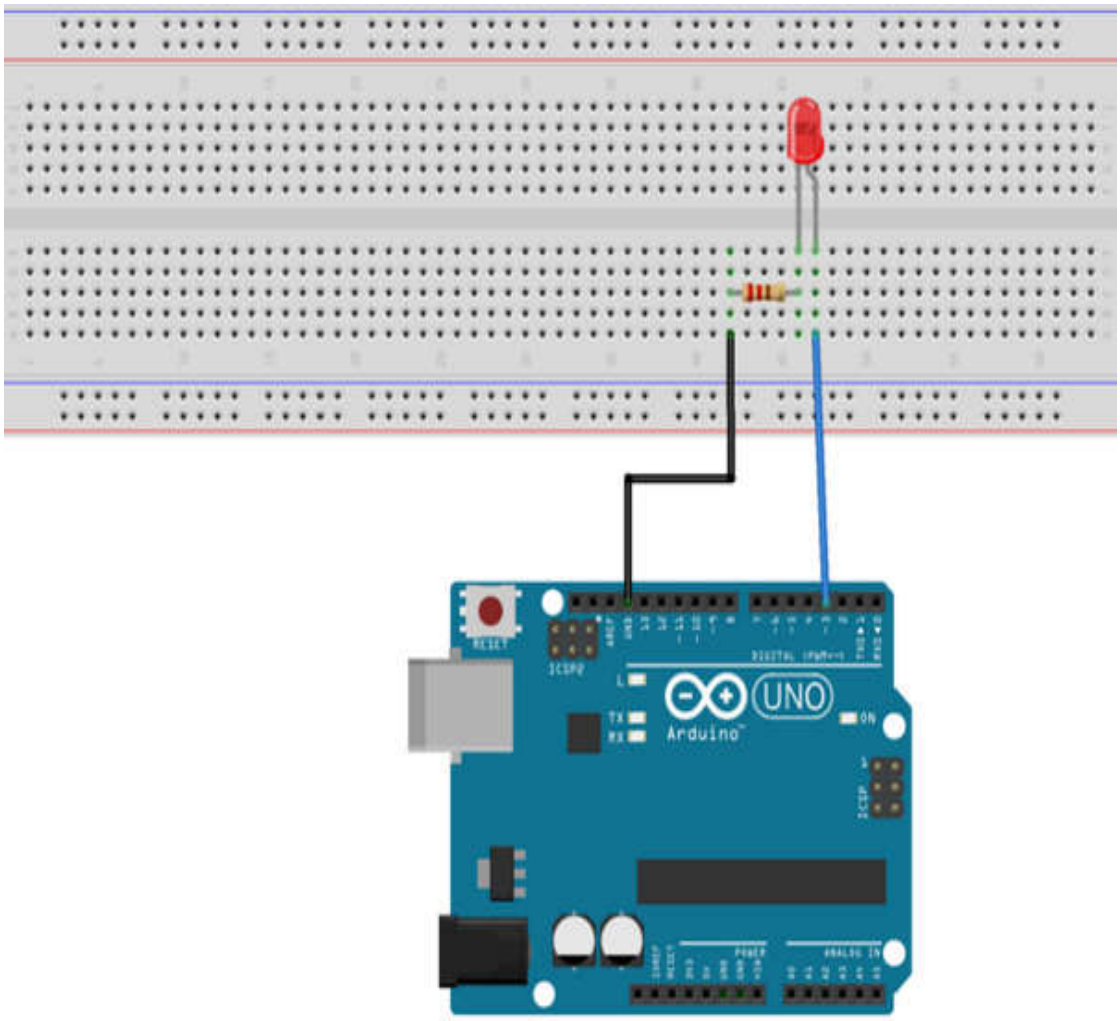


Fig 3.7: Connecting LED With Arduino.

6.1.2 The Lighting Management Flowchart:

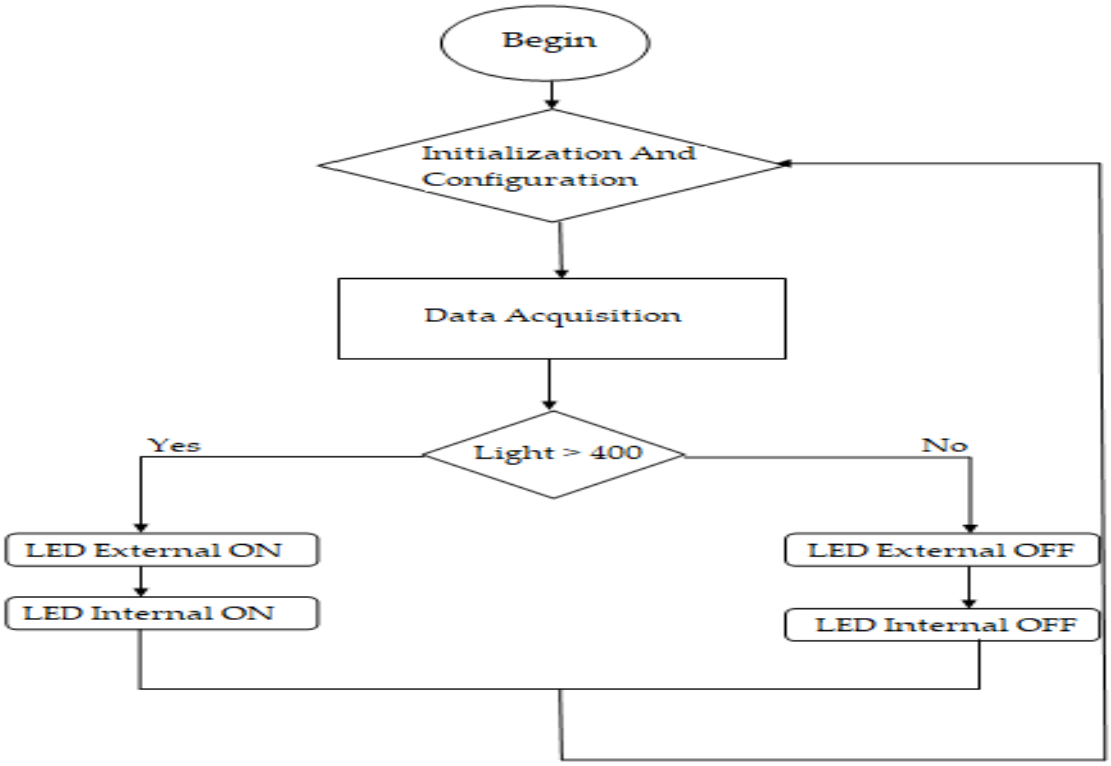


Fig 3.8: Lighting Management Flowchart.

6.2 Gas leak detection function:

Safety has become a key element in choosing a home. And one of the biggest fears of accidents is fire and suffocation. So i have associated different components to create a gas detector. Any gas leak into the air in the room will open the window using a servo motor.

6.2.1 Materials:

A. Arduino UNO.

B. MQ-9.

C. Buzzer.

D Servomotor

E. Resistor 220 ohm.

B. MQ-9 Semiconductor Sensor for CO/Combustible Gas:

Sensitive material of MQ-9 gas sensor is SnO2, which with lower conductivity in clean air. It makes detection by method of cycle high and low temperature, and detect CO when low temperature (heated by 1.5V). The sensor's conductivity is higher along with the gas concentration rising. When high temperature (heated by 5.0V), it detects Methane, Propane etc. combustible gas and cleans the other gases adsorbed under low temperature. Please use simple electro circuit, convert change of conductivity to correspond output signal of gas concentration. MQ-9 gas sensor has high senility to Carbon Monoxide, Methane and LPG. The sensor could be used to detect different gases contains CO and combustible gases, it is with low cost and suitable for different application.

Character:

- Good sensitivity to CO/Combustible gas
- High sensitivity to Methane, Propane and CO
- Long life and low cost
- Simple drive circuit

Application:

- Domestic gas leakage detector
- Industrial gas detector
- Portable gas detector

Connecting MQ-9 with Arduino UNO:

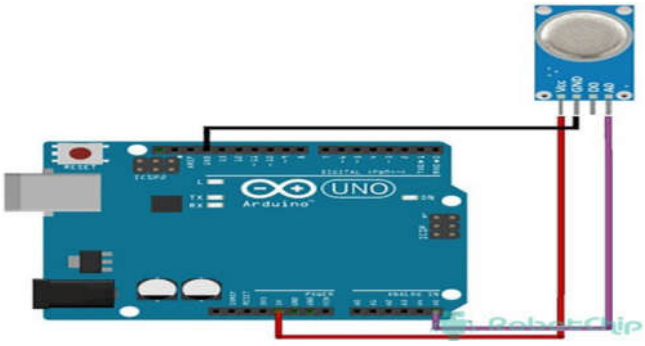


Fig 3.9: Connecting MQ9 with Arduino.

A. Buzzer:

A **buzzer** is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications. There are two types are buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But the one shown here is most widely used because it can be customized with help of other circuits to fit easily in our application. This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

Applications of Buzzer :

- Alarming Circuits, where the user has to be alarmed about something.
- Communication Equipment.
- Automobiles électroniques.
- Portable equipment's, due to its compact size.

Buzzer Features and Specifications :

- Rated Voltage : 6V DC
- Operating Voltage : 4-8V DC
- Rated curent : <30mA
- Sound Type : Continuos Beep
- Résonant Frequency : ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

Connecting of a buzzer with Arduino UNO:

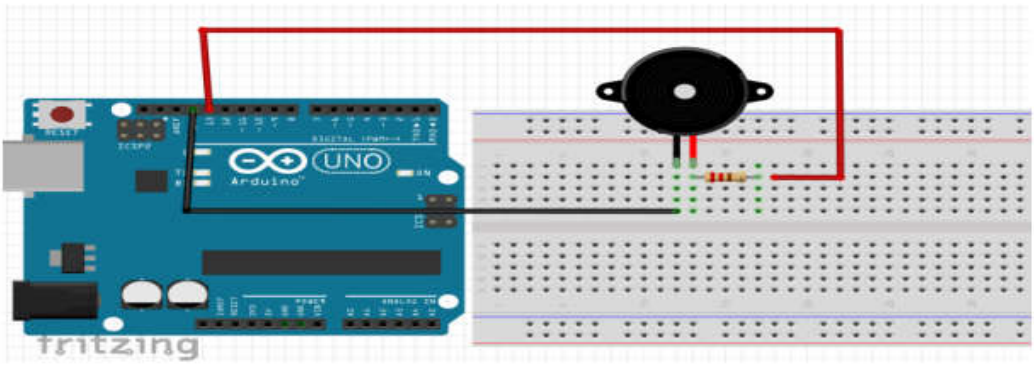


Fig 3.10: Connecting Buzzer with Arduino.

D. Servo Motor:

Definition:

A **servo motor** is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through **servo mechanism**. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages. Doe to these features they are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc.

Servo Mechanism:

It consists of three parts:

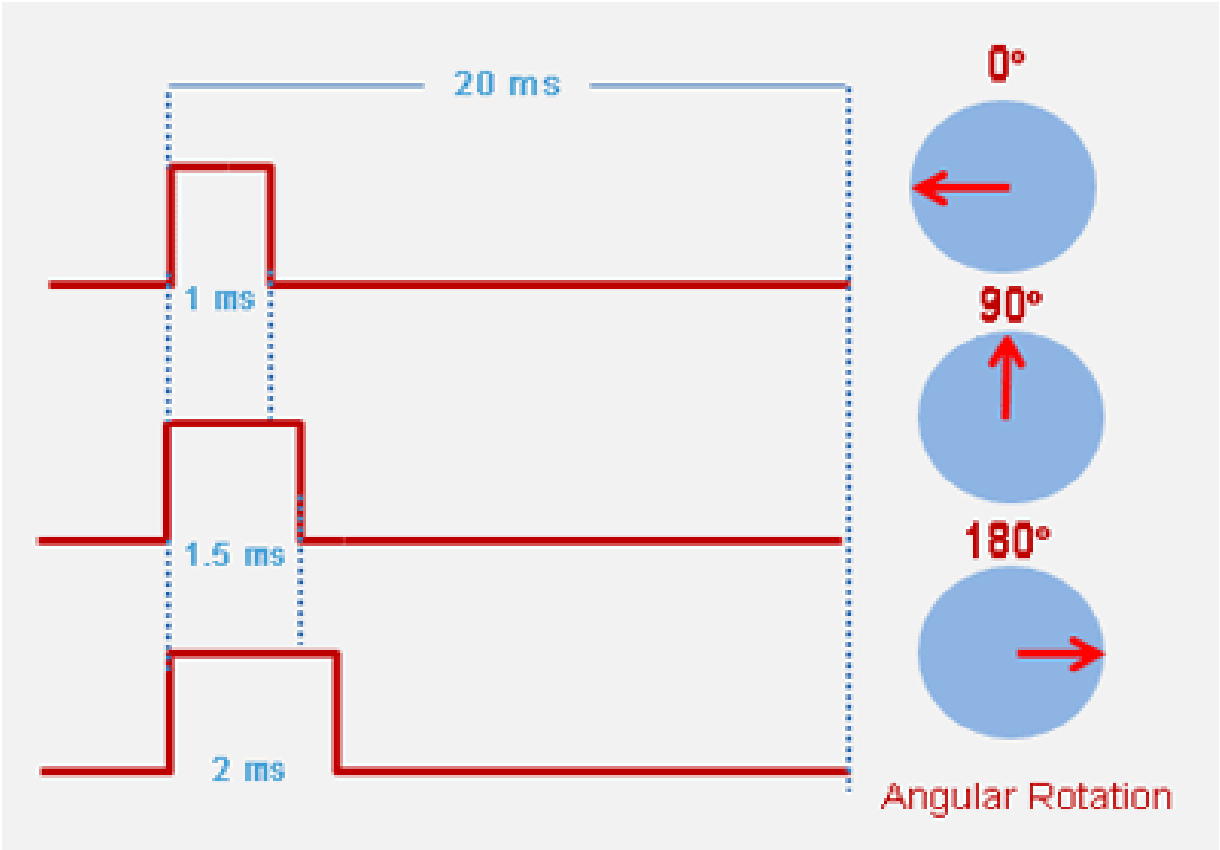
1. Controlled device
2. Output sensor
3. Feedback system

Controlling Servo Motor:

All motors have three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is to be sent from the MCU.

Servo motor is controlled by PWM (Pulse with Modulation) which is provided by the control wires. There is a minimum pulse, a maximum pulse and a repetition rate. Servo motor can turn 90 degree from either direction form its neutral position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns.

For example, a 1.5ms pulse will make the motor turn to the 90° position, such as if pulse is shorter than 1.5ms shaft moves to 0° and if it is longer than 1.5ms than it will turn the servo to 180°.Servo motor works on PWM (Pulse width modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Basically, servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears. High speed force of DC motor is converted into torque by Gears. We know that WORK= FORCE X DISTANCE, in DC motor Force is less and distance (speed) is high and



in Servo,

Fig 3.11: Servo Motor PWM.

force is High and distance is less. Potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on required angle.Servo motor can be rotated from 0 to 180.degree, but it can go up to 210 degree, depending on the manufacturing. This degree of rotation can be controlled by applying the **Electrical Pulse** of proper width, to its Control pin. Servo checks the pulse in every 20 milliseconds. Pulse of 1 ms (1 millisecond) width can rotate servo to 0 degree, 1.5ms can rotate to 90 degree (neutral position) and 2 ms pulse can rotate it to 180 degree.

Servomotor connection with Arduino UNO:

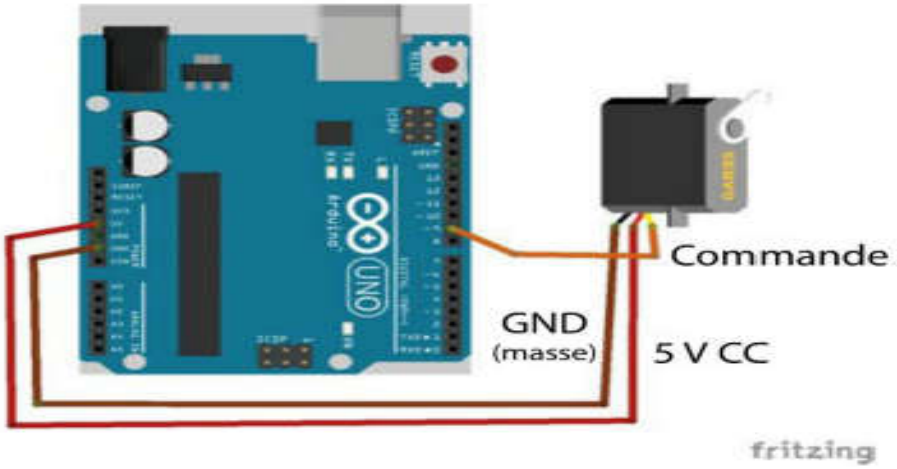


Fig 3.12: Connecting Servo Motor with Arduino.

6.2.2 The gas leak detection management flowchart:

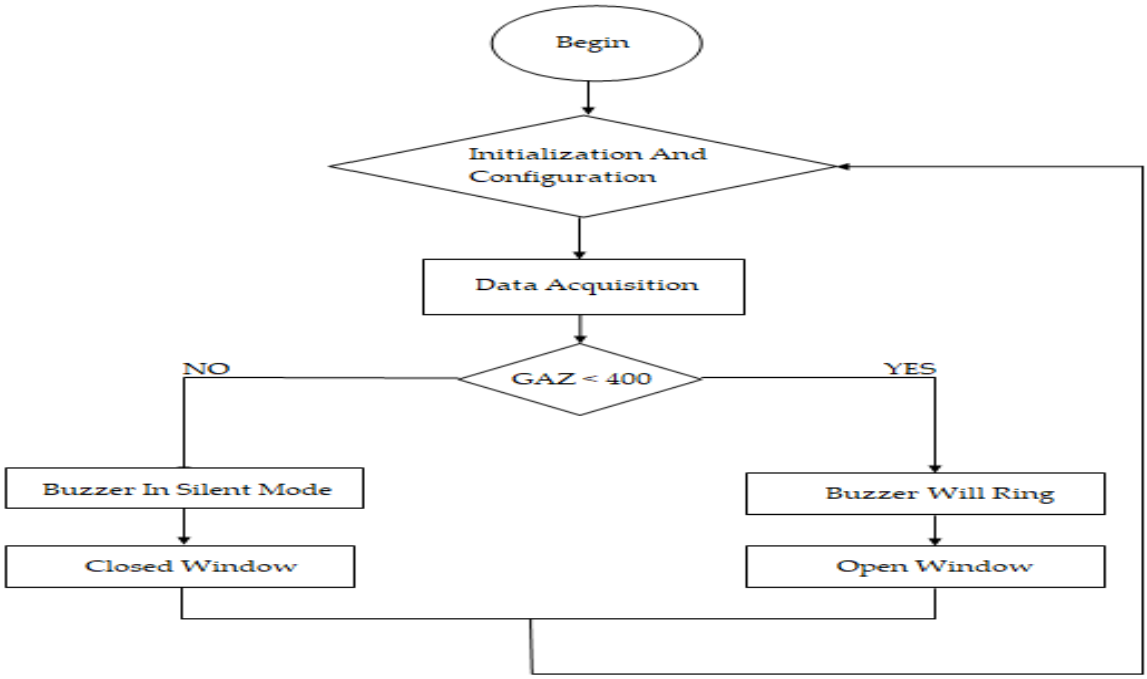


Fig3.13: The flowchart of gas leak detection management.

6.3 Ventilation management function:

The cost on heating or air-conditioning is an important part of the budget energy. Thus, in order to reduce this cost, we have created a device that supports the management of the ventilation according to a temperature detected by the DHT11, the fan turns on or off to adjust the ambient temperature. DHT11 accepts a power supply between 3.3 and 5.5V. We can therefore without problem connect these components to the 5V of an RPi, we used an external power supply to power the fan which is connected with the Arduino uno.

Passing to the software side:

The DHT11 program on python uses the AdafruitPythonDHT library of the Adafruit company to operate the sensor. It is downloadable Python library under MIT license.

6.3.1Materials :

A. Raspberry pi.

B. DHT11.

C. Resistor.

D. Arduino uno.

E. Ventilator.

F. Battery.

B. DHT11 Temperature & Humidity sensor:

1. Introduction:

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology,it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, o□erring excellent quality, fast response, anti-interference ability and cost-e□ectiveness.

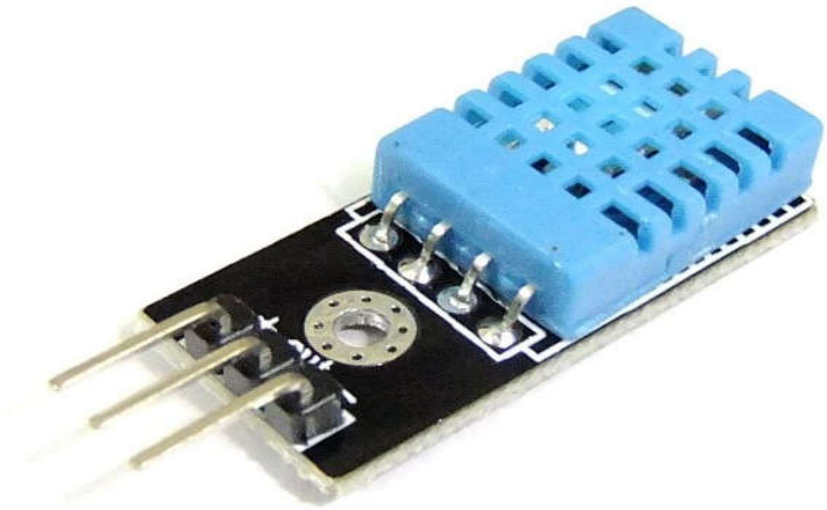


Fig 3.14: DHT11.

Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are usedby the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20-meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users'request.

2.TechnicalSpecifications:

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 □	±5％RH	±2□	1	4 Pin Single Row

Table 3.3 Technical specifications of the DHT11

Detailed Specifications :

Parameters	Conditions	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25□		±4%RH	
	0-50□			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0□	30%RH		90%RH
	25□	20%RH		90%RH
	50□	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25 □，1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term	Typical		±1%RH/year	

Stability				
Temperature				
Resolution		1□	1□	1□
		8 Bit	8 Bit	8 Bit
Repeatability			±1□	
Accuracy		±1□		±2□
Measurement Range		0□		50□
Response Time (Seconds)	1/e(63%)	6 S		30 S

Table 3.4 Detailed specifications of the DHT11

Power andPin:

DHT11's power supply is 3-5.5V DC. When power is supplied to the sensor, do not send any instruction to the sensor in within one second in order to pass the unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering.

Electrical Characteristics :

	Conditions	Minimum	Typical	Maximum
Power Supply	DC	3V	5V	5.5V
Current Supply	Measuring	0.5mA		2.5mA
	Average	0.2mA		1mA
	Standby	100uA		150uA
Sampling period	Second	1		

Table3.5 Electrical specifications of the DHT11

Note: Sampling period at intervals should be no less than 1 second.

WHAT IS RELATIVE HUMIDITY?

The DHT11 measures *relative humidity*. Relative humidity is the amount of water vapor in air vs. the saturation point of water vapor in air. At the saturation point, water vapor starts to condense and accumulate on surfaces forming dew. The saturation point changes with air temperature. Cold air can hold less water vapor before it becomes saturated, and hot air can hold more water vapor before it becomes saturated. The formula to calculate relative humidity is:

$$RH = (\frac{\rho_w}{\rho_s})\ x\ 100\%$$

$RH: \ Relative\ Humidity$
$\rho_w: \ Density\ of\ water\ vapor$
$\rho_s: \ Density\ of\ water\ vapor\ at\ saturation$

Relative humidity is expressed as a percentage. At 100% RH, condensation occurs, and at 0% RH, the air is completely dry.

HOW THE DHT11 MEASURES HUMIDITY AND TEMPERATURE:

The DHT11 detects water vapor by measuring the electrical resistance between two electrodes. The humidity sensing component is a moisture holding substrate with electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes, while lower relative humidity increases the resistance between the two electrodes.

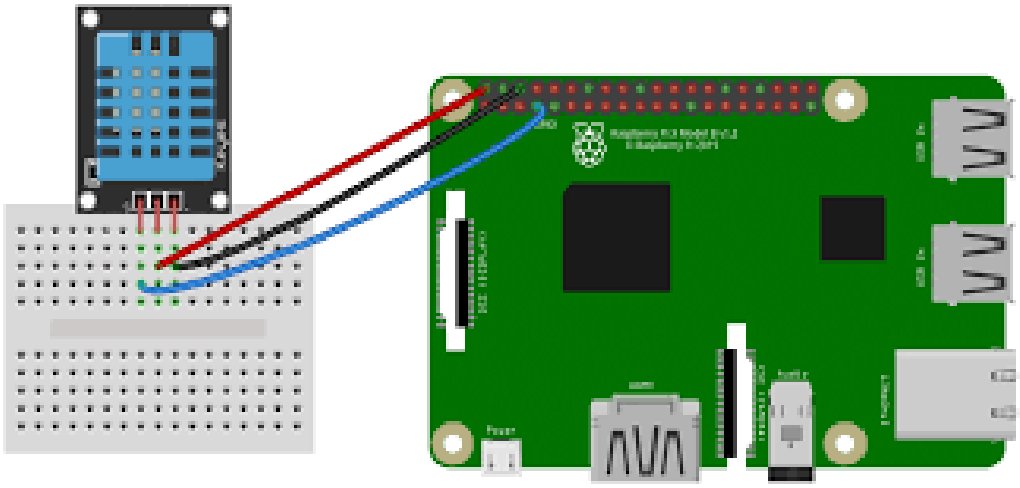


Fig 3.15: Connecting DHT11 with Raspberry Pi.

D. Ventilator:

The electric fan is one of the most popular electric devices due to its cost efficiency and low power consumption. It is a common circuit and widely used in many applications. It is also one of the solutions for providing comfort and energy saving. In fact, the fan has been in use for a long time and is still available in the market.

Fig 3.16: Ventilator.

6.3.2 The temperature and humidity management flowchart:

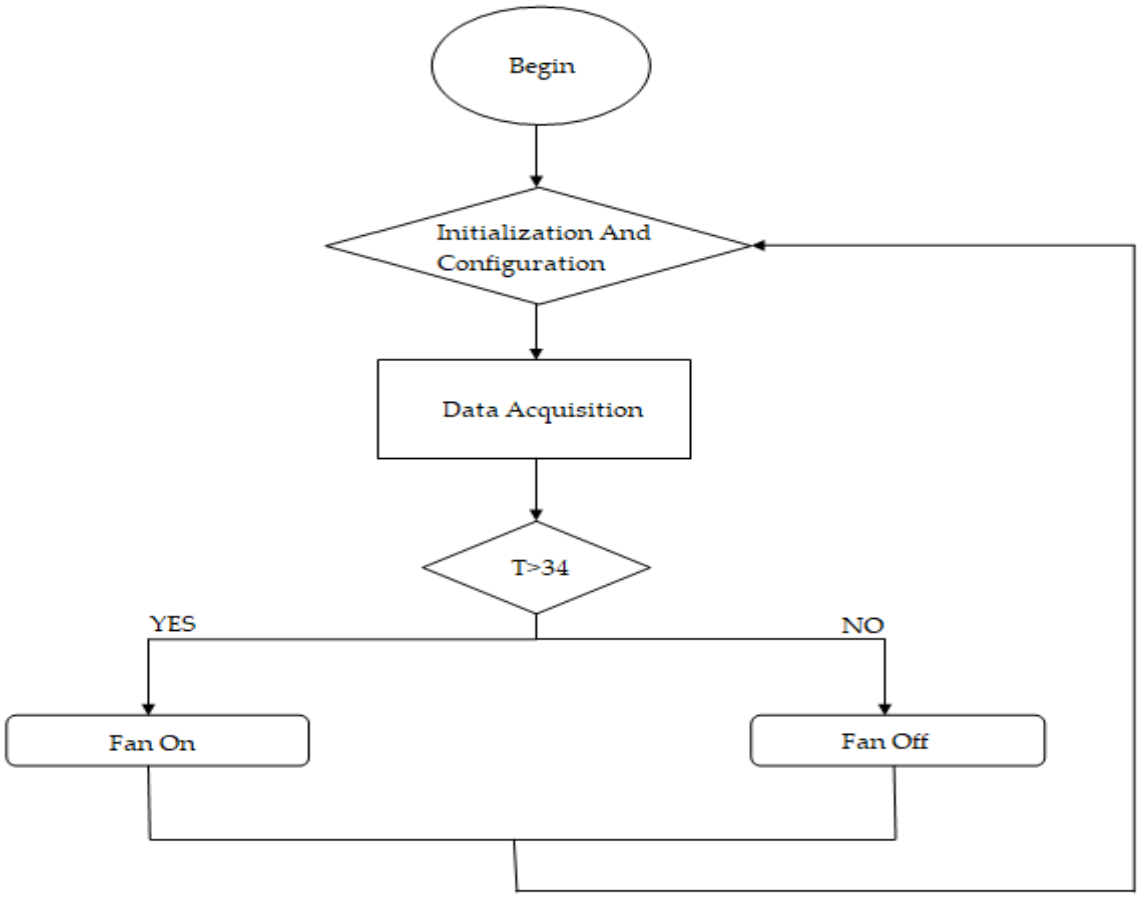


Fig 3.17: Temperature Management Flowchart.

7. Communicate with Arduino from a Raspberry Pi:

Arduino is a simple, robust, real-time machine. It also has an analog to digital converter.Raspberry Pi is a top-level machine that runs a complete Linux operating systemArduino was used to interact directly with sensors and outputs, and being controlled by the Raspberry Pi.

7.1 Bi-directional Communication Raspberry Pi Arduino UNO:

Internet of Things (IoT): Concepts and Applications. Cham: Springer International Publishing, 2020.This communication will allow data to be sent from the Arduino to the Raspberry and in the Raspberry to Arduino direction ... it mixes a one-way Raspberry Pi → Arduino UNO and one-way Arduino UNO → Raspberry Pi communication and it allows both

send and receive data from the other card on each card.Arduino communicates through the serial port via the USB.To read serial data from the Raspberry Pi, we use Python and PySerial.Serial communications are essential for all microcontrollers to communicate between the Arduino microcontroller and the RPI microcontroller.The Microcontroller sends these 1 and 0 (bits) containing the necessary information one by one orSerial. These bits will be transformed into bytes (composed of 8 bits).

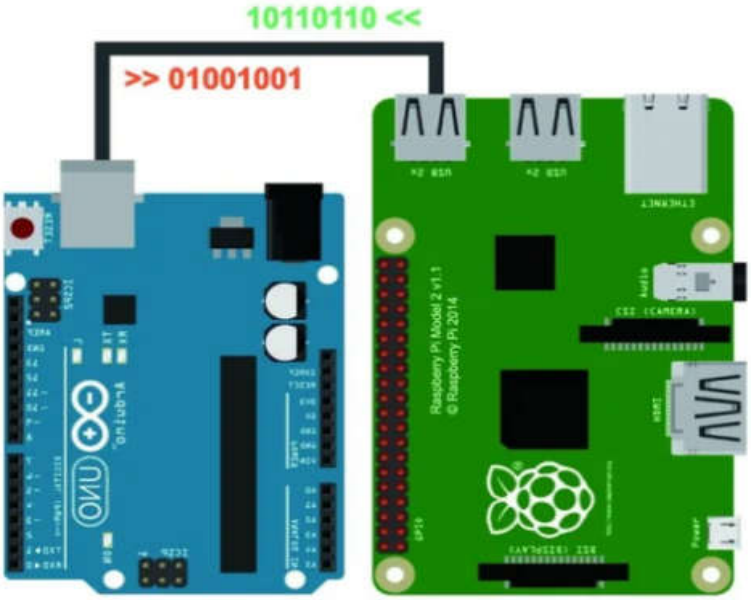


Fig 3.18: bidirectional communication between Arduino AND Raspberry pi.

8. The overall system flow chart:

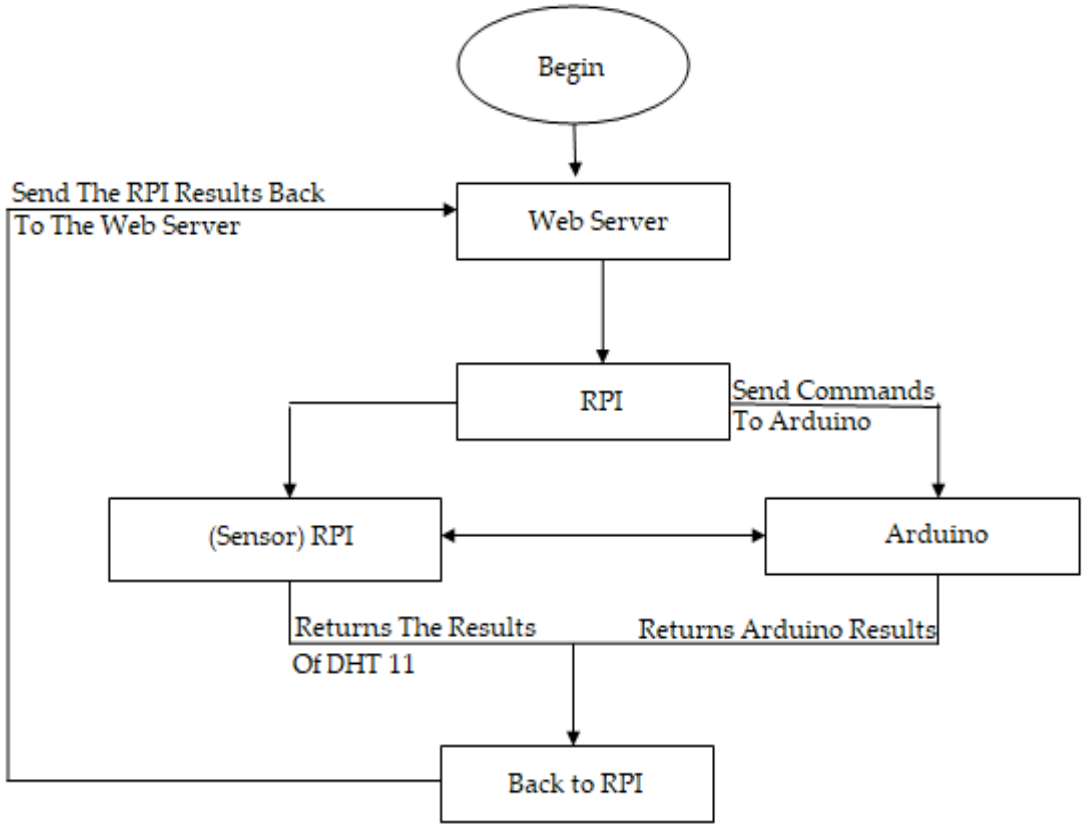


Fig 3.19: Overall Flowchart System.

9. Conclusion:

This chapter is very important, especially to understand the context of my project, and its content, including the hardware part and the software part. The next chapter is just as importantly, it is intended for the creation of the web page that is used to control the house.

ChapterIV :

Introduction

The successful completion of a project is based on a good approach that guarantees its success.: In this chapter, i will describe the process for creating the command interfaces, by highlighting the set of technologies used, the operation.

4.1 Design of the web page:

The central organ I have chosen for our home automation system is designed around a

raspberry pi board equipped with an Arduino board.

4.1.1 Choice of the development board:

Today the technology is heading toward automaton, IOT, Real time sensors monitoring, Data Acquisition, Robotics and Raspberry pi is a perfect device which is capable of doing all these things very efficiently so among all the existing development boards, i opted for the Raspberry pi board for reasons of simplicity of hardware and software implementation**.**The Raspberry pi 3b+ is a small size Single Board Computer (SCB) having almost the size of a credit card. It uses ARM (Advance RISE Machine) with clock speed 1.4 GHz 64Bit quad-core processor. Now a days it became very popular in the field of IOT (Internet of Thing), Data acquisition, Real time sensor monitoring, robotics, Home automation because of its low cost, small size and great performance.

Fig 4.1: Raspberry pi 3 B+.

Today the technology is heading toward automaton, IOT, Real time sensors monitoring, Data Acquisition, Robotics and Raspberry pi is a perfect device which is capable of doing all these things very efficiently.

For many years the work was done on Arduino but the difference is Arduino is a micro-controller and Raspberry pi is a microprocessor it can process the data very efficiently with its 1.4 GHz ,64 Bit Quad-core ARM processor.The Raspberry Pi is small size single board computer which can be use in various fields such as Robotics, IOT, Medicine, sensors monitoring, Data Acquisition system and many others, The price of Raspberry pi is low and due to its processing speed Pi based systems can be easily develop and also it is very helpful for making smart cities, smart home and smart systems. Lastly it can be said that Raspberry pi is a very efficient single board computer and it will play a significant role in making a smartworld.Raspberry pi is based on Linux and now windows Operating system is also available which is windows 10 IOT core various versions of operating system are Raspbian, Ubuntu Mate, Ubuntu core, OSMC, PiNet, RISC os these can be downloaded from Raspberry Pi forum. It supports python as its main programming language and it also supports BASIC, C,C++,JAVA, Perl and Ruby.

4.1.2 Specificationof Raspberry Pi 3b+:

Broadcom BCM2837B0, Cortex-A53 (ARM) 64-bit

•SOC 1.4 GHz 64-BIT quad-core CPU

- 1 GB RAM• USB 2.0=4 ports
- Video: Video Core IV 3D. Full-size HDM
- WIFI: Dual-band 802.11ac wireless LAN (2.4GHz and
- 5GHz) and Bluetooth 4.2

Ethernet: Gigabit Ethernet over USB 2.0 (max 300Mbps). Power-over-Ethernet support (with separate PoE HAT). Improved PXE network and USB mass storage booting.

- Camera Serial Interface (CSI), Display Serial Interface (DSI)

•40-GPIO (General purpose input/output) pins.

Raspberry Pi uses 40 GPIO pins it is use to take input and give output, in raspberry pi all the GPIO pins are digital pins they Cannot read Analog input or output so to connect the raspberry Pi with Analog sensor external ADC (Analog to Digital Converter) is required.

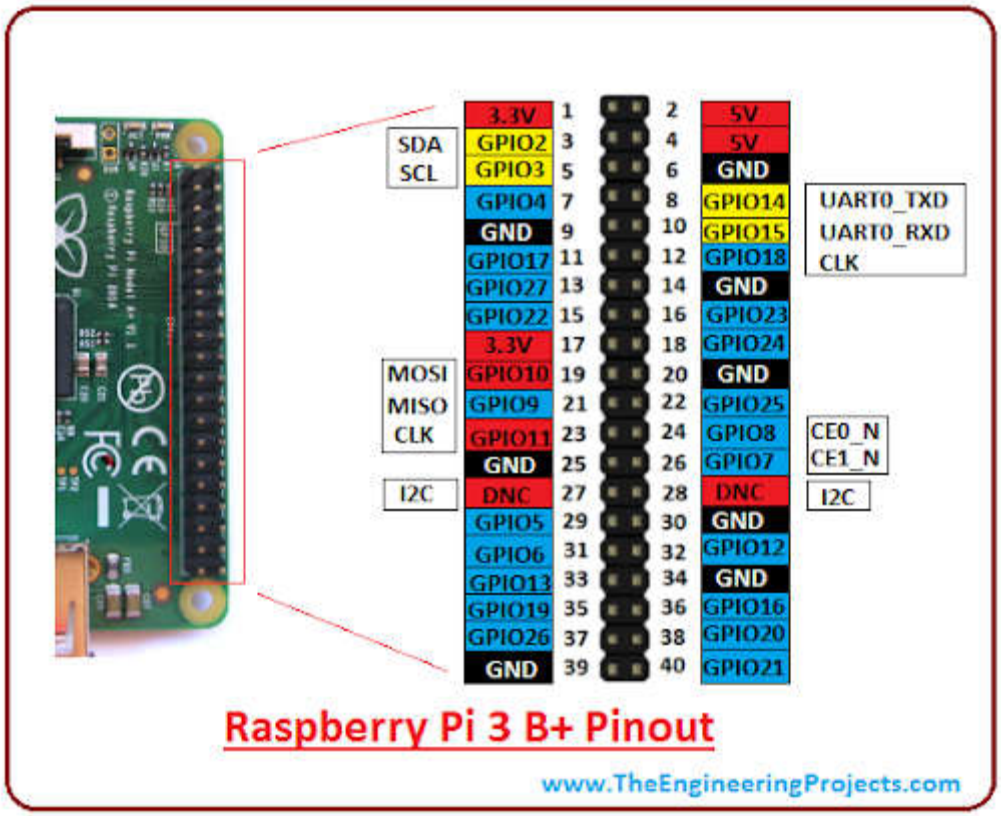


Fig 4.2: GPIO pins.

The Raspberry Pi is able to search for data on the Internet, but also offer it if you turn it into a web server. That's why I used one of the many software designed for this purpose, precompiled for Linux to build my web page. I used another category of tools that add functionality to dynamic languages such as Python, Flask. These extensions manage the network connection and allow scripts to automatically generate HTML pages. each time they receive a request from a web browser. This means is ideal for triggering physical actions, store data or remotely read the value of a sensor with our browser.so, I will describe the process of realizing my system highlighting all the development environments (software), as well as an overview of the interfaces of the website. Like all other computers, the Raspberry Pi uses an operating system. The one provided by default is a version of GNU / Linux called Raspbian1.GNU / Linux is ideal for the Raspberry Pi because it is free and open source. Not only does it make the platform cheap, but also very flexible and customizable. And you are not limited to Raspbian as there are other different versions (also called distributions) of Linux that you can load into the Raspberry Pi. A few non-Linux systems are also available.

4.1.3 Introduction to Linux:

From smartphones to cars, supercomputers and home appliances, home desktops to enterprise servers, the Linux operating system is everywhere. Linux has been around since the mid-1990s and has since reached a user-base that spans the globe. Linux is actually everywhere: It's in your phones, your thermostats, in your cars, refrigerators, Roku devices, and televisions. It also runs most of the Internet, all of the world's top 500 supercomputers, and the world's stock exchanges. But besides being the platform of choice to run desktops, servers, and embedded systems across the globe, Linux is one of the most reliable, secure and worry-free operating systems available.Just like Windows, iOS, and Mac OS, Linux is an operating system. In fact, one of the most popular platforms on the planet, Android, is powered by the Linux operating system. An operating system is software that manages all of the hardware resources associated with your desktop or laptop. To put it simply, the operating system manages the communication between your software and your hardware. Without the operating system (OS), the software wouldn't function.

4.1.4Why use Linux:

Linux is also distributed under an open source license. Open source follows these key tenants.

- The freedom to run the program, for any purpose.
- The freedom to study how the program works, and change it to make it do what you wish.
- The freedom to redistribute copies so you can help your neighbor.
- The freedom to distribute copies of your modified versions to others.

The command interface makes extensive use of HTML / CSS, python and http requests, they are all three complementary and essential to create a web page communicating with the raspberry pi server.

4.1.5 HTML and CSS:

To create a site, we have to give instructions to the computer. It is not enough to simply type the text that should be on the screen (as would be done in a word processor); it is also necessary to indicate where to place this text, insert images, make links between pages, etc.

HTML (Hypertext Markup Language):

Is the standard **markuplanguage** for documents designed to be displayed in a **webbrowser.** It can be assisted by technologies such as **CascadingStylesheets** (CSS) and **scripting languages** such as **JavaScript. Web** receive HTML documents from a **web server** or from local storage and **render** the documents into multimedia web pages. HTML describes the structure of a **web page semantically** and originally included cues for the appearance of the document.

CSS:

CSS is the language we use to style an HTML document. Stands for "Cascading Style Sheet." Cascading style sheets are used to format the layout of Web pages. They can be used to define text styles, table sizes, and other aspects of Web pages that previously could only be defined in a page's **HTML.**CSS helps Web developers create a uniform look across several pages of a Web site. Instead of defining the style of each table and each block of text within a page's HTML, commonly used styles need to be defined only once in a CSS document. Once the style is defined in cascading style sheet, it can be used by any page that references the CSS file. Plus, CSS makes it easy to change styles across several pages at once. For example, a Web developer may want to increase the default text size from 10pt to 12pt for fifty pages of a Web site. If the pages all reference the same style sheet, the text size only needs to be changed on the style sheet and all the pages will show the larger text.While CSS is great for creating text styles, it is helpful for formatting other aspects of Web page layout as well. For example, CSS can be used to define the cell padding of table cells, the style, thickness, and color of a table's border, and the padding around images or other objects. CSS gives Web developers more exact control over how Web pages will look than HTML does. This is why most Web pages today incorporate cascading style sheets.

4.1.6 Python:

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales. Python features a dynamic type system and automatic memory management.

It supports multiprogramming paradigms including oriented, imperative, functional and procedural, and has a large and comprehensive standard library.

Programming input/output with python:

Pins marked GPIO can be used as input, output pins in other words, any pin can be programmed as an input or output. In this sense I will use several programming languages capable of controlling these pins like C, Java, Bash...etc. but in my project, we opted for python to control these pins.

4.1.7 Flask:

Flask is a lightweight **WSGI** web application framework. It is designed to make getting started quick and easy, with the ability to scale up to complex applications. It began as a simple wrapper around **Werke** and **Jinja** and has become one of the most popular Python web application frameworks.

Why is Flask a good web framework choice?

Flask is considered more **Pythonic** than the **Django** web framework because in common situations the equivalent Flask web application is more explicit. Flask is also easy to get started with as a beginner because there is little boilerplate code for getting a simple app up and running.

Use of Flask in our project:

i will write code that will take care of the server-side processing. The code will receiverequests. It will determine what these requests process and what they ask for. Itwill also determine what response to send to the user.To do all of this, we'll be using Flask.

4.2 Organization of the project:

Flask, unlike other frameworks, does not impose a structure. i can quiet develop an entire application on one and the same file. But again, following certain conventions will be very useful later. Here they are:

- style sheets, scripts, images and other elements that will never be generated dynamically must be in the static folder.
- the HTML files must be in the templates folder.
- the tests must be in file thing.py contains the tests file.
- The thing.py file contains the objects and their declarations.
- the main.py file contains the different routes of the application.

A. Installation:

Use the following command to install Flask

```
pi@raspberrypi ~ $ sudo apt-get install python3-flask
```

B. Install Python:

Use the following command to install Flask

```
pi@raspberrypi ~ $ sudo apt-get update
pi@raspberrypi ~ $ sudo apt-get install python3.6
```

Flask is a module, so its installation is fairly standard, using the Terminal, create a new Python script

```
pi@raspberrypi ~ $ mkdir projet
pi@raspberrypi ~ $ cd projet
pi@raspberrypi ~ $ /projet $
```

The code allows us to run a basic web application that we can use, as if it were a website.

the code is stored in main.py.

```python
from flask import Flask

app = Flask(__name__)

@app.route("/")
def home():
    return "Hello, World!"

if __name__ == "__main__":
    app.run(debug=True)
```

- Here we import the Flask module and create a Flask web server from the Flask module.
- Name means this current file. In this case, it will be main.py. This current file will represent my web application.
- We create an instance of the Flask class and call it app. Here we are creating a new web application.
- When the user goes to my website and goes to the default page (nothing after the slash), the function below is enabled. [10]
- When you run your Python script, Python assigns the name "__main__" to the script when executed.
- This will launch the application. Having debug = True allows possible Python errors to appear on the web page. This will help us locate errors.

In the terminal or command prompt, navigate to the folder containing the main.py file. In the terminal or command prompt we should see this output

```
$ python main.py
 * Serving Flask app "main" (lazy loading)
 * Environment: production
   WARNING: Do not use the development server in a production environment.
   Use a production WSGI server instead.
 * Debug mode: on
 * Restarting with stat
 * Debugger is active!
 * Debugger PIN: 153-530-207
 * Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
```

The important part is where it says running on **http://127.0.0.1:5000**/127.0.0.1 means this local computer, the main idea is that 127.0.0.1 and localhost refer to this local computer.

When we go to this address, we should see the following:

C. Add HTML templates to the web:

- First, create a template in the project by:

```
projet $ cd templates
```

- Create index.html file on a Text editor program

```
/projet
main.py
/templates
index.html
```

- Enter HTML code

```
<!DOCTYPE HTML>
<html>
<header>
<title></title>
</header>
<body>
<h1>Hello from the Raspberry Pi</h1>
</body>
</html>
```

- Save the file.
- Return to main.py and modify the first line.

```
from flask import *
```

- * to import template file.
- Finally, we will need to modify our index view to return the HTML template.

```
@approute('/')
def index():
return render_template('index.html')
```

- Save file.
- Flask will look for the index.html file.
- Execute python main.py if Web has stopped.
- Refresh page to see our new HTML template displayed.

D. Browse other devices:

As I'm using host = '0.0.0.0' on the app.run line, means the web application will be accessible to any device on the network.The web server is accessible to any device on the same network, tablets and smartphones.

Presentation of interfaces:

- building an internet 'thing' with the Raspberry Pi, dives into creating a simple Python flask web application to turn on/off a LED and read a switch.

Here is the code:

```
import
thing
        from flask import *
        # Create flask app and global pi 'thing' object.
        app = Flask(__name__)
        pi_thing = thing.PiThing()
        # Define app routes.
```

```
# Index route renders the main HTML page.
@app.route("/")
def index():
    # Read the current switch state to pass to the template.
    switch = pi_thing.read_switch()
    # Render index.html template.
    return render_template('index.html', switch=switch)
# LED route allows changing the LED state with a POST
request.
@app.route("/led/<int:state>", methods=['POST'])
def led(state):
    # Check if the led state is 0 (off) or 1 (on) and set the
LED accordingly.
    if state == 0:
        pi_thing.set_led(False)
    elif state == 1:
        pi_thing.set_led(True)
    else:
        return ('Unknown LED state', 400)
    return ('', 204)
# Start the flask debug server listening on the pi port 5000
by default.
if __name__ == "__main__":
    app.run(host='0.0.0.0', debug=True)
```

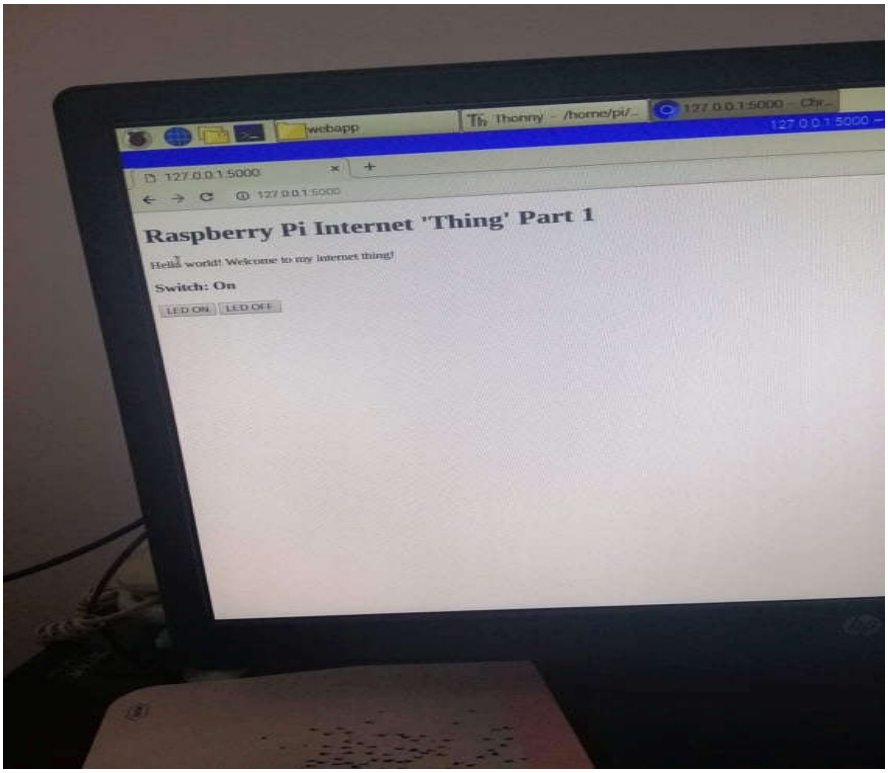


Fig 4.3: on/off LED and read switch.

- Making a nicer looking webpage with Bootstrap, and receive real time updates from the switch using HTML5 server sent events.

```
import
```

```
    def read_switch():
        while True:
            switch = pi_thing.read_switch()
            yield 'data: {0}\n\n'.format(switch)
            time.sleep(1.0)
    return Response(read_switch(),
mimetype='text/event-stream')
# Start the flask debug server listening on the pi
port 5000 by default.
if __name__ == "__main__":
    app.run(host='0.0.0.0', debug=True, threaded=True)
```

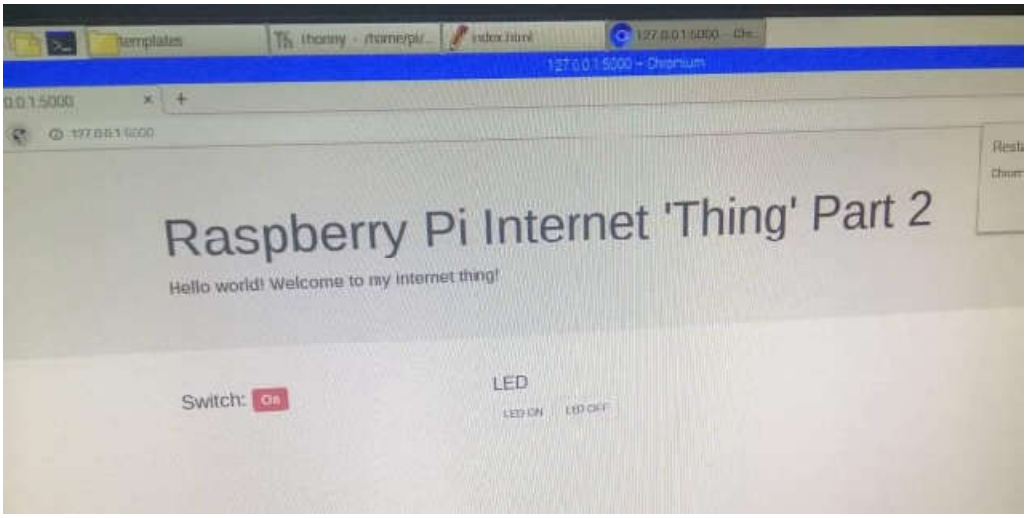


Fig 4.4: interface after using HTML.

- I add a DHT temperature & humidity sensor to the Pi and have it dynamically rendered its data in a chart on the webpage. The code:

```
import
json
        import random
        import time
        import thing
        from flask import *
        # Create flask app and global pi 'thing' object.
        app = Flask(__name__)
        pi_thing = thing.PiThing()
        # Define app routes.
        # Index route renders the main HTML page.
        @app.route("/")
        def index():
            # Read the current switch state to pass to the template.
            switch = pi_thing.read_switch()
            # Render index.html template.
            return render_template('index.html', switch=switch)
        # LED route allows changing the LED state with a POST
        request.
        @app.route("/led/<int:state>", methods=['POST'])
        def led(state):
            # Check if the led state is 0 (off) or 1 (on) and set the
        LED accordingly.
            if state == 0:
                pi_thing.set_led(False)
            elif state == 1:
                pi_thing.set_led(True)
            else:
                return ('Unknown LED state', 400)
```

```
    return ('', 204)
# Server-sent event endpoint that streams the thing state
every second.
@app.route('/thing')
def thing():
    def get_thing_values():
        while True:
            # Build up a dict of the current thing state.
            thing_state = {
                'switch': pi_thing.read_switch(),
                'temperature': pi_thing.get_temperature(),
                'humidity': pi_thing.get_humidity()
            }
            # Send the thing state as a JSON object.
            yield('data:
{0}\n\n'.format(json.dumps(thing_state)))
            # Wait a second and repeat.
            time.sleep(1.0)
    return Response(get_thing_values(), mimetype='text/event-
stream')
# Start the flask debug server listening on the pi port 5000
by default.
if __name__ == "__main__":
    app.run(host='0.0.0.0', debug=True, threaded=True)
```

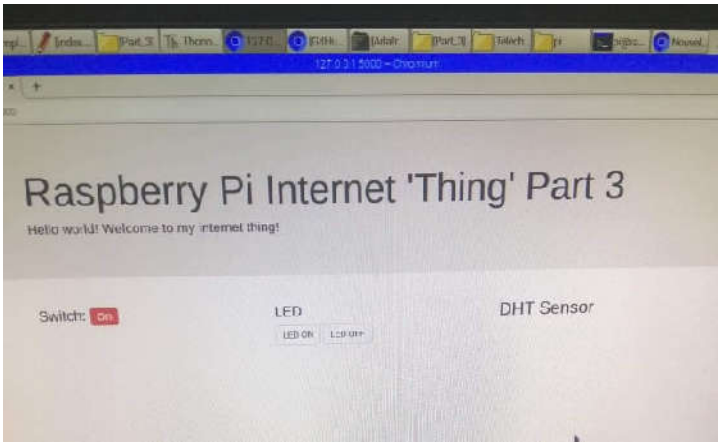


Fig 4.5: on/off LED and read switch and dht sensor.

Each function is illustrated by a representative icon that allows all devices connected to the system to be "on" or "off" respectively.

The degree of temperature and humidity recovered from a DHT11:

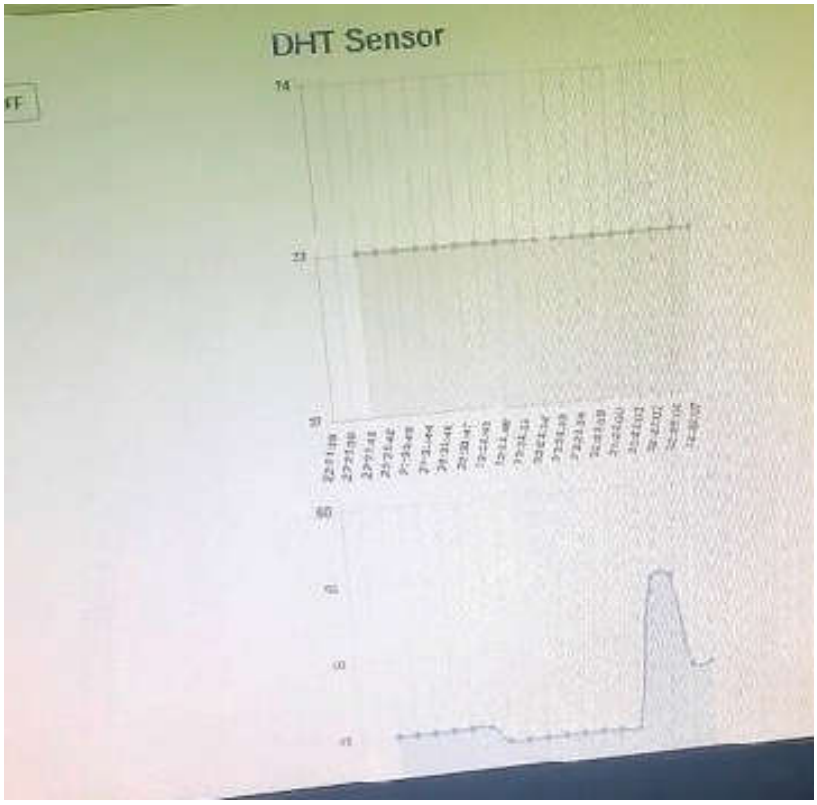


Fig 4.6:temperature and humidity graph.

I am improving this interface by developing the home page of the connection via the internet in which appear two fields, the user ID, and his password after authentication with the server.The user is redirected to this page (home interface) on which the user can consult the value of the sensors; control the light in the house, closing and opening the shutters, controlling the air conditioning, turning off the buzzer when the MQ9 sensor detects a gas leak.Each function illustrated by a representative icon which respectively enables all devices connected to the system to be turned “on” or “off”.

Conclusion:

In this chapter, I have presented the development and realization phase of this project.

General Conclusion

General conclusion:

Thanks to the development of communication technologies, computers, software and intelligent systems, future connected homes are no longer a utopia but a reality.This has given a new boost to the comfort of people in their homes. Thus, several new services are offered, among them we quote:

- ✓ Ensure the safety and protection of people.
- ✓ Improve comfort.
- ✓ Energy saving.

This issue has been the subject of much research. Thus, the opportunity that was offered to me to work on this issue through my end of study project entitled "Design of an iot platform based on sensor-actuator network for system automation" allowed me to gauge my ability to work under pressure, highlight the knowledge already acquired and acquire new ones. In addition, the problematic is a very recent and constantly evolving subject which will also allow me a continuous learning.In addition, in this thesis, i have illustrated the operation of a home automation systembased on Raspberry Pi, with the aim of designing the monitoring and control of home devices using a web page. Despite the scope and difficulty of this research topic, I was able to achieve the objectives assigned to this project which boils down to these three main points;

- ✓ Ordering via the internet.
- ✓ Monitoring the condition of the sensors.
- ✓ The creation of a so-called "intelligent" model, with intelligent scenarios.

Indeed, the contribution of this project is mainly summed up in the discovery of a new field called home automation, which is a very interesting and very vast and innovative field, in the same way it brought me a lot of knowledge. , and this allows me to say that the period of the realization of this project was an educational period, in spite of the home automation, i penetrated another field such as: the internet of things.During the course of this project I encountered several difficulties which essentially resided in not having completed the practical part due to COVID-19.As far as the prospects for continuation are concerned, several avenues can be considered as an indication and not an exhaustive one, i propose to examine and develop the following points:

- ✓ Develop a desktop application in such a way as to enrich the control system with other home automation functions.

- ✓ Add intrusion detection functionality while using a surveillance camera.
- ✓ Add a thermostat, can be controlled remotely.
- ✓ Management of multimedia.
- ✓ Add the function of a smart refrigerator with artificial intelligence, and connected to the internet and even accessible via a control interface, likewise, it controls the expiration date of the products, and informs the owner when this deadline has arrived.
- ✓ Improve the function of automatic lighting during someone's intrusion by adding proportional lighting with outdoor lighting.
- ✓ Add a function of opening and closing the shutters automatically according to the degree of brightness outside.
- ✓ The transition from the model to a real realization at the level of our own houses.

In conclusion, I really hope that this project can be used as a basis for further in-depth studies.

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