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Theme

Developing a smart embedded data collection system using microcontroller

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الملخص

شهدت السنوات الأخيرة زيادة سريعة في إستخدام تقنيات المنزل الذكي المبتكرة. إكتسب هذا الأخير قبول المستخدم أكثر وأكثر. إنترنت الأشياء IoT هو عبارة عن شبكة من مليارات الأجهزة المادية المتصلة بالإنترنت التي تجمع البيانات وتشاركها ، وهو مفهوم لكيفية جعل التكنولوجيا الحياة أسهل مثل الرعاية الصحية والمدن الذكية وأي جانب من جوانب حياتنا ، وهذا يكفي للسماح للناس التركيز على المجالات المنتجة والفعالة. بالإضافة إلى ذلك ، فإن منصات التشغيل الآلي للمنزل مفتوحة المصدر والتي لا تعتمد على التكنولوجيا والتي تعمل كمركز لمنزلك الذكي تساعد في أفضل الممارسات في مجال المباني الذكية.

الغرض النهائي من هذه الورقة البحثية هو دمج هذه التقنيات في منزل ذكي وفي أي بيئة لتكون ذكية وإنشاء بنية تحتية كبيرة وجمع البيانات حول كل ما نريد من حولنا وتخزينه وكل هذا بطريقة بسيطة باستخدام مجموعة نظام البيانات. إذن ، كيف يمكننا جمع البيانات من أشياء متعددة في بيئة ذكية.

الكلمات المفتاحية: إنترنت الأشياء، المنزل الذكي، البيانات، المدينة الذكية، نظام جمع البيانات.

Résumé

Ces dernières années ont vu une augmentation rapide de l'utilisation de technologies innovantes pour la maison intelligente; ce dernier est de plus en plus accepté par les utilisateurs. Internet des objets L'IoT est le réseau de milliards d'appareils physiques connectés à Internet collectant et partageant des données. Il s'agit d'un concept dont la technologie facilite la vie, comme les soins de santé, les villes intelligentes et tout aspect de notre vie, cela suffit pour permettre aux gens de se concentrer zones productives et efficaces. De plus, les plates-formes domotiques open source indépendantes de la technologie qui fonctionnent comme le centre de votre maison intelligente contribue aux meilleures pratiques dans le domaine des bâtiments intelligents.

Le but final de ce document de recherche est d'intégrer ces technologies dans une maison intelligente et dans n'importe quel environnement pour être intelligent et créer une grande infrastructure et collecter des données sur tout ce que nous voulons autour de nous et le stocker et tout cela de manière simple à l'aide d'une collection système de données. Alors, comment pouvons-nous collecter des données à partir de plusieurs choses dans un environnement intelligent.

Mots clés: Internet des objets, maison intelligente, données, ville intelligente, système de collection de données.

Abstract

Recent years have seen a rapid increase in the use of innovative smart home technologies; this last has gained more and more user acceptance. Internet of things (IoT) is the network of billions of physical devices connected to the internet collecting and sharing data and it's a concept of how technology makes life easy like healthcare, smart cities, and any aspect of our lives, that enough to let people focus on productive and efficient areas. In addition, open-source technology-agnostic home automation platforms those run as the center of your smart home help in best practices in the area of smart buildings.

The ultimate purpose of this research paper is to integrate these technologies in a smart home and in any environment to be smart and make a big infrastructure and collect data about everything we want around us and store it and all this in a simple way using a collection data system. So, how we can collect data from multiple things in a smart environment.

Keywords: Internet of things, Smart home, Data, Smart city, Collection data system.

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General introduction

Today, technology has become an integrated part of people's lives. It has, and continues to influence many aspects of daily life and has allowed better social interaction. One of these technologies is the internet; the Internet is not only a source of information but has been providing many services in different fields such as smart home technology, ease of transportation, the ability to indulge in entertainment and media and has helped in the development in medicine [1]. The creation of many devices such as mobile phones and computers have caused many people to rely on technology to communicate with their friends, store information such as pictures, movies, documents, and music. The internet has become a common interface that many devices use in order to simplify the daily life of many people. Internet helps us to bring in with immediate solutions for many problems and also able to connect from any of the remote places which contribute to overall cost reduction and energy consumption and environmental conservation all this to increase users' awareness.

Home automation or sensible home may be delineated as introduction of technology within the home atmosphere to provide ease and protection to its occupants. By using the technology of the Internet of Things, the examination and execution of home automation have got additional average [2].

Various wireless technologies that are able to support some sort of remote knowledge transfer, sensing and management like Bluetooth, Wi-Fi and cellular networks are used to enter abundant levels of acumen within the home. Home automation for the older and disabled will offer raised quality of life for persons [3]. It may provide an interface to home appliances or the automation system itself, via telephone line or the internet, to supply management and observance via a smartphone or personal computer. The Internet might even be utilized in home automation that offers several decisions from economical use of energy to additional console, protection and safety. Even over great distances the user can monitor and manage their home gate, various appliances and

turn on/off the T.V without any human intervention. Despite these advantages, home automation has however received extensive approval and attention owing to its high significance and complexness [1]. All these decisions that it took from the data that come from our data collection devices at smart home.

Despite the development of technology to solve the problems of people and meet their requirements, but the requirements and problems do not stop appearing because the lives of people are continuing and increasing developmentally. Moreover, during this acceleration, the 24 hours are not enough for humans to take care of all the details of their life. People are always busy and preoccupied [1], things like how to get their lives better and expect what will happen in their daily lives and in their homes, we need to protect lives and advice people to be aware and look-up.

Internet of Things (IoT) presents an enormous opportunity and can solve many problems. A smart data collecting system is one of these applications of the IoT and it will be based on IoT, to collect data about all physical devices in the home and store this data on database to be useful in either make decisions or benefit people when to show this data as statics about devices' status to know everything happens in our home.

Through this modest work, the rest of the paper is structured as follows. Presentation of the various stage of building the system, from the stage of identifying the basics to one of the implementation. Furthermore, our work is divided into three sections. The first section presents the state of art and the works that near our system, collection data and IoT. The second section explains the conceptual stage and laying of the foundation for our system and the picture in our minds of our system. Finally, the third stage accounts for the realization of an automated data collection system prototype as well as implementing the storage of the collected data of any environment.

1st part

Related works

1.1 Introduction

In order to clarify the concepts and objectives of this work and the techniques that be used in many applications to collect data, we will discuss the concept of the Internet of things and their uses in the smart home in this section, especially the smart data collection system using microcontroller and what does provide concerning latest technologies and their characteristics to facilitate our daily lives. So, we will touch the Internet of things, the smart home, and the smart systems of data collection.

1.2 Internet of things

The Internet of things (IoT) is an emerging topic of technical, social, and economic significance, physical devices, consumer products, vehicles, sensors [1], home appliances around the world that are now connected to the internet, collecting and sharing data. Powerful data analytic capabilities that promise to transform the way we work and live. We can turn anything into part of the IoT where everything has a unique identifier. This adds a level of digital intelligence to the devices that enable them to communicate without a human being involved, and merging the digital and physical worlds [4][5].

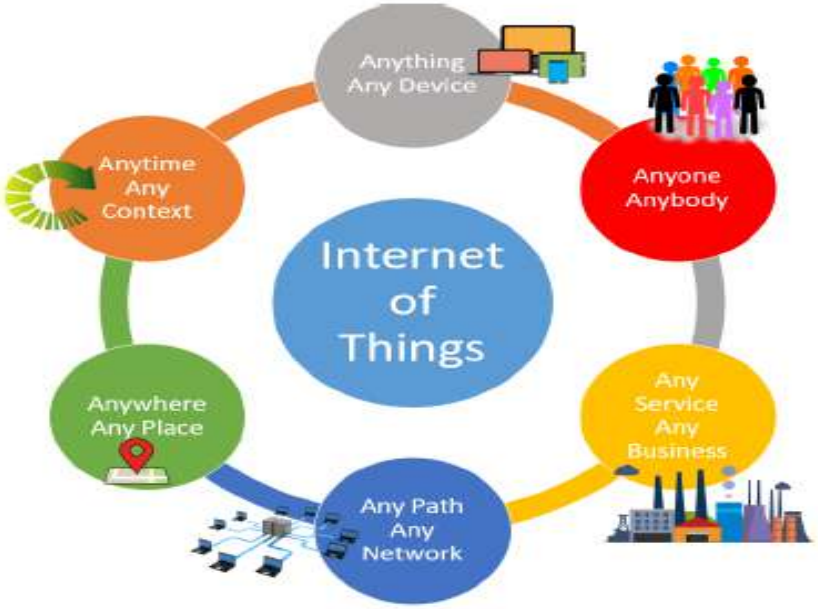

FIGURE 1 – Internet of things.

IoT can be defined as connecting the various types of objects like smartphones, personal computer and Tablets to the internet, which brings a newfangled type of communication between things and people and also between things. With the introduction of IoTs, the research and development of home automation are becoming popular in recent days [7].Additionally, various wireless technologies help in connecting from remote places to improve the intelligence of the home and any environment it uses in. An advanced network of IoT is being formed when a human being is in need of connecting with other things (smart network). IoT's technology is used to come in with an innovative idea and great growth for smart homes to improve the living standards of life [7].

Some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025 [1].The IoT allows sensing and remote control of objects across the network infrastructure leading to direct integration of the physical world into computer-based systems, thus improving accuracy, efficiency, and economic benefit [5].

When the Internet of Things technology is augmented with sensors and actuators, it becomes an extension of physical cyber systems, including smart networks, virtual power plants, smart homes, smart cities, intelligent transportation [5].

"Things," in the IoT context, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring, or field operation devices

that assists firefighters in search and rescue operations. Legal scholars suggest "things" as an "inextricable mixture of hardware, software, data, and service" [5].

So, the idea of IoT is becoming the concern of governments nowadays, many of them are racing to use technology in just about every aspect of their cities operations which means the combined use of Software System network infrastructure and client devices Smart City combined of so many parts like (smart building, smart Health, Smart government, smart Mobility smart economy).

Singapore is the is one of the most cities that collect data on daily living now they applying systems that can tell when people are smoking in prohibited Zone, Singapore launched its own smart Nation program in 2014 and they grated plenty of cameras in the street so the government can effectively monitor the crowd density, cleanliness of public spaces, all the above is based on software the can collect or gather the data and store it is what we called data collecting system.

The data collecting system is not only playing the rule of gathering data from sub-node (sensors, devices) or another node (another collecting system) but is responsible of recognizing and storing data, all the algorithms that we have from image treatment and machine learning to expectation algorithm they all based on data that got collected before in another way they based on data collecting system and with the help of many technologies, these devices collect useful information and then flow data with other devices autonomously [5].

Users can use a data collecting system as a simple dashboard that represents the data that we are trying to study, and even though the user has nothing to do with computer science but he still can understand because it's simple and effective.

1.2.1 IoT Platforms

A multi-layer technology that is used to manage and automate the connected devices is known as the IoT platform. In other words, it is a service that helps you in bringing the physical objects online [8], using Internet transport protocols to transmit information. Internet platforms are seen as a bridge between sensors and data networks [9].

1.2.1.1 IoT Architecture

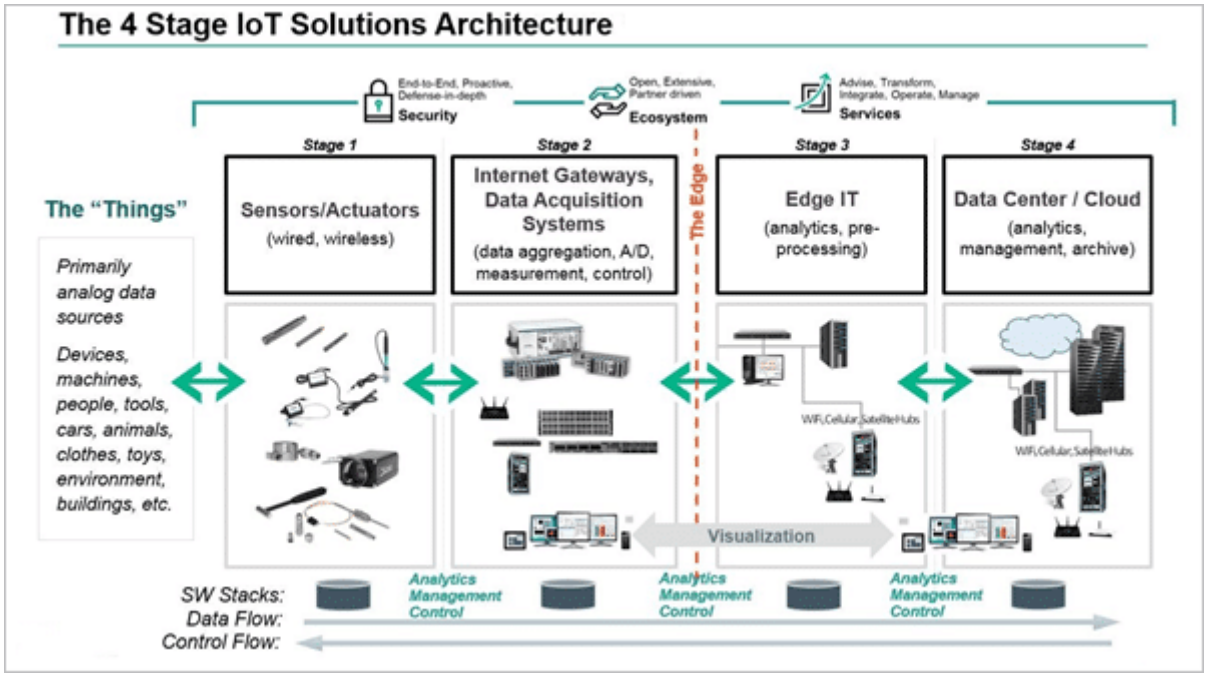

Figure 2 - The four stage architecture of the IoT system [8].

In the first stage, data is collected and converted into useful data. In the second stage, data is converted from an analog form to the digital form. In the third stage, Edge IT system does more analysis of data. At stage four, data which requires more processing and doesn't need immediate processing will be passed on to the data center or cloud-based systems [8].

The basic thing in the four layers is the data collected that we try to get it and work on it, so we work on the first layer to find a system of data collection. Some types of IoT platforms like End to End, Connectivity, Cloud and Data.

The primary function of the IoT platform is to act as middleware or as plumbing to connect devices or applications to another end. IoT contains a mixture of functions like Sensors & controllers, a gateway device, communication network, data analyzing & translating software, and end application service [8]. The following are some of the top IoT platforms on the market today:

- Amazon Web Services.
- Microsoft Azure.
- ThingWorx IoT Platform.
- IBM's Watson.

How to select the best Internet of Things platform depends on the requirements of a company for hardware, real-time access, custom reports, budget, development skills, and the business model [8].

1.2.2 Cloud computing

Instead of storing information and files on a hard drive or a local storage device, Cloud Computing is a way to deliver information technology (IT) services that retrieve resources through tools and applications on the Internet. And it's can handle huge data volume from devices, applications, websites, and sensors and take actions to give a real-time response [8]. The Cloud layer consists of a broker and the database. Broker connects to all the devices and database stores the data coming from the devices. Cloud-based storage lets the user save information in a remote database, as long as the user has access to the Internet, he or she has the right to access the database [10].

It's called cloud computing because the information being accessed is found in "the cloud" and does not require a user to be in a specific place to gain access to it. This type of system allows employees to work remotely. Companies providing cloud services enable users to store files and applications on remote servers and then access all the data via the internet [10].

1.3 IoT Applications

Internet of things examples extend from smart connected homes to wearable to healthcare and smartwatches which allow text messages and phone calls, fitness tracking, environment protection, and smart cities. It is not wrong to suggest that IoT is now becoming part of every aspect of our lives. Since there are many areas we will mention only some of them [9].

1.3.1 Wearables

Just like smart homes, wearables remain a hot topic among IoT currently. Wearable IOT technology is a wide range which includes fitness, health and entertainment equipment. Apart from this, there are plenty of other wearable devices that make our life easy, such as the Sony Smart B Trainer, LookSee bracelet, or the Myo gesture control [11]. The use of Internet technology in wearable applications requires highly energy efficient or ultra-low power and small-sized [9].

1.3.2 Smart Cities

Smart cities, like its name suggests, is a big innovation and spans a wide variety of use cases, from water distribution and traffic management to waste management and environmental monitoring. The reason why it is so popular is that it tries to remove the discomfort, poor infrastructure shortage of power supply, and problems of people who live in cities.

IoT solutions offered in the smart city sector solve various city-related problems, comprising of traffic, reducing air and noise pollution, and helping to make cities safer [11].

1.3.2.1 Examples of Smart Cities

As we said before there's Singapore one of the smart cities, Barcelona and Stockholm stand out on the list of smart cities. Barcelona has a CityOS project, where it aims to create a single virtualized OS for all the smart devices and services offered within the city. Barcelona has mainly focused on smart transportation and smart water. Where Stockholm started way back in 1994 and its first step in this direction was to install an extensive fiber-optic system. Subsequently, the city added thousands of sensors for smart traffic and smart water management applications, recently the city created a smart parking system, where it is possible to easily locate parking spots nearby. Parking lots have sensors, which let a server know about their usage [12].

1.3.3 Healthcare

IoT appliances have proven really beneficial in the health and wellness domains. Many wearable devices are being developed, which monitor a person's health condition. An example of this is UroSense and its function is to measure the Core Body Temperature (CBT). This intelligent monitoring will avoid many diseases such as cancer, diabetes, heart failure, and other diseases [9].

Health applications make independent living possible for the elderly and patients with serious health conditions. Currently, IoT sensors are being used to continuously monitor and record their health conditions and transmit warnings in case any abnormal indicators are found. If there is a minor problem, the IoT application itself may suggest a prescription to the patient.

IoT applications can be used in creating an Electronic Health Record (EHR), which is a record of all the medical details of a person. It is maintained by the health system. An EHR can be used to record allergies, surges in blood sugar and blood pressure. In the fitness sector, we have applications that monitor how fit we are based on our daily activity level. Smartphone accelerometer data can be used for activity detection by applying complex algorithms. For example, we can measure the number of steps taken and the amount of exercise done by using fitness trackers. Fitness trackers are available in the market as wearables to monitor the fitness level of an individual. In addition, the gym apparatus can be fitted with sensors to count the number of times an exercise is performed [12].

1.3.4 Agriculture

Smart farming is often overlooked in IoT applications. The Internet provides the agricultural sector with technological solutions that represent a better working environment for the farmers. Environmental parameters such as temperature, humidity, and soil information are measured in real-time and sent to a server for analysis are important for agricultural production. All that by using Sensors are used by farmers to measure such parameters and this data can be used for efficient production and improved yield and expectations of harvest [9].

Pesticide residues in crop production are detected using an Acetylcholinesterase biosensor. This data is saved and analyzed for extracting useful information such as the sample size, time, location, and amount of residues. We can thus maintain the quality of the crop [12].

Air pollution is an important concern today because it is changing the climate of the earth and degrading air quality. Vehicles cause a lot of air pollution. An IoT application proposed by Manna et al. Monitors air pollution on the roads. It also tracks vehicles that cause an undue amount of pollution. Electrochemical toxic gas sensors can also be used to measure air pollution. Vehicles are identified by RFID tags. RFID readers are placed on both sides of the road along with the gas sensors. With this approach, it is possible to identify and take action against polluting vehicles [12].

Smart farming has the potential to become an important application field, specifically in the agricultural-product exporting countries.

1.3.5 Smart Home

Smart homes are becoming more popular today because of two reasons. First, the sensor and actuation technologies along with wireless sensor networks have significantly matured. Second, people today trust technology to address their concerns about their quality of life and security of their homes. So, an intelligent home is a comfortable home equipped with devices that can be automatically controlled remotely from anywhere using connected networks, mobile devices, or others. Smart home consists of interconnected devices through the Internet and these devices have functions to facilitate intelligent home control such as security access, temperature, lighting, and Home Theater. Home automation and smart building are terms related to the smart home [13].

In smart homes, various sensors are deployed, which provide intelligent and automated services to the user. They help in automating daily tasks and help in maintaining a routine for individuals who tend to be forgetful. They help in energy conservation by turning off lights and electronic gadgets automatically. We typically use motion sensors for this purpose. Motion sensors can be additionally used for security also [12].

For example, the project MavHome provides an intelligent agent, which uses various prediction algorithms for doing automated tasks in response to user-triggered events and adapts itself to the routines of the inhabitants. Prediction algorithms are used to predict the sequence of events in a home [12] [14].

Energy conservation in smart homes is typically achieved through sensors and context awareness. The sensors collect data from the environment (light, temperature, humidity, gas, and fire events). This data from heterogeneous sensors is fed to a context aggregator, which forwards the collected data to the context-aware service engine. This engine selects services based on the context. For example, an application can automatically turn on the AC when the humidity rises. Or, when there is a gas leak, it can turn all the lights off [12] [15].

Smart home applications are really beneficial for the elderly and differently-abled. Their health is monitored and relatives are informed immediately in case of emergencies. Floors are equipped with pressure sensors, which track the movement of an individual across the smart home and also help in detecting if a person has fallen down. In smart homes, CCTV cameras can be used to record events of interest. These can then be used for feature extraction to find out what is going on.

1.5.3.1 Smart embedded data collection system using microcontroller

Smart embedded data collection system using microcontroller can collect data from any environment either we need to study about it or to do reports; any study about anything needs real data. So we work on the device layer in all the systems that use this part that system provides collect data we look for. As stated earlier, we rely on a data collection system which provides both sensation and transmission.

The data acquired includes the occupancy of different areas, environmental attributes, and interactions between occupants and devices. Sensory devices are responsible for data collection and a variety of sensors are readily available to perform this task [16].

This system will be able to send data from environment that it in according the sensors we use and the request on this data.

Several elements and objects pertaining to a system are interlinked via IoT with the help of digital controllers, meters and sensors. This system allows generation and accumulation of data via internet or where we store this data with zero human interaction [17].

1.5.3.2 Related work of the system

A. The use of traditional on-road sensors (e.g. inductive loops) for collecting data is necessary but not sufficient because of their limited coverage and expensive costs of implementation and maintenance. In the last years, we have been witnessing the emergence of alternative data sources.

Broadly speaking, technologies refer to traffic data measured by the means of detectors located along the roadside. Generally, traffic count technologies can be split into two categories: the intrusive and non-intrusive methods. The intrusive methods basically consist of a data recorder and a sensor placing on or in the road. They have been employed for many years and the most important ones are briefly described hereafter: Piezoelectric sensors, Magnetic loops, and Manual counts [18].

B. The data gathering in wireless ad-hoc networks where a data mule traverses a set of sensors, each with vital information on its surrounding, and collects their data. The mule goal is to collect as much data as possible, thereby reducing the information uncertainty, while minimizing its travel distance.

Most of the work on data mules in ad-hoc networks is focused on finding efficient algorithms by means of energy or schedule, the authors' purpose a schema for collecting data from sensors that transmit messages at a specific rate.

C. The smart home system for remotely controlling and monitoring the smart home environment is presented. The system consists of an app developed using the Android platform and an Arduino Ethernet-based micro web-server. The Arduino microcontroller is the main controller that hosts the micro web-server and performs the necessary actions that needs to be carried out. The sensors and actuators/relays are directly interfaced to the main controller.

It relies on a data collection system which provides both sensation and transmission. The data acquired includes the occupancy of different areas, environmental attributes, and interactions between occupants and devices. Sensory devices are responsible for data collection and a variety of sensors are readily available to perform this task [19].

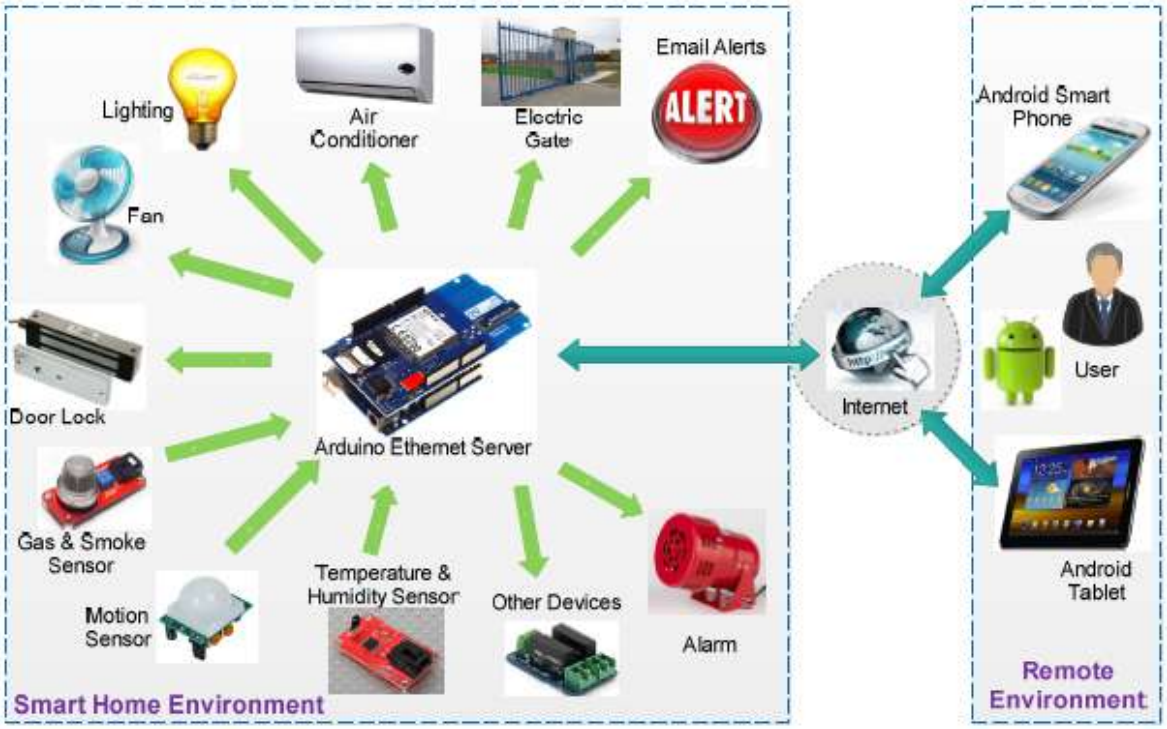

Figure 3 - System Architecture of the proposed Ubiquitous Smart Home [19].

D. The problem of rubbish, a waste collection solution based on providing intelligence to trashcans, by using an IoT prototype embedded with sensors, which can read, collect, and transmit trash volume data over the Internet. This data put into a Spatio-temporal context and processed by graph theory optimization algorithms can be used to dynamically and efficiently manage waste collection strategies.

Results: An IoT based prototype with sensors measuring the waste volume in trashcans or containers, with the capability of transmitting information to the Internet via a wireless link. This data is used to optimize the management and strategies of waste collection logistics.

Advantages:

- Joining forces with the goal of boosting up the efficiency of municipal services and increasing benefits and convenience to their communities.
- Quality of life, economy, sustainability and infrastructure management.

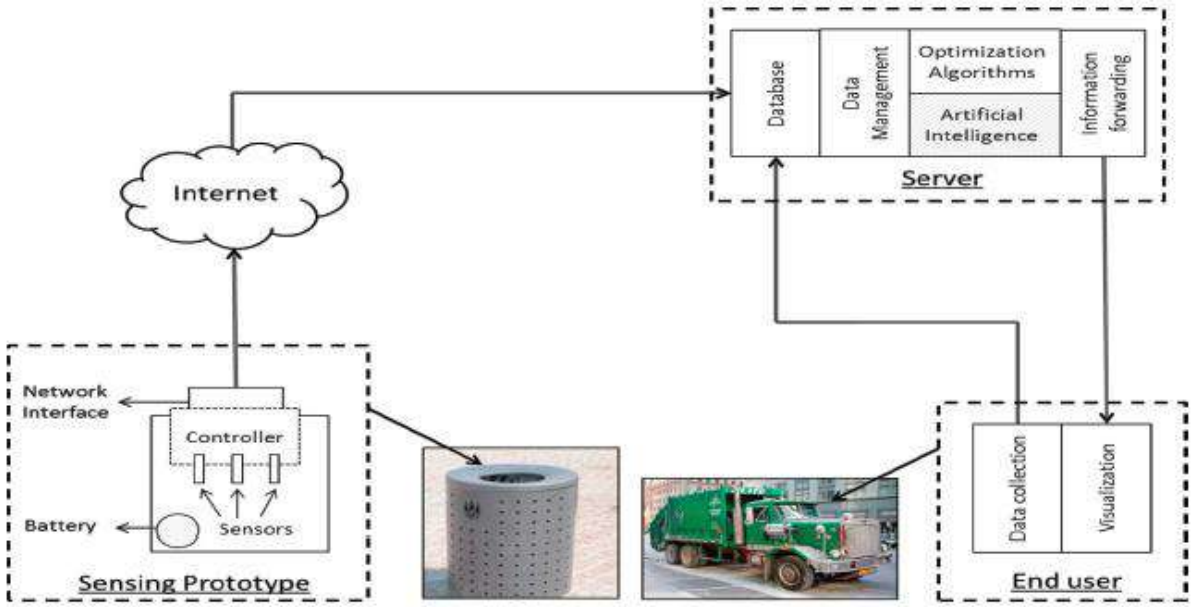

Figure 4 - System overview of the smart waste collection system [20].

E. Presentation of a realistic approach to obtaining the optimal performance from an IoT-based smart home monitoring system. Realistic application for activity detection and pattern forecasting for ambient assisted living raises different challenges. To offer a consistent solution, we have implemented a smart home, based on an integrated framework to analyse the inhabitants' activities from real-time data. The system is executed on two levels: hardware and software. At the hardware level, heterogeneous wellness sensors are deployed to get multi-activity and multi-event data, and to collect it into the server through a coordinator. The software modules are subdivided into different levels, such as data logging, data extraction and data storage; but their ultimate task is to forecast the change in activity and correlate it in real time or near real time with the wellness of an inhabitant.

The data has been collected and passed through data mining and machine learning algorithms for the decision-making process [21].

Figure 5 - Layout of sensor deployment in the smart home [21].

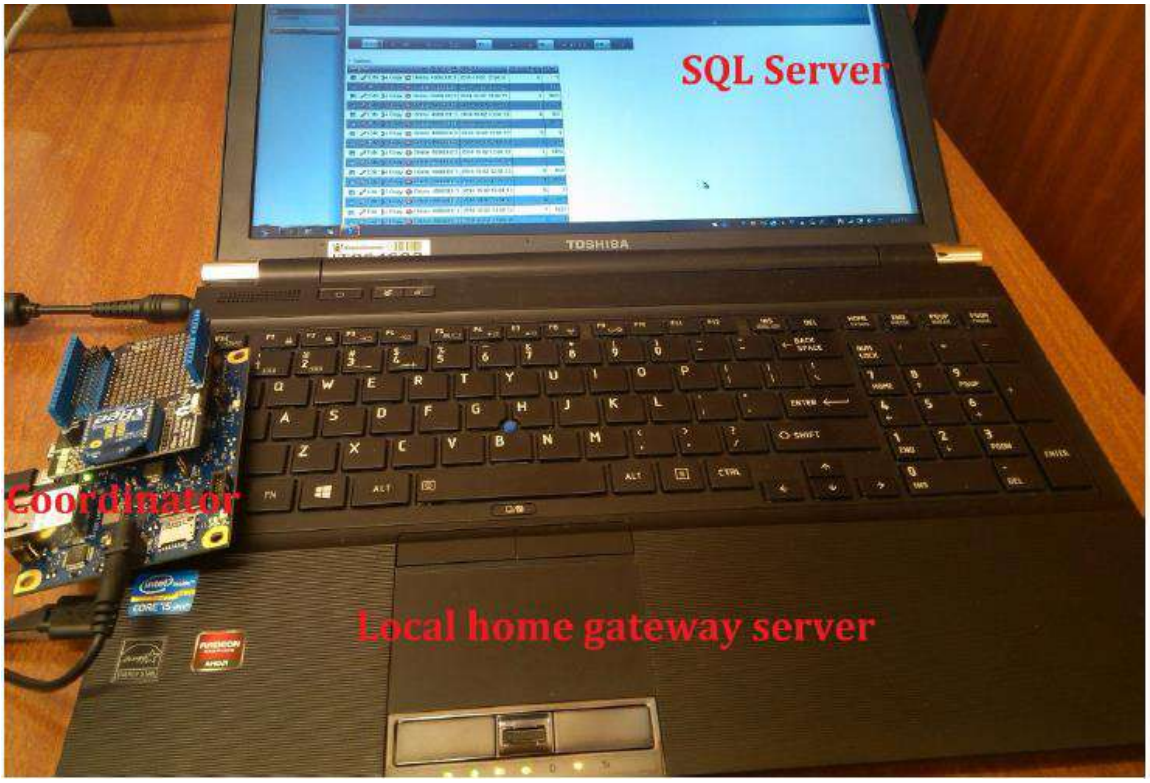

Figure 6 - Local home gateway server [21].

F. Automation plays a crucial role in all workplaces and living homes. Presently automation techniques are implemented either using a microcontroller or computer. Microcontrollers cannot run multiple programs at a time. With the use of Microcontroller, it is difficult to control both the appliances and surveillance at a time i.e., it is very complex to perform the multiple functions simultaneously. We can achieve this with the computer, but using the computer is very expensive for this purpose and consumes more power. The Raspberry Pi is a single-board computer and it can be used to overcome these problems. Simply, the Raspberry Pi system functions like a computer with a small setup. It contains GPIO and USB ports. Using these ports we can control the appliances with the sensors as well as interface the camera for surveillance. Raspberry Pi can be used for multiple purposes based on our requirements [22].

J. WSNs are designed and deployed for different purposes by various organizations. WSN based monitoring applications range from simple data gathering to complex Internet-based information systems. In other words, the observations obtained from sensor networks may be helpful in many software applications like environmental, industrial and meteorological monitoring, building and home automation, medicine, urban sensor networks, intelligent transportation, security, etc.

Sensor nodes consist of four basic elements: the sensor unit, processing unit, communication and power units. Sensor nodes are the small, low power single board computers with a radio for wireless communication. The number and types of sensors depends on the applications. Sensor nodes collect and transfer data using four stages: collecting the data, processing the data, packaging the data, and communicating the data [23].

1.4 The use of microcontroller in a smart data collecting system

The core functionality of the smart embedded data collection system using a microcontroller is collecting data from any environment because it's compatible with any environment is in it as a home, a city until a farm. All that by the available sensors in the system, that system provides a lot of hard in collecting data by the old ways, special in the places of big projects that we need information about it to decide the project will be successful or not or we can extract information from the data collected by using a machine learning.

1.5 Benefits and challenges of a smart embedded data collection system using microcontroller

A smart embedded data collection system using microcontroller comes with many benefits and in return there are some challenges, and in this part, we will talk about some of the benefits and challenges after the emergence of a the system.

A. Benefits

Regardless of the challenges, the system has been proposed to make our lives easier and find solutions to our problems. So, the biggest benefit is you will get a big data of what you need to do from collecting the data from the place that the system is it in and from any device connected with it because it has different protocols connect with devices like a smart home to its store it in a database. Save lives, by using the database in machine learning and learn from that data, or reducing energy consumption, etc.

B. Challenges

After we have viewed these various benefits, there are some risks attached to this upcoming system. Like any Internet-connected device and a system of a smart home, there are many challenges and issues with regard to smart home applications. There are many challenges and issues with regard to smart home applications. The most important is security and privacy since all the data about the events taking place in the home is being recorded. If the security and trustworthiness of the system are not guaranteed, an intruder may attack the system and may make the system behave maliciously. Smart home systems are supposed to notify the owners in case they detect such abnormalities [24]. In addition, sources of energy of this system to save energy of the home and we put it in the many different places in a home how to collect data and send the last result.

1.6 Source of Big data

The term is an all-inclusive one and is used to describe the huge amount of data that is generated by organizations in today's business environment. The thinking around big data collection has been focused on the 3V's – that is to say the volume, velocity, and variety of data entering a system. For many years, this was enough but as companies move and more and more processes online, this definition has been expanded to include variability — the increase in the range of values typical of a large data set.

1.6.1 The Sources of Big Data

The bulk of big data generated comes from three primary sources: social data, machine data, and transactional data. In addition, we need to make the distinction between data, in our case the data comes from smart home and we use the second type of source of data by using sensors to collect data. Let's define the type we are in...

Machine data is defined as information which is generated by industrial equipment, sensors that are installed in machinery. This type of data is expected to grow exponentially as the internet of things grows ever more pervasive and expands around the world. Sensors such as medical devices, smart meters, road cameras, satellites, games, and the rapidly growing Internet of Things will deliver high velocity, value, volume, and variety of data in the very near future [42].

No	Source of big data	Type of data	Data minning technique
1	Healthcare	Electronic Health Record (EHR) Medical Imaging Data Genetic Data	Natural language processing Content-based image retrieval system Penalised logistic regression
2	Social networking	Text Data Graph Data	Sentiment analysis Community detection Social influence analysis Collaborative filtering
3	CCTV surveillance	Video	Labour-based surveillance system
4	Sensor data	Unstructed Data	Contextual anomaly detection

Table 1 - Source of big data.

1.7 Big Data and IA

The world was already entrenched in Big Data before it even realized that Big Data existed. By the time the term was coined, Big Data had accumulated a massive amount of stored data that, if analyzed properly, would reveal valuable insights into the industry to which that particular data belonged.

IT professionals and computer scientists quickly realized that the job of sifting through all of that data, parsing it (converting it into a format more easily understood by a computer), and

analyzing all of it for purposes of improving business decision-making processes was too much for human minds to tackle. Artificially intelligent algorithms would have to be written to accomplish the enormous task of deriving insight out of chaos.

1.7.1 How AI is Used in Big Data

The internet now provides a level of concrete information about consumer habits likes and dislikes, activities, and personal preferences that were impossible a decade ago. Social media accounts and online profiles, social activity, product reviews, tagged interests, “liked” and shared content, loyalty/rewards apps and programs, and CRM (customer relationship management) systems all add potentially insightful data to the Big Data pool.

Using data from multiple sources, AI can build a store of knowledge that will ultimately enable accurate predictions about you as a consumer.

AI’s ability to work so well with data analytics is the primary reason why AI and Big Data are now seemingly inseparable. AI machine learning and deep learning are learning from every data input and using those inputs to generate new rules for future business analytics. Problems arise, however, when the data being used is not good data.

Data is the lifeblood of AI. An AI system needs to learn from data in order to be able to fulfill its function. Essentially, there must be an agreed-upon methodology to data collection (mining) and data structure before running the data through a machine learning or deep learning algorithm.

Like what it was said, the data is the lifeblood and using data from multiple sources, and there must be an agreed-upon methodology for data collection. For that, we create that system and use it in the smart home to collect data from any IoT devices to know about their states and make good expectations to save the lives of people and expect all that benefit them [43].

1.8 The Open Home Automation Bus (OpenHab)

The OpenHab is an open-source, technology-agnostic home automation platform which runs as the center of your smart home.

Some of openHAB's strengths are:

- Its ability to integrate a multitude of other devices and systems. OpenHAB includes other home automation systems, (smart) devices and other technologies into a single solution.
- To provide a uniform user interface and a common approach to automation rules across the entire system, regardless of the number of manufacturers and sub-systems involved.
- Giving you the most flexible tool available to make almost any home automation wish come true; if you can think it, odds are that you can implement it with OpenHAB.

OpenHAB is just a computer program. The computer will only do what you tell it to do. OpenHAB can provide many default solutions that are easy to setup, just do hard. After you have read the documentation for openHAB, you will have: Identified a computer on which to run openHAB. Basic functions can be achieved in openHAB rather quickly, e.g., switch lights on at a certain time. Others will require much more effort and thought.

OpenHAB 2 is developed in Java and uses OSGi for modularity. Apache Karaf serves as a container with Eclipse Equinox as the OSGi runtime environment. Jetty is included as an HTTP server.

OpenHAB is highly modular software that can be extended through "Add-ons". Add-ons give openHAB a wide array of capabilities, from User Interfaces to the ability to interact with a large and growing number of physical Things [44].

Though you can of course use the web interface from a mobile device, OpenHAB has native apps for both iOS and Android – and they look a lot nicer than the default browser interface. On the settings screen, enter the local URL as the internal IP you've been using until now, including the port number. For a remote URL, enter https://my.openhab.org, and your username (email) and password that you entered when you signed up. If you haven't signed up for MyOpenHAB yet, just leave the authentication and remote URL blank, but you'll only be accessing your system from your local Wi-Fi [45].

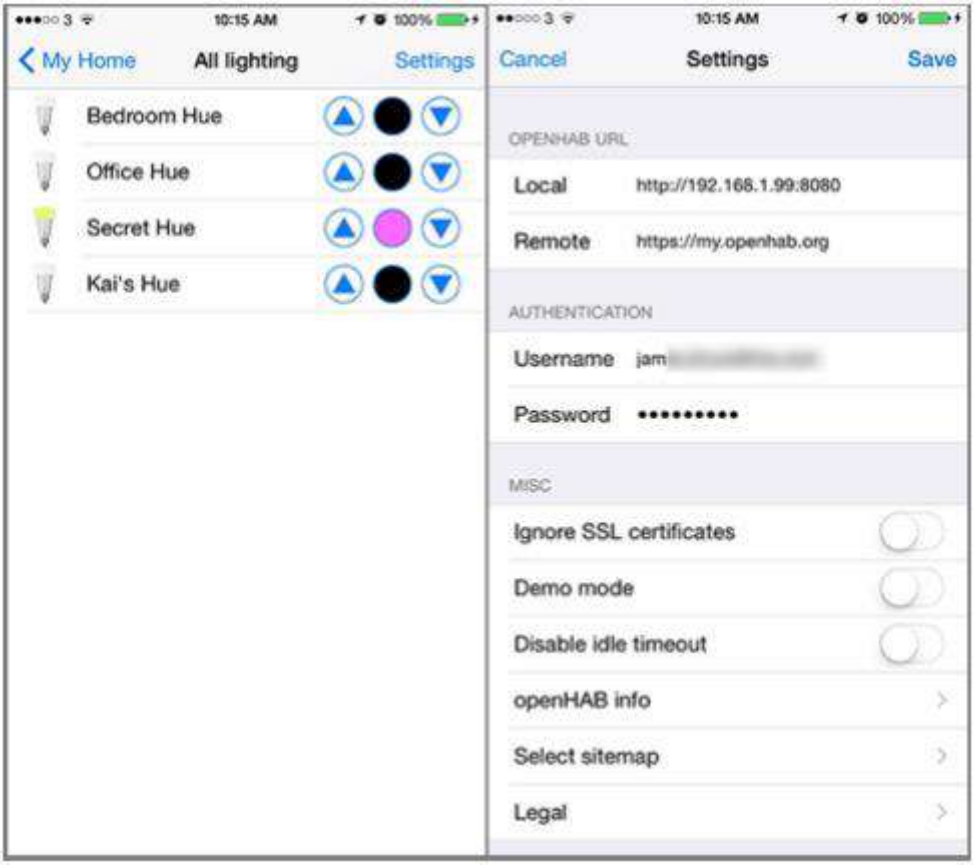

Figure 7 - OpenHAB Mobile App [45].

All this description about OpenHab and the way it works but we did not talk about how collecting data of IoT devices in smart home and send it to OpenHab and make a big control of your house by it.

1.8.1 Use of social sensors

Usually, the control of conditions in public buildings is determined by different sensors. The regulation of the room's temperature, for example, is coupled with measurements of temperature sensors [46].

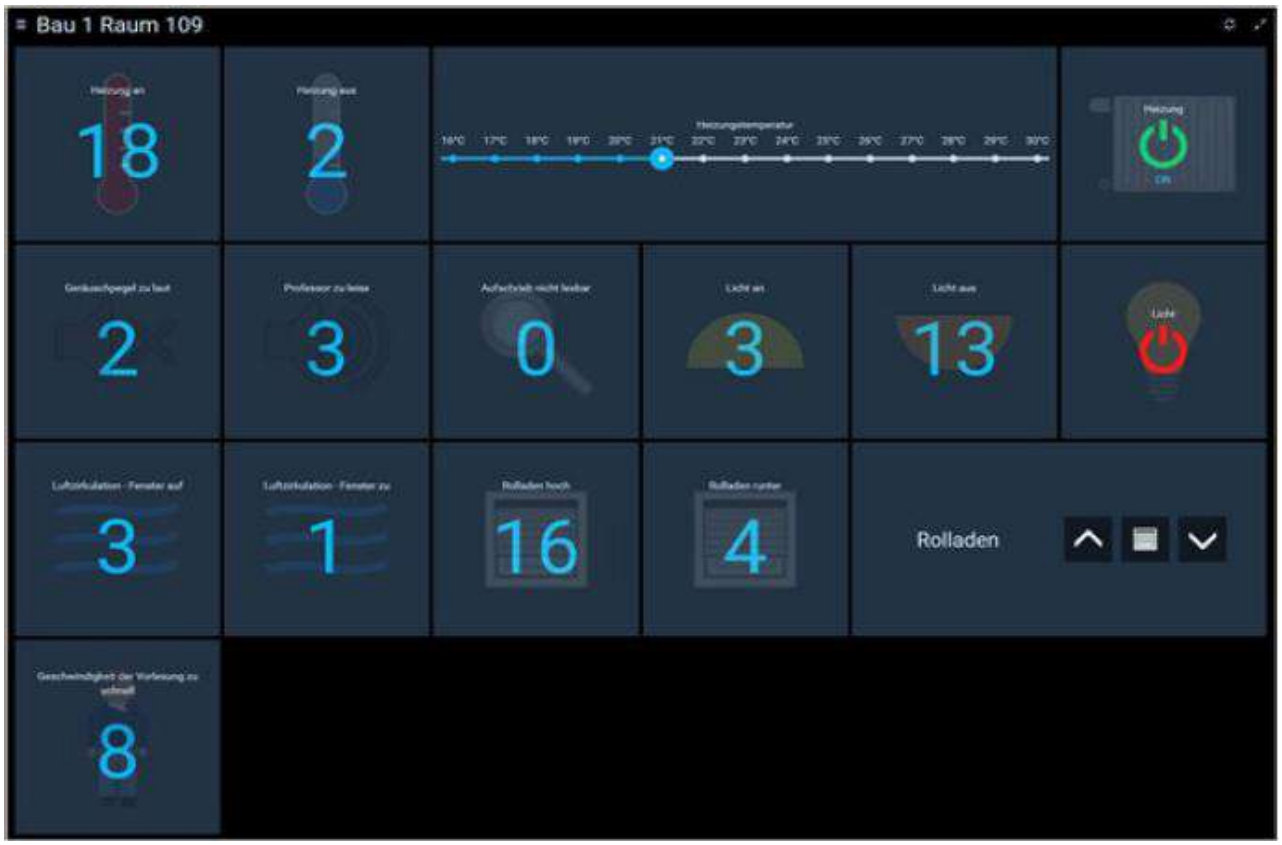

Figure 8 - A HABpanel view of a lecture room, including real sensor data, perceived noise levels, ratings of lecture speed and other data influencing students [46]

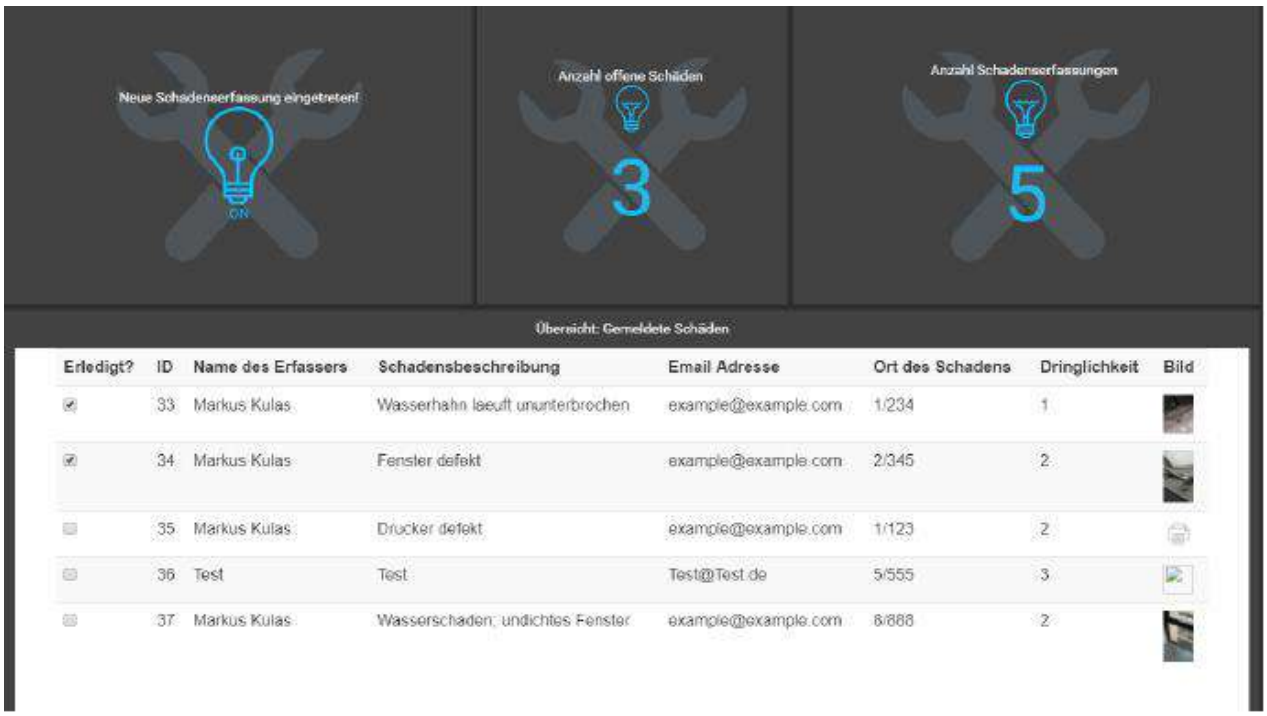

Figure 9 - Presentation of damage reports in openHAB [46]

Figure 10 - Multi-sensor attached above a door [46]

The Z-Wave network accesses the various sensors from a central server. Through the use of Z-Wave extenders, the signal is amplified and repeated over the different rooms.
Using a MySQL database, the sensor data is collected and stored persistently.

The data is displayed via the external visualization tool Grafana and presented via the OpenHab user interface [46].

Figure 11 - Representation of sensor data via HABpanel [46]

1.9 Conclusion

As a conclusion, we note that each of the above of systems is based on its own method of data collection, transmission, and saving his data collection and they follow different approaches like protocols of processing and saving techniques of data in learning about the smart home or his interests but all of them in the same begin because they need data to move on and build their applications.

2nd part

Conception

2.1 Introduction

This part is about the conception, related to the method of analysis and design that aims to formalize the preliminary stages of the development of a system, in order to make this development more precise and answers the needs. This leads us to create a smart data collecting system that could improve our daily lives.

A smart data collecting application will represent an interface between the user and the smart environment, the interface is a simple dashboard which the user can interact easily, it contains multiple data about our smart environment; this data can be temperature, gas, and humidity. Basically anything that could have a sensor.

In this section we study the methods that will allow us to collect data from a smart environment and store it in a database, furthermore, we checking the best machine learning algorithm that we can apply on our database and take good advantage from it. In addition, we have got to determine what means and techniques will help us in completing the work and in the latter.

2.2 Sending the data

After collecting the data from a sensor, we have to send it wirelessly from the microprocessor to our system; we have to study the different mechanism that allows us to send data wirelessly, and we put in count the coast, the security, and the speed for transmitting the data.

The table below represents the difference between these mechanisms:

Wireless Technical Standard	Bluetooth	Infrared	NFC	Wi-Fi	ZigBee
Governing Body	Bluetooth SIG	Infrared Data Association	NFC forum	Wifi alliance	ZigBee Alliance
IEEE Specification	802.15.1	802.11	802.2	802.11 a/b/g	802.15.4
Frequency Band	2.4 GHz	875 nm +-	13.56 MHz	5MHz– 2.4 GHz	868/915 MHz, 2.4 GHz
Standard Range	1-100 m	0.2-1 m	< 0.2 m	100 m	10-100 m
Number of RF Channels	79	50	1	14	1,10,16
Max number Of nodes	8	2	2	2007	>65000
Data Transfe rate	3 Mbit / s	4 Mbit / s	424 Kbit / s	54 Mbit / s	250 Kbit / s
Modulation Type	GFSK	Pulse	ASK	BPSK,QPSK COFDM ,CCK M-QAM	BPSK(+ASK) O-QPSK

Wireless Technical Standard	Bluetooth	Infrared	NFC	Wi-Fi	ZigBee
Basic cell	Piconet	Point to point	Point to point	BSS	Star
Encryption Method	E0 stream Cipher	NA	AES	RC4 stream cipher (WEP),AES Block cipher	AES Block cipher
Authentication	Shared secret	NA	In-build	WPA2	CBC-MAC
Data Protection	16 bit CRC	16 bit CRC	32 bit CRC	32 bit CRC	16 bit CRC
Spreading	FHSS	PPM	NA	DSSS, CCK,OFDM	DSSS

Wireless Technical Standard	Bluetooth	Wi-Fi	ZigBee
System resource	>250KB	>1M	4KB-32KB
Power waste	Common	Common	Low
Battery life	1-7	1-5	100-1000+
Applications	Device interconnection Data transfer Audio	Data transfer Internet	Device interconnection Illumination Sensing Control & automation
Advantages	Low coast Easy to operate	High speed & Adaptebility	Low coast Low power consuming

Table 2 – The difference between some wireless methods.

From the table 1, and 2 we can see that the Wi-Fi is the best choice for our system and that is based on the perfect range that the Wi-Fi can provide the data protection (Security), the low coast, high speed, adaptability and power saving.

2.2.1 Sending method

In our system, we are trying to send data through Wi-Fi from node A to node B Or from multiple; node to one node using the **TCP/IP** method.

A TCP /IP (Transmission Control Protocol / Internet Protocol)

TCP/IP, or Transmission Control Protocol /Internet Protocol, is a suite of communication protocols used to interconnect network devices on the internet. TCP/IP can also be used as a communication protocol in a private computer network.

A.1 In the case of two nodes

In this case, there are only two nodes, one server, and one client, the microprocessor is going to act as a server and listen to one and only one client and the computer is going to act as a client. The client going to ask for the data periodically.

A.2 In the case of multiple nodes

In this case, there are multiple nodes, one server, and multiple clients, each microprocessor is going to act as a client and the computer as a server, it could listen to multiple clients at the same time.

After the first connection, the raspberry pi going to check if there is any data being stored in its integrated data-based, this last going to send the stored data first before start sending the new ones.

2.2.2 Storing data

In this phase, we have two cases, if there is a connection between node A and B and if there is not each case we are showing handle it differently:

1 If there is connection between node A and B

After receiving data from a node we are not going to store it immediately, The data must go through two stages:

A Data preparation

After the data being recognized from where node it came from, it then enters the data preparation stage. often referred to as “pre-processing” is the stage at which raw data is cleaned up and organized for the following stage of data storying. During preparation, raw data is diligently checked for any errors. The purpose of this step is to eliminate bad data (Irrational values).

B Data storage

After the data being cleaned up, it is then must be stored for future use. Every data that received will be stored in the database with these attributes (name, value, date, time place, ip address) in form of a table.

2 If there is no connection between node A and B

In this case, the microprocessor (raspberry pi) will store the data on its own memory, and this going to happen through stages:

A Data preparation

In this phase, the raw data will be processed and clean up and organized for the following stages of data storying. During preparation, raw data is diligently checked for any errors, this will happen at the level of the microprocessor. The purpose of this step is to eliminate bad data (Irrational values).

B Data storage

After the data being cleaned up, we storing it in an integrated database that we have created in an SD card, and that's because the microprocessor (raspberry pi) has no extra

memory, every data will be stored in the integrated database with this attributes (name, value, date, time place, Ip address) in form of a table

We chose is 6 attributes:

- Name: is going to contain The name of the data whether its temperature or humidity.
- Value: is going to contain Numerical value that the sensors picked up.
- Date: is going to contain the current date.
- Time: is going to contain the current time.
- Place: is going to contain the lasting values.
- Ip address: is going to contain the Ip address of the microprocessor.

We choose 6 attributes to help us later on for extracting specific data that we need. The database will be filling in new values automatically every 1 hour through a thread. In our system, we are using SQLite and that's because we are dealing with small size value and SQLITE fulfills the needs.

2.3 Data usage

After our database being set up, we are using the **Expectation-Maximization algorithm** on our data set in order to predict the future temperature and humidity. This phase contains 4 important steps:

1 Given a set of incomplete data

We pass in a set of starting parameters, in our case; it would be values of temperature and humidity of some out of an X day.

2 Expectation step (E-step)

Using the observed available data of the dataset, estimate the values of the missing data (the future temperature and humidity).

3 Maximization step (M-step)

Complete data generated after the expectation (E) step in used in Order to update the parameter (the new values of temperature and humidity).

4 Repeat until the convergence

In this step we will repeat step 2 (E-step) and 3 (M-step) until the convergence [25].

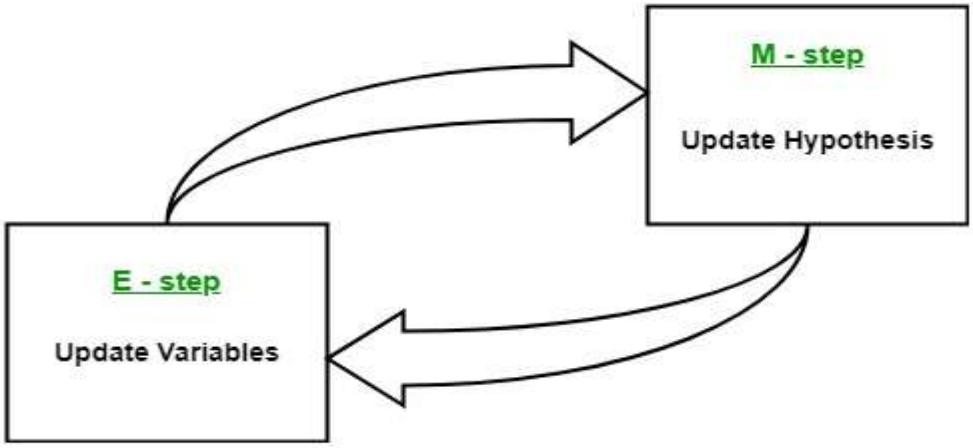

Figure 12 – Representation until convergence (Step4) [25].

2.4 Components of smart data collecting system

Every system needs components to be instructed, in our system, we will mention:

2.4.1 Sensors

The sensor is a device that responds and detects a type of physical environmental input. These inputs can be light, heat, motion, humidity, pressure, or anything else that belongs to environmental phenomena. This sensor generates signals that are converted to human-readable display at the sensor location or transmitted electronically via a network for reading or further processing [26].

2.4.2 Gateway

The modem (modulator-demodulator), is a computer peripheral used to communicate digital information through an analog network, such as the switched telephone network.

Technically, the device is used to convert the digital data of the computer into a modulated signal, called "analog", transmissible through an analog network and vice versa. Since the advent of voice over IP, this modulated data can also be transmitted in an encoded voice communication without any type of compression [27].

2.4.3 Microprocessor

A microprocessor, sometimes called a logic chip, is a computer processor on a microchip. The microprocessor contains all, or the most of the central processing unit (CPU) functions, and is the engine that goes into motion when you turn your computer on. A microprocessor is designed to perform arithmetic and logic operations that make use of small number-holding areas called registers [28].

The computer connected wirelessly to the microprocessor. This last collects data and sends it periodically to the computer.

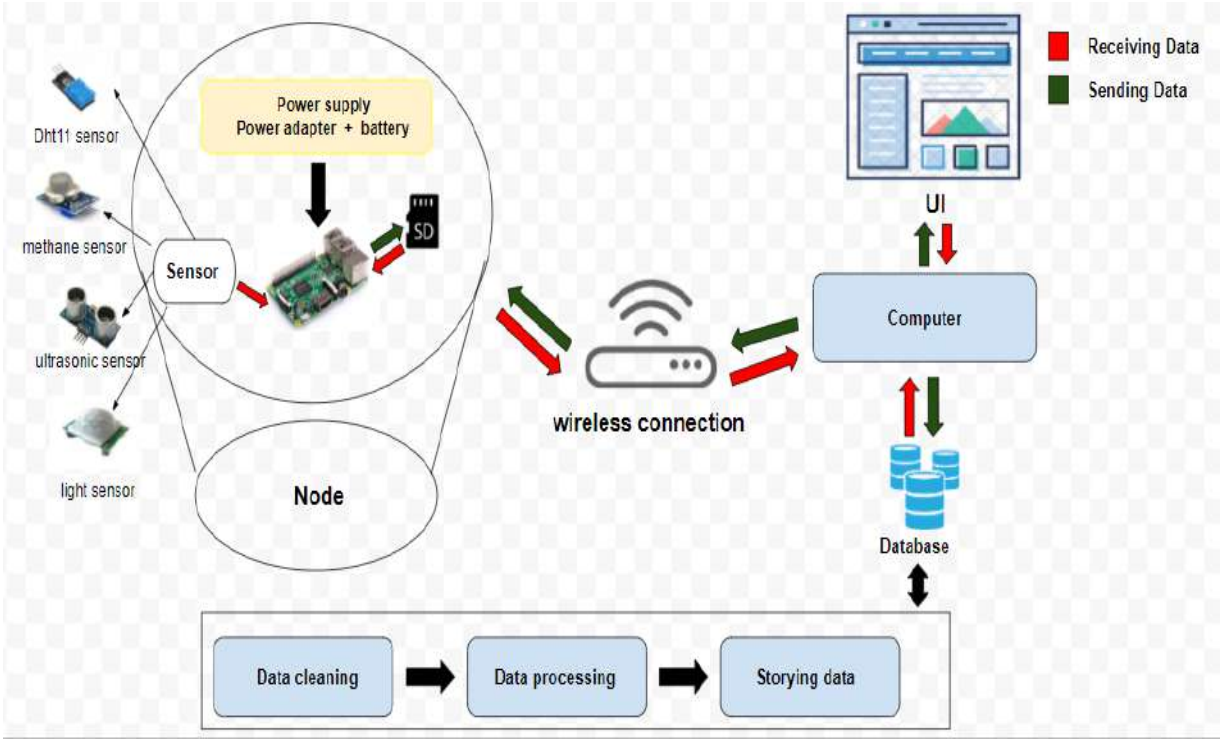

Figure 13 - Architecture of smart data collecting system.

2.5 Description of application interfaces

The smartest data collecting systems that already exist are specified for a special environment or they are limited in the types of data that are being collected. so they are not systems that offer the same features that we imagined we want to develop the prototype of an interface available on the computer that linked to multiple nodes.

1 The desired features of the application interfaces

The functions of the interface are numerous. Moreover, the goal is to collect as much as possible the data from the environment and convert it to information it in a way that the user can understand.

2 The user interface will allow:

- Present the currently collected data from the environment.
- Warn the user if any danger is expected.
- Present the expected temperature of tomorrow
- Present the old data being collected through graphs.

2.6 Conceptual model and Scenarios

The conceptual stage is the most important stage of building the project because it establishes the foundations and paves the way for a safe and effective start. We will use the UML language and especially Use Case Diagram, Sequence Diagram, and Activity Diagram.

2.6.1 Use case diagram for the Smart data collecting system

This diagram represents various actions performed by sensors, raspberry pi, Computer and the user interface.

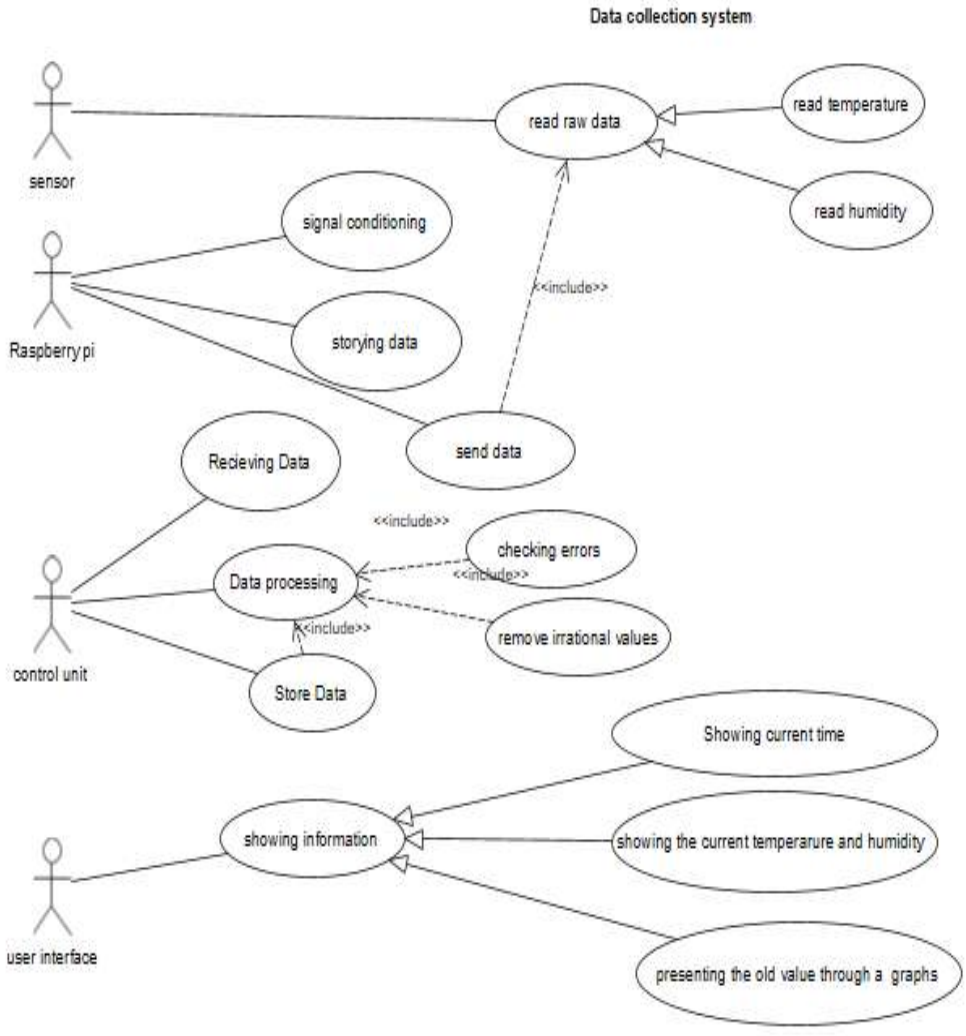

Figure 14 - Use case diagram for the Smart data collecting system.

2.6.2 Sequence diagram for the Smart data collecting system

Every element in the system (sensor, raspberry pi, Computer, user interface) has sequence actions; we choose to use a sequence diagram to describe these actions in an accurate way. We have two diagrams, in the case of two nodes and multiple nodes.

1 In case of one node

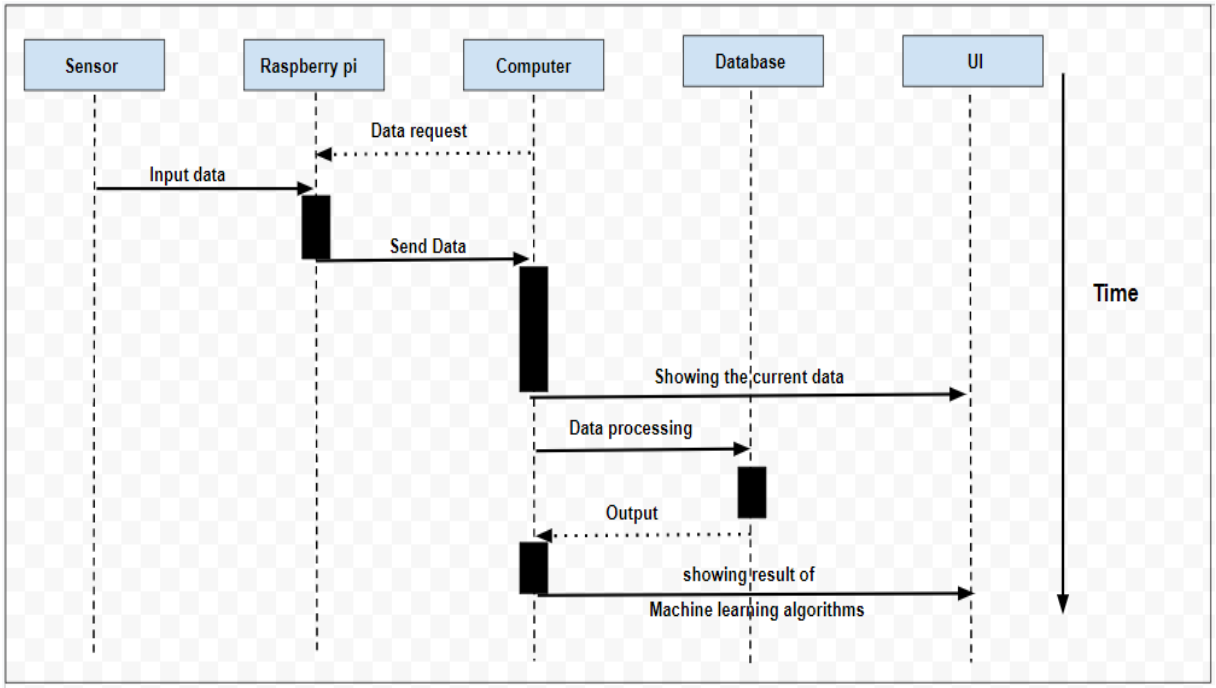

Figure 15 - Sequence diagram for the Smart data collecting system (One node).

2 In case of multiple nodes

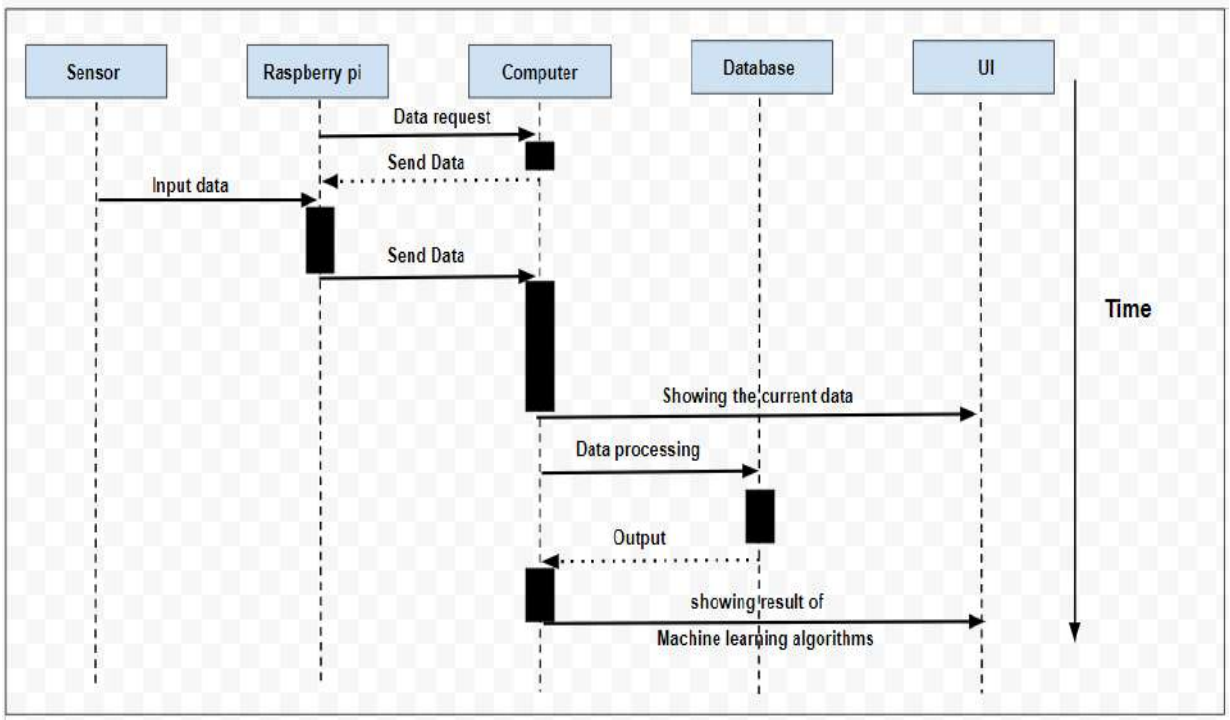

Figure 16 - Sequence diagram for the Smart data collecting system (Multiple nodes).

2.6.3 Activity diagram

This diagram explains the various activities that the element can perform through the embedded smart data collecting system.

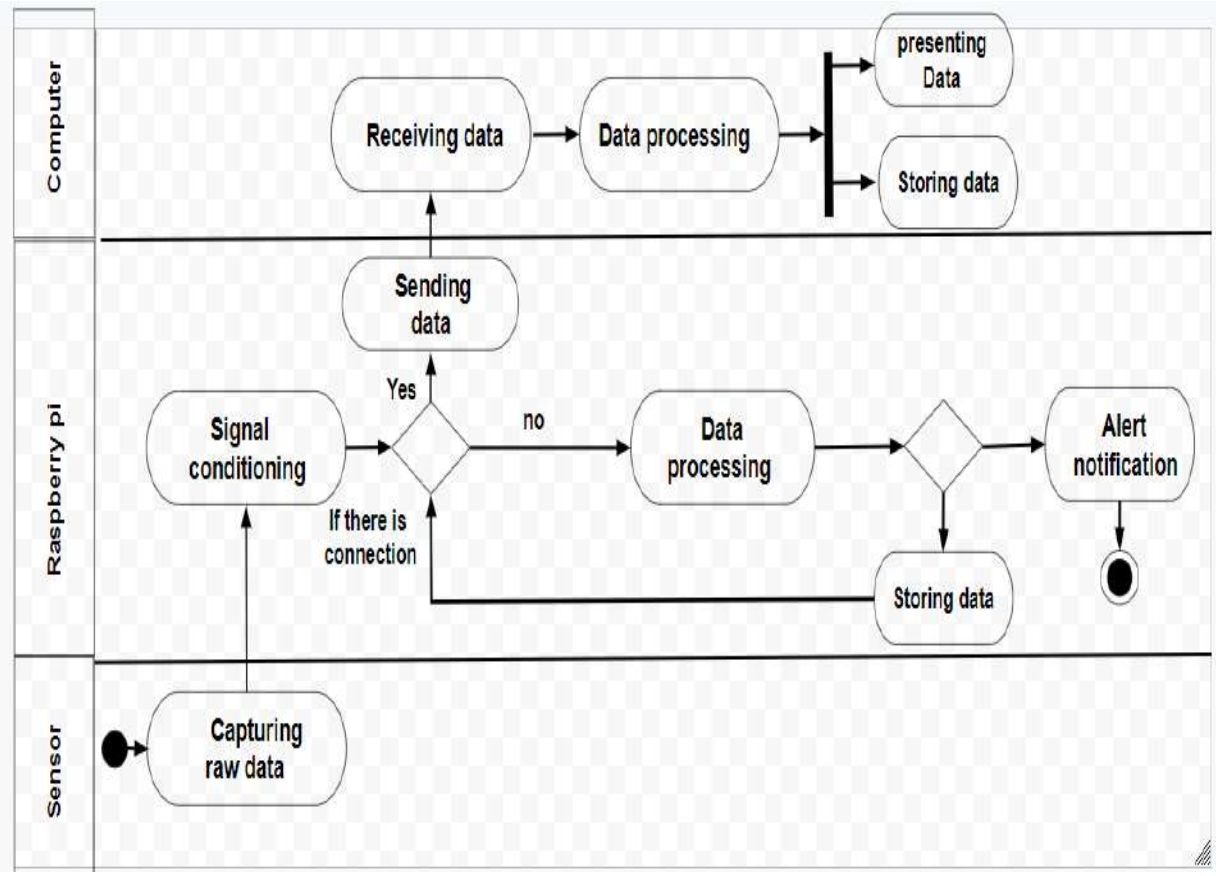

Figure 17 – Activity diagram for the Smart data collecting system.

2.7 Conclusion

The elements of this survey part explain how collecting data from any environment that the system is in and how to send these data, then how the storing is and developing the work plan and defining the structure of the application. After that, the usage data and database in Machine Learning. Then, we tackled the stage of weaving the scenarios, developing the work plan, and defining the structure of the applications. Therefore, it is time to explain the pro stage which is related to the implementation and the construction which runs the collection data system.

3rd part

Implementation

3.1 Introduction

After we identified in the previous sections of the Internet of things and we discussed the initial concepts. Then we moved to the conceptual stage that explained the work and how to reach it and identified it within a specific framework. Where we said the goal of our system is to collect data from any environment that it is in, that data helps us to instruct and aware people to any change around them they cannot feet it and the most important one is using this collecting data to extract featured and future probabilities by using algorithms of Intelligence Artificial. Now in the implementation phase, we will analyze the requirements, installation, configuration, execution, testing, and analyze the results we have reached.

In this part, we try to account for the implementation of the solution which includes the chosen IoT platform especially in a smart home that we focus on it the first prototype is in, the software, and the hardware we have used.

3.2 Components of a smart embedded data collection system using microcontroller

In our system, we will need some electronic and virtual components to implement and structure the work, so we will discuss the definition of these components. We mention:

3.2.1 Sensors:

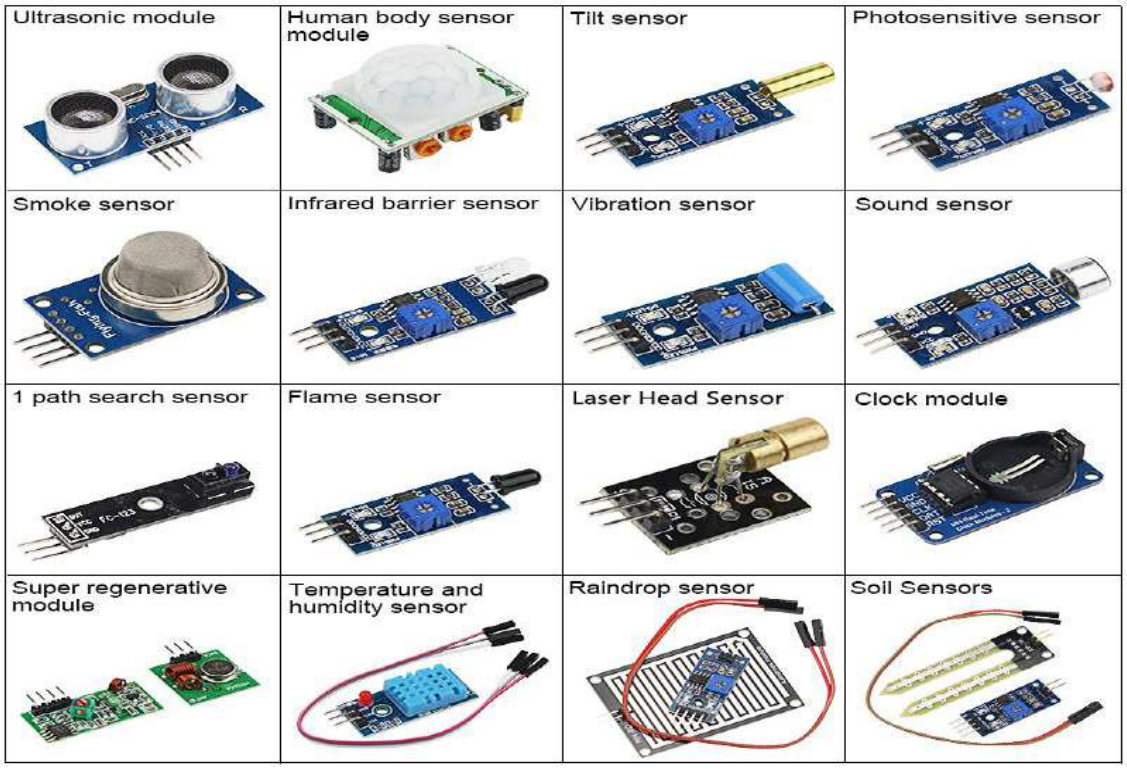

Figure 18 - Different types of sensors

The sensor is a device that responds and detects a type of physical environmental input. These inputs can be light, heat, motion, humidity, pressure or anything else that belongs to environmental phenomena. This sensor generates signals that are converted to human-readable display at the sensor location or transmitted electronically via a network for reading or further processing [29]. With help from sensors, the microcontroller receives information from the surrounding environment and makes decisions based on it.

The following table shows some sensors and their activity classification usage:

Sensors	Detected Parameter	Usage Example
Accelerometer	Movement	Occupant running and falling
Hand-worn sensors	Gestures and step counter	Drinking, walking
Smartphone	Movement	User sleep or activity duration
RFID	Object-interaction	Using utensils
Vital monitoring sensors	Vital signs	Blood pressure, heart bit rate

Table 3 - Wearable sensors used for activity classification

3.2.2 Actuators:

An actuator is a component of a machine that is responsible for moving and controlling a mechanism or system where it converts the energy into motion, for example by opening a valve. In simple terms, it is a "mover".

An actuator requires a control signal and a source of energy. The control signal is relatively low energy and maybe electric voltage or current, pneumatic or hydraulic pressure, or even human power. Its main energy source may be an electric current, hydraulic fluid pressure, or pneumatic pressure. When it receives a control signal, an actuator responds by converting the source's energy into mechanical motion [30].

3.2.3 Gateway:

A gateway is a network node that connects two networks using different protocols together (different topology). In addition to that, it is known that a gateway is a router that connects a home network or an enterprise network to the Internet. In most IP-based networks, the only traffic that does not pass through at least one gateway is the traffic flowing between nodes on the same LAN for example computers connected to the same key [31].

3.2.4 Microcontroller:

The microcontroller is a compact integrated circuit designed to perform specific operations in an embedded system. Integrates on a single chip, processor (CPU), memory, input, and output peripherals.

A microcontroller is a small, low-cost computer that performs specific tasks in embedded systems like displaying microwave's information, receiving remote signals [32].

With this single-chip integrated circuit design of the microcontroller, the size of the control board is reduced and power consumption is low [33].

3.2.5 Server:

A computer server is a computing device (hardware and software) that provides services to one or more clients (sometimes thousands). The most common services are:

- Access to information from the World Wide Web.
- Sharing of peripherals (printers, hard drives, etc.).
- Database storage.
- Management of authentication and access control.

In operation, a server automatically responds to requests from other computer devices (clients), according to the so-called client-server principle. The format of requests and results is standardized, conforms to network protocols and each service can be operated by any client that implements the protocol specific to this service.

In our case and in our system, it's no obligation to be the server a computing device maybe be any device of sending data to it and database storage.

3.3 Hardware

To implement the solution and collect data we hope to get from any environment and store it to future using, we will use these following devices:

3.3.1 Raspberry pi 3 model B

Figure 14 - Raspberry pi

Raspberry Pi is using the Advanced Reduced Instruction Set Computing Machine (ARM) technology. ARM technology is used on the board which reduces cost, heat, and power consumption. It is energy effective multi-core CPU implemented as System-On-Chip (SoC) weighing 50gm and operates on 5V, 700mA power rating. This board is available in three models named A, B, B+. The B+ Raspberry Pi board is the latest version among them, and it runs on an ARM11 processor with 512MB RAM operating at 700 MHz frequency. It has an SD card slot, which is used for booting operating systems like Raspbian, Pidora, and Raspbm. Raspbian has a desktop environment similar to Windows and Mac called Lightweight X11 Desktop Environment (LXDE), so it provides an easy transition for those not familiar with the Linux command line. It has four USB2.0 ports to connect to the peripherals like mouse, keyboard, and Wi-Fi adapter, etc.

Making it a full-sized portable pocket computer. It also has an Ethernet port to connect to the network. GPIO ports are used to interface and control the LEDs, switches, sensors, and other devices. With the help of the HDMI port, all kinds of monitors like LCD screens, projectors, TVs can be connected. In this board, some additional features like a camera connector are available to interface a camera and an audio jack. With all these features, Raspberry Pi is not just limited to single-use; it can be used in many applications.

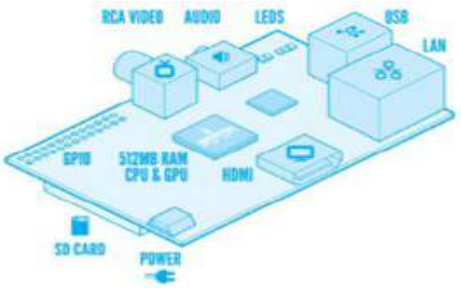

Figure 15 - Raspberry pi Components

3.3.2 Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P, and it is the best board to get started with electronics and coding. Arduino Uno is a microcontroller board, and it is considered as the best board for programming electronic projects [34] [35] [36]. And its characteristics:

- Operating Voltage 5V.
- Input Voltage 7-12V.
- Digital I/O Pins 14

(Of which 6 provide PWM output).

- Analog Input Pins 6.

Figure 16 - Arduino Uno

3.3.3 Temperature and Humidity Sensor

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any microcontroller such as Arduino, Raspberry Pi, etc… to measure humidity and temperature instantaneously.

Figure 17 - Temperature and Humidity Sensor

DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED.

- In the solution we use the Raspberry Pi, because of its capacities and for installing a system of OpenHab to collect the data from the environment and send them to Raspberry Pi to control by them the OpenHab allow us to make an interface of the devices we collecting data from them.

- for experimental, we use just one sensor and all that for collect data looking for results and we can add sensors as we want to see more results and data.

3.4 Development tools

We need a set of development tools to implement the solution:

3.4.1 Python

Python is an interpreted, multi-paradigm, cross-platform programming language. It promotes structured, functional, and object-oriented imperative programming. It has strong dynamic typing, automatic memory management by garbage collection, and an exception management system; it is thus similar to Perl, Ruby, Scheme, Smalltalk, and Tcl.

Figure 18 - Python

The Python language is placed under a free license close to the BSD5 license and works on most computer platforms, from smartphones to mainframe computers6, from Windows to UNIX within particular GNU / Linux via macOS, or even Android, iOS, and can also be translated into Java or .NET. It is designed to optimize the productivity of programmers by offering high-level tools and an easy-to-use syntax.

It is also appreciated by some educators who find in it a language where the syntax, clearly separated from the low-level mechanisms, allows an easy initiation into the basic concepts of programming [37].

3.4.2 Qtpy

Qt an object-oriented API developed in C ++, jointly by The Qt Company and Qt Project. Qt offers graphical interface components (widgets), data access, network connections, management of threads, XML analysis, etc. In some respects, it looks like a framework when used to design graphical interfaces or when we design the architecture of its application using the mechanisms of signals and slots for example.

Qt enables the portability of applications that only use its components by simply recompiling the source code. Supported environments are UNIX that uses the X Window System or Wayland graphics system. The fact of being a multiplatform software library attracts a large number of people who therefore have the opportunity to broadcast their programs on the main existing OS [38].

Figure 19 - Qtpy Library

Qt integrates bindings with more than ten languages other than C ++, such as Ada, C #, Java,

Python, Ruby, Visual Basic, etc.

3.4.3 SQLite

SQLite is a C-language library that implements a small, fast, self-contained, high-reliability, full-featured, SQL database engine. SQLite is the most used database engine in the world. SQLite is built into all mobile phones and most computers and comes bundled inside countless other applications that people use every day. More Information...

Figure 20 - SQLite

Unlike traditional database servers, such as MySQL or PostgreSQL, its particularity is not to reproduce the usual client-server scheme but to be directly integrated into programs. The entire database is stored in a file independent of the platform [39].

3.5 Data Base of system

3.5.1 Data showing

We represent the data in a user interface that contains 3 panels, the first one is the home panel, this last shows the current, temperature, humidity, time, and the expected future temperature (every data shows on its own label).

The second panel is the line charts panel, this right here have two line charts, one for the temperature and the other is for humidity, both of them contains two axis X and Y. X-axis represents the time (24 H) of the current day and the Y represent the value of that hour (Humidity and Temperature).

The last panel is the information panel, this last contains a calendar which links to a table, in the calendar, you can select the day, month, and the year that you want to know about its data, the table will represent the temperature and the humidity of every single hour in that day that being selected in the calendar.

Our database contains only one table that has 6 records:

- Name: represent the name of data (Humidity and Temperature).
- Value: the value of data.
- Days: the current day (dd/mm/yyyy), all the days of week and everyday has 24H.
- Time: the current time.
- Place: represent the longitude/latitude.
- Id: represent the id of the raspberry pi.

1 Data storing process

```
def fillin(self,n,v,j,d,p,i):
  data1 = Data(n,v,j,d,p,i)
  self.cur.execute(''' INSERT INTO Data(name,value,days,time,place,id)
        VALUES(n,v,j,d,p,i) ''')

  self.cur.commit()
```

```
self.c.fillin('Temperature', x_data[0], dt_string, dt_string1, self.g.latlng)
self.c.fillin('Humidity', x_data[1], dt_string, dt_string1, self.g.latlng)
```

2 Data extracting process

To extract the data we used 4 functions, each function have a specific results

2.1 extracting all data:

This function extracts all the data in the database:

```
def read_Data(self):
  # from math import *
  data = self.cur.execute(''' SELECT * FROM Data ORDER BY days''')
```

2.2 extracting data by name:

This function will extract the data by the name; it could be temperature or humidity:

```
def getting_data_byname(self,N):
  # from math import *
  data = self.cur.execute(''' SELECT * FROM Data Where name = (?) ''', (N))
```

2.3 extracting data by date:

This function extracts the data by the name of it and the date:

```
def getting_data_by_days(self,N,D):
  # from math import *
  data = self.cur.execute(''' SELECT * FROM Data Where name = (?) and days = (?) ''', (N,
D))
```

2.4 extracting data by time:

This function extracts the data by the name of it and the time:

```
def getting_data_by_time(self,n,o):

  data = self.cur.execute(''' SELECT * FROM Data Where name = (?) and time = (?) ''',(n,o))
```

3.6 Data Structure

We have just one software interface that will appear the data, which is the Python application using the Qt library to build the interface. We explained how data transfers from the microcontrollers to our server to store, then their processing in the past phase.

We built a lightweight data-interchange structure to do our work easily.

3.7 Choosing IOT Platform

In order to choose what is the most suitable Internet of things platform to work on it, a comparison between a numbers of the most famous platforms and the most effective is necessary. And this table proves that:

	Microsoft Azure	**AWS**	**IBM Watson IoT**
Protocols	HTTP, AMQP, MQTT	HTTP, MQTT, WebSockets	HTTP, MQTT, Sockets/WebSocket
Certified Hardware	Intel, Raspberry Pi2, Freescale, Texas Instruments	Broadcom, Marvell, Renesas, Texas Instruments, Microchip, Intel	ARM mbed, Texas Instruments, Raspberry Pi, Arduino Uno
SDK/ Language	.Net and UWP, Java,C, NodeJS	Java, C, NodeJS	C#, C Python, Java, NodeJS, php, Go, Ruby and more
Connection	Easy configuration	Easy configuration	Difficult configuration
Pricing	Paying for IoT Hub unit related to number of devices and messages per days	Paying millions messages traffic	30 day trial for free. Paying related to number of device, data traffic and data storage.

Table 4 - Comparison of different IoT platforms [40].

To implement our system, we took some ideas from many IoT platforms, all that to create just what we need to do our project and provide our requirements in the application; we use sensors and actuators to collect data and using the HTTP protocol to transfer data and our server or cloud is our machine to store data then their visualization after all that we use our database in AI Algorithms. IoT platforms like:

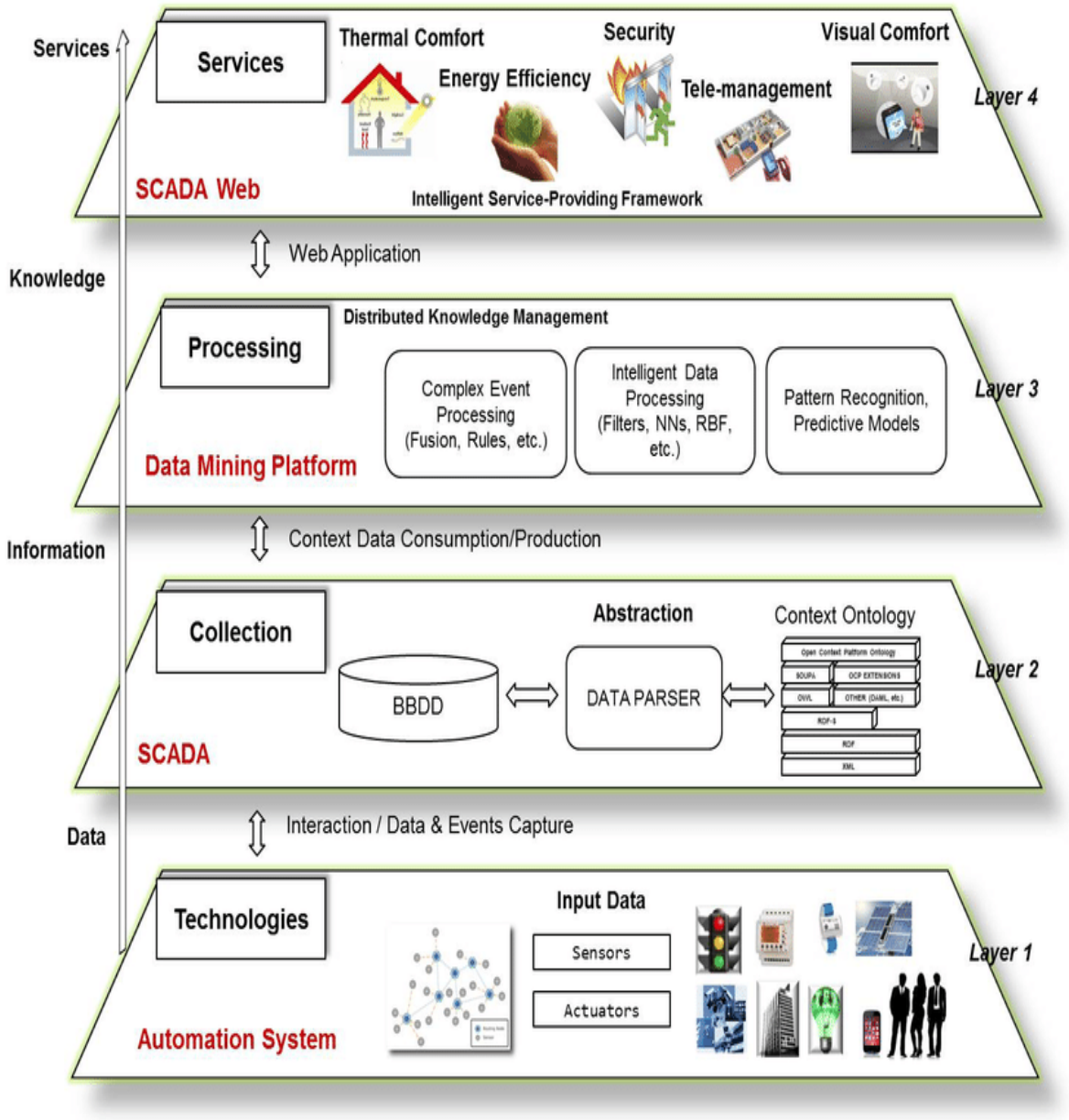

Figure 26 - An IoT Platform

For this intelligence and interconnection, IoT devices are equipped with embedded sensors, actuators, processors, and transceivers. IoT is not a single technology; rather it is an agglomeration of various technologies that work together in tandem.

Sensors and actuators are devices, which help in interacting with the physical environment. The data collected by the sensors has to be stored and processed intelligently in order to derive useful inferences from it. Note that we broadly define the term sensor; a mobile phone or even a microwave oven can count as a sensor as long as it provides inputs about its current state (internal state + environment). An actuator is a device that is used to effect a change in the environment such as the temperature controller of an air conditioner.

The storage and processing of data can be done on the edge of the network itself or in a remote server. If any preprocessing of data is possible, then it is typically done at either the sensor or some other proximate device. The processed data is then typically sent to a remote server. The storage and processing capabilities of an IoT object are also restricted by the resources available, which are often very constrained due to limitations of size, energy, power, and computational capability. As a result, the main research challenge is to ensure that we get the right kind of data at the desired level of accuracy. Along with the challenges of data collection, and handling, there are challenges in communication as well. The communication between IoT devices is mainly wireless because they are generally installed at geographically dispersed locations. The wireless channels often have high rates of distortion and are unreliable. In this scenario reliably communicating data without too many retransmissions is an important problem and thus communication technologies are integral to the study of IoT devices.

Now, after processing the received data, some action needs to be taken on the basis of the derived inferences. The nature of actions can be diverse. We can directly modify the physical world through actuators. Or we may do something virtually. For example, we can send some information to other smart things.

The process of effecting a change in the physical world is often dependent on its state at that point in time. This is called a context-awareness. Each action is taken keeping in consideration the context because an application can behave differently in different contexts. For example, a person may not like messages from his office to interrupt him when he is on vacation [41].

There are many devices in the smart home and different, every one of them uses a protocol to connect with the internet to be a smart device and share its data, a comparison between some of them in many characteristics is necessary. And the table shows that:

Protocols	Frequency	Data Rate	Range	Network Size	Network Topology
WiFi	2.4-5.8 GHz	450 Mpbs	10-100 m	Thaousands	Star, Tree, P2P, Mesh
Bluetooth	2.402-2.48GHz	0.7-2.1 Mbps	15-20 m	8	Star
BLE	2.402-2.48 GHz	2 Mbps	10-15 m	N/A	Star
ZigBee	868/915 GHz, 2.4 GHz	20/40 Kbps 250 Kbps	10-100 m	65.536	Star, Mesh, Cluster, Tree
Z-Wave	868/915 GHz	10-100 Kbps	30-50 m	232	Mesh

Table 5 - Wireless communication Protocols

3.8 Implementing the solution

This section will be divided into four parts, the first one represents the smart data collection system, the second is the application.

3.8.1 The prototype of the smart data collection system

To test how the system performs and its components in real life, we managed to build a prototype.

The raspberry pi and DH11 Sensor and a source of power.

It must be a source of power to turn the microcontroller and the available sensors.

As we said and explained the ways of work; the sensors collect data and the raspberry pi send it to database of laptop or store in its SD card, etc.

3.8.2 The application

The first interface is the home interface it contains the current date and time and presents the current temperature and humidity.

The navigation section: you can navigate between the 3 interfaces through the navigation section with 3 buttons (Home page, line charts, and more information).

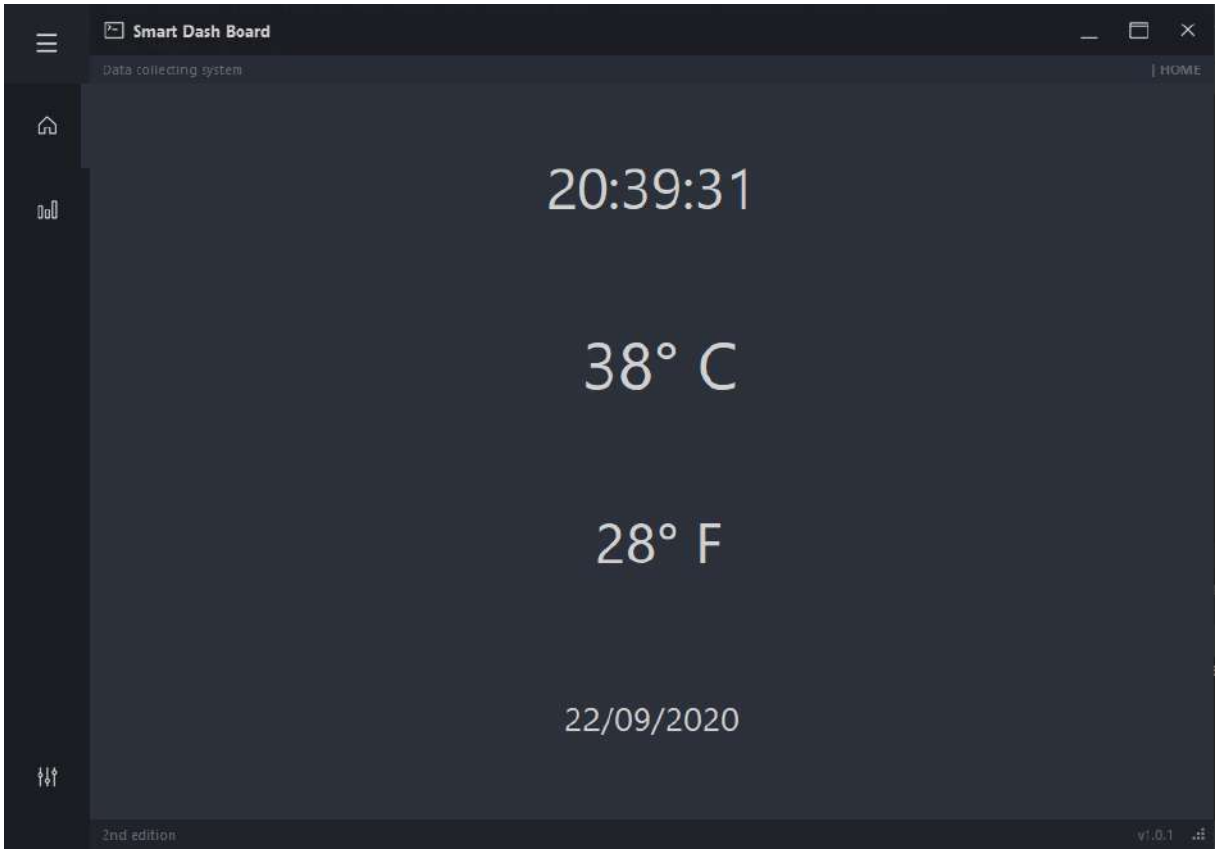

Figure 27 - Home interface.

Second interface is the line chart interface each line chart represent the values of the highest temperature and humidity of the current week.

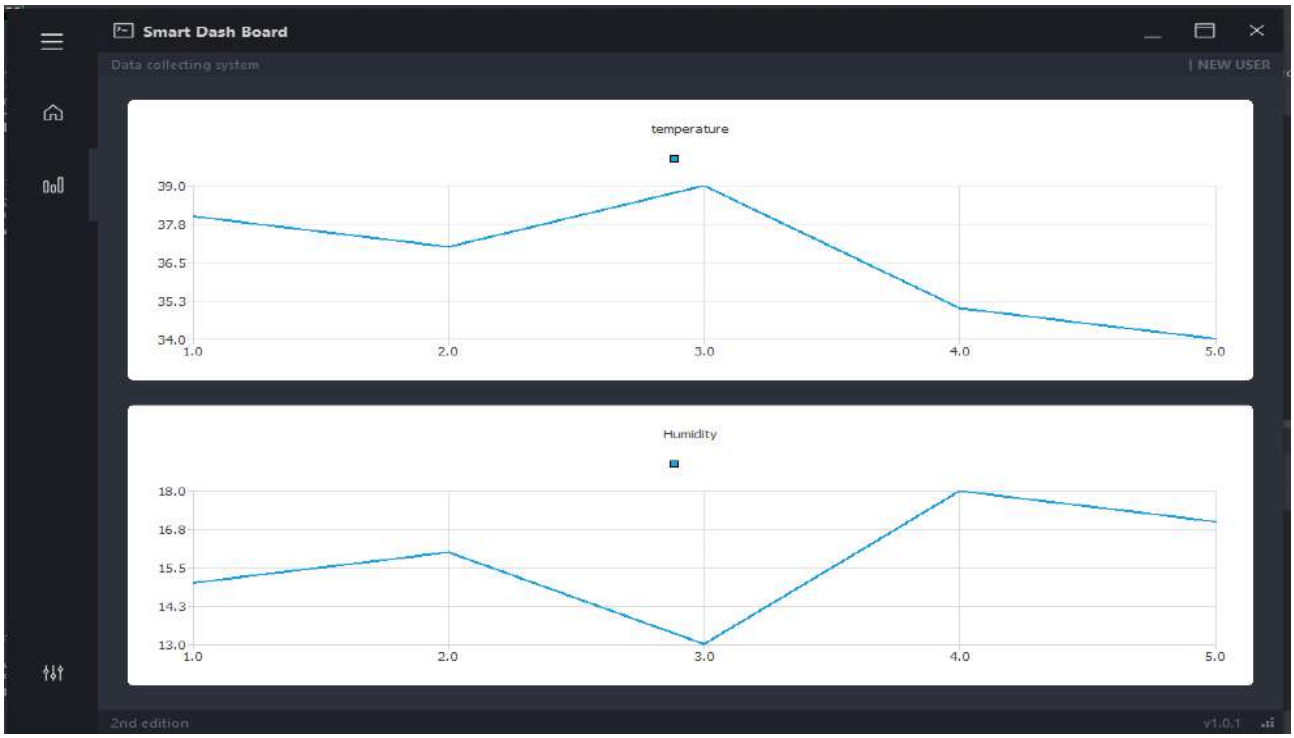

Figure 28 - Line chart interface.

The third interface is the last interface it contains a weekly calendar that we can navigate through it.

The calendar linked to a table and this last show the value of the temperature and humidity of the selected week.

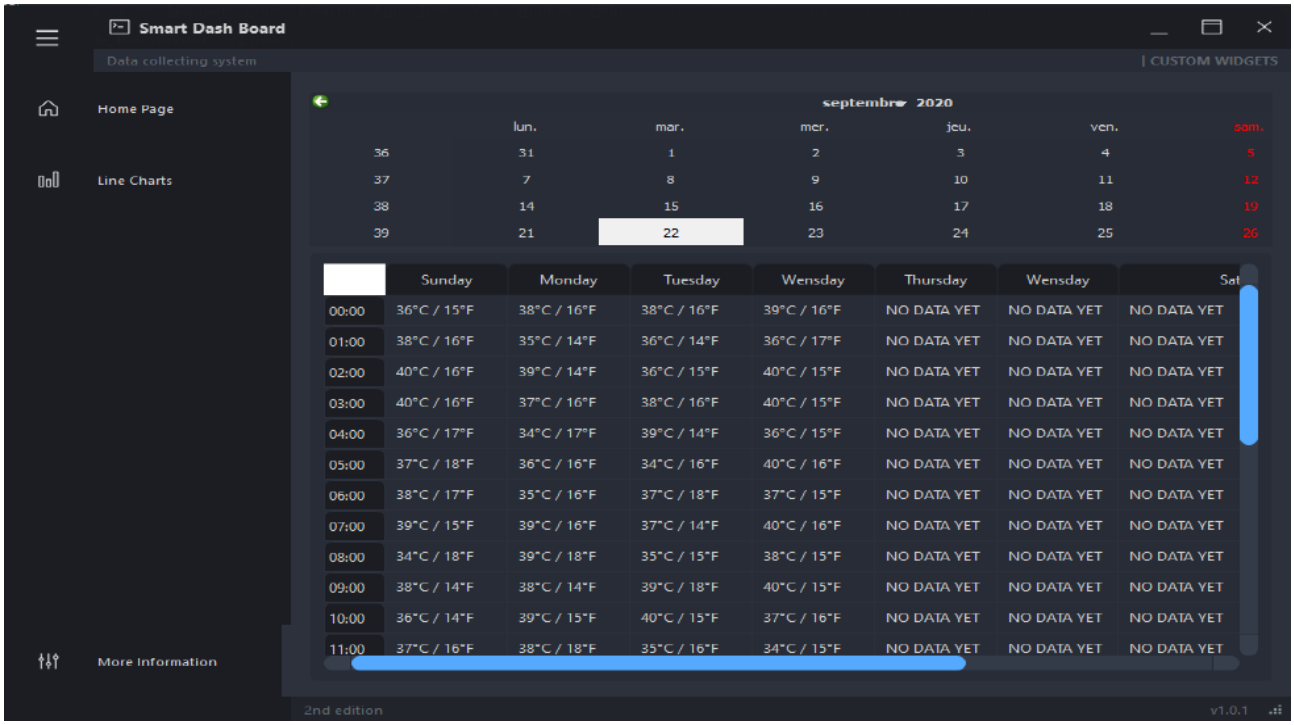

Figure 29 – Older data interface.

3.9 Conclusion

We can now say that we have achieved the system that we work for, as we have been able to introduce the Internet of things technology into a system of collecting the embedded data to make it smart. We can now collect data from any place in the whole world using needed sensors and store these data to future usage in many fields. Despite this, we faced many problems at the beginning of work because of the stopping of commerce in the world to get the requirements of work and we could not achieve all that we wanted to reach to solve many of the problems and requirements of the customer.

General conclusion

In this project, we worked on a smart embedded collection data system that collects data from any place or environment we look for and we need it. We tried in using the internet of things in home automation because it is our primary concern, that we collect data about it by using requirements and materials in the field. It is important to mention that we have only worked to collect useful data and store using databases. On the other side, it is a different project because all the other projects we have seen collect data then, processing it without really storing it.

We took the idea of an IoT cloud-based platform that creates a cloud or server to store data; we tried to do our work completely without using an internet cloud. All that work faced problems and difficulties and the main cause is what the world passed Coronavirus and the loss of many people infected by it and stopping everything in the world that caused the lack of microcontrollers and sensors the requirements of work. The new era of the internet is the access almost to anything using the same existing internet infrastructure to collect more real-time or stored data and generating more values using algorithms or processing tools conventionally called AI (Artificial Intelligence) to analyzing the huge quantity of data which is called (BigData). Values are information generated by AI from BigData should give decision-makers a clear vision for what is going in real-time and what is expected both in the short and the long period.

To conclude, collecting data in a smart home or any place that people use or they will use is very important to be aware of the environment to reduce many costs or failure of the project and we can save the souls of many people and make good decisions in life and make our life very easy and comfortable. For example, you can the consumption in your home or detect the gas leak and the system automatically does the right thing.

We should work to implement this humble work in reality and pass all the difficulties to see results and the system will be in use to benefit the people and our environment.

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