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- **Réseaux et Télécommunications**
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ABSTRACT :

The objective of our project is to design and implement an IOT-based system for monitoring the state of the flood in order to protect cities and human lives from dangers. Monitoring and detection system using the Raspberry pi model or water sensor and rain sensor are used to detect the, authorities regarding the heavy rain and monitoring of water levels in a lake or river for example.

To accomplish this task various technologies, the data is automatically transmitted over the Internet. This data is presented on a "ThingSpeak" cloud website with a developed graphical user interface.

RESUME :

L'objectif de notre projet consiste en la conception et met en œuvre d'un système basée sur l'IOT permettant le suivie de l'état de l'inondation afin de protéger les villes et les vies humaines des dangers. Système de surveillance et de détection utilisant le modèle Raspberry pi ou de capteur d'eau et de capteur de pluie sont utilisées pour détecter le, les autorités en ce qui concerne la lourdeur des pluies et la surveillance des niveaux d'eau dans un lac ou une rivière par exemple.

Pour accomplir cette tâche diverses technologies, les données sont automatiquement transmises sur internet. Ces données sont présentées sur un site web cloud ''ThingSpeak'' avec une interface graphique utilisateur développée.

ملخص :

الهدف من مشروعنا هو تصميم وتنفيذ نظام قائم على إنترنت الأشياء Iotلرصد حالة الفيضان من أجل حماية المدن والأرواح البشرية من الأخطار. يتم استخدام نظام المراقبة والكشف باستخدام نموذج Raspberry pi أو مستشعر المياه ومستشعر المطر للكشف عن السلطات فيما يتعلق بالمطر الغزير ومراقبة مستويات المياه في بحيرة أو نهر على سبيل المثال .

لإنجاز هذه المهمة ، يتم إرسال البيانات تلقائيًا عبر الإنترنت. يتم تقديم هذه البيانات ThingSpeak بواجهة مستخدم رسومية مطورة على موقع ويب سحابي

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I dedicate this work,

Not all words can express gratitude, love, respect,
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It is simply that: I dedicate this Master's thesis to:
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Finally, to my grandchildren, Djaouad Maria Hakim.

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List of Symbols:

RPi: Raspberry Pi.

IOT: Internet of thing.

API: Application Programming Interface.

SBC: Single-Board Computer.

SWE: Sensor web Enablement Framework.

HTTP: HyperText Transfer Protocol.

MQTT: MQ Telemetry Transport.

HDFS: Hadoop Distributed File System.

CDNN: Context Dependent Neural Network.

ANN: Artificial Neural Network.

DNN: Deep Learning Neural Network.

AMS: Automatic Meteorological Stations.

NodeMCU: Node MicroController Unit.

GSM: Global System for Mobile Communications.

GPS: Global Positioning System.

AI: Artificial Intelligence.

IBM: International Business Machines Corporation.

AWS: Amazon Web Services.

ERP: Enterprise Resource Planning.

TLS: Transport Layer Security.

LDAP: Lightweight Directory Access Protocol.

RAM: Random Access Memory.

CPU: Central Processing Unit.

GPU: Graphics Processing Unit.

UART: Universal Asynchronous Receiver Transmitter.

PC: Personal Computer.

OS : operating system.

USB : Universal Serial Bus.

LAN: Local Area Network.

ULP: Ultra-Low Power.

ADC: Analog Digital Converter.

SDIO: Secure Digital Input Output.

SPI: Serial Peripheral Interface.

CAN: Community Area Network.

IDLE: Integrated Development and Learning Environment.

BLE: Bluetooth Low Energy**.**

NET: Negative Temperature coefficient.

PCB: Printed-Circuit-Board.

LED: Light Emitting Diod.

I2C : Inter-Integrated Circuit.

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General Introduction:

A natural disaster is an event with a natural, as opposed to human, because that results in large-scale loss of life and damage to properties.

Natural disasters include all types of severe weather, which have the potential to pose a significant threat to human health and safety, property, critical infrastructure, and homeland security. Natural disasters occur both seasonally and without warning, subjecting the nation to frequent periods of insecurity, disruption, and economic loss. These resources serve to prepare IHEs for a variety of natural disasters, including floods, waste management, forests fire, wildfires, earthquakes, or any combination thereof.

In this project, we use a real-time monitoring system based on any meteorological conditions to identify climate problems, and introduce the research in the operation of the Internet of Things.

For this reason, the projects are organized in three chapters:

First, we introduce the general Situation In the structure of this project, we present the general introduction and the problems raised, then the stat of art concerning existing solutions, and finally present our solutions and methodology.

The second chapter is dedicated to the hardware and software used in the project. We presented more details concerning sensors and main single board computer “raspberry pi 3b+”.

The third is dedicated to the implementation part. It introduces the working environment, technical capabilities, an overview of the cards used, and tests to verify this work. We conclude this chapter with our findings, suggestions, and various research perspectives on the subject, which make recommendations for future work.

CHAPTER I
INTRODUCTION

1. Introduction:

In our work we selected the Floods to monitor, is the submersion by water of land adjacent to the bed of a watercourse, are the most destructive natural disasters in the world by their frequencies and impacts on the environment, the economy and the populations. Overall, it is estimated that between 1980 and 2008, 2,887 heavy floods occurred, affecting more than 2.8 billion people for 6,700 deaths, that is to say around a hundred million people affected per year on average. On the plan economic impact amounts to 400 billion dollars for the same period (United Nations Office for Disaster Risk Reduction, UNISDR).

Floods are among the significant natural hazards in Algeria. They cause severe case u-alties, damage to building and destruction of roads, public works, and infrastructures. Algeria experienced devastating floods in the past that caused considerable damage. They are regularly affected by these natural disasters whose effects are intensified by other factors that aggravate them. These dramatic events, with heavy results, are not always linked to exceptional weather situations and occur following seasonal rain in episodes and are not exceptional. The major event is the flood that affected Bab El Oued district (Algiers) on 10 November 2001 caused one of the most unique and worst di s-asters that leaded over 800 fatalities, 150 missing persons, 30,000 people left homeless, in addition to net economic damages of over 250 million euro. It causes an important psychological shock. The second important floods, in and around the Algerian oasis town of Ghardaia on 2 October 2008, are caused by heavy rains have killed at least 33 people and injured 50 and approximately 2,000 families left homeless. Many others floods event was registered in many Algerians cities. This floods event is often characterized as rapidly developing events which leave little time for people to take actions to reduce damage to property and the risk to life. This floods event is actually a flash flood event; this type is not well known in Algeria. In this paper, we focus on the flash floods challenges and mitigation in Algeria: what we know and what we can do. We will present a one of the scientific works and the research projects on this topic. We will discuss various aspects of flood analysis, and their evolution in relation to urbanization and climate change. As well as various observations related to the development of floods in Algeria**. [1]**

2. IOT applications in environmental tracking:

1. Earthquake:

The internet of things could be the solution to one of the most deadly natural hazards, earthquakes; Technologies of IOT like Sensor Web Enablement Framework (SWE) and Message Queue Telemetry Transport (MQTT) give the benefit of achieving an Early Warning System capable of anticipating up to 12 seconds the maximum seismic peak in the epicenter zone through smartphones. The system is supported by a wireless sensor network and its main components, requirements and design decisions are described. It considers time and spatial analyses, not present in any other work, making it more precise and customizable, and adapting it to the features of the geographical zone and resources. **[2]**

2. Flood:

We can use internet of things for detected flood disaster and that is done by: First, the input data is taken from the flood BD. Next, the repeated data are reduced by using HDFS map-reduce. After removal of repeated data, the data are pre-processed using missing value imputation and normalization function. Then, centred on the pre-processed data, the rule is generated by using a combination of attributes method. At the last stage, the generated rules are provided as the input to the CDNN classifier which classifies them as a) chances for the occurrence of flood and b) no chances for the occurrence of a flood. The outcomes obtained from the proposed CDNN method is compared parameters like Sensitivity, Specificity, Accuracy, Precision, Recall and F-score. Moreover, when the outcomes are compared other existing algorithms like Artificial Neural Network (ANN) & Deep Learning Neural Network (DNN), the proposed system gives is very accurate result than other methods. **[3]**

3. Forest fire:

Effectiveness and response time in emergency situations management are key factors that directly influence the number of victims. The analysis of environmental conditions inreal time could provide relevant data on the environment that could help prevent or detect an emergency situation. The developed system integrates IOT devices and sensors that can perform a real time control of different atmospheric variables and polluting gases, in order to activate alerts when pollution levels increase excessively or when detecting certain conditions that are considered to be possible factors for causing adverse climatic events. These events can favor the occurrence of fires and other emergency situations. Particular attention has been paid to the communication security among IOT devices, Web service and mobile devices. Moreover, a secure data transmission protocol, a block cipher algorithm and a secure authentication scheme have been implemented. **[4]**

4. Waste mangement using IOT:

Along with the development of the Internet of Things (IOT), waste management has appeared as a serious issue. Waste management is a daily task in urban areas, which requires a large amount of labor resources and affects natural, budgetary, efficiency, and social aspects. Many approaches have been proposed to optimize waste management, such as using the nearest neighbor search, colony optimization, genetic algorithm, and particle swarm optimization methods. The method vigorously and efficiently achieves waste management by predicting the probability of the waste level in trash bins. By using machine learning and graph theory, the system can optimize the collection of waste with the shortest path. **[5]**

3. Problematic:

These last years, flash floods have been more disaster in north and south in Algeria causing loss humans and materials.

Now, in developed countries, the main tools used to detect heavy rainfall associated with flash floods are satellites, lightning observation systems, radars and rain gauges. This method is heavy and need satellite and energy possessing.

Figure 2 : "Heavy rain provequent of floods in Algier « 08 Septembre 2020 » "

Figure 1: "Heavy rain provequent of floods in Algier « 03 octobre 2008»"

We made a research on resent flash floods in Algeria, the research is summarized on **table 1**.

Table 1: flood statistics in Algeria

Place	Date	Damage check-up
Alger (Babel oued) **[6]**	09-11/2001	More than 700 deaths, 115 missing, thousands injured, damage (30 Billion DA)
Skikda **[6]**	17-11-2004	more than 100 homeless families, 219 affected families, settlements closed schools (3 high schools, 6 colleges average education and 4 schools fundamentals)
Sud (régions d'Illizi, Adrar et Tamanrasset) **[6]**	06-09/03/2005	3 deaths, 09 missing and 70 evacuated by helicopters, roads, agriculture and damaged infrastructure, several flooded villages
Tindouf **[6]**	09-11/02/2006	50-60% of infrastructure destroyed Sahrawi refugee camps (12,200 homeless families)
Bechar **[6]**	18 October 2007	2 dead washed away
Ghardaia **[6]**	01 October 2008	More than 34 deaths and 50 injuries, homes collapsed on their inhabitants, dozens of vehicles taken away by the water, torn trees, poles buried electrical, damage to agricultural land and sheep herds, more than 1,000 flooded homes 600 are damaged.
Bechar **[6]**	10 October 2008	8 dead, major property damage, the largest flood since 1959.
El Baydh **[7]**	01 October 2011	10 dead and 600 billion cents of damage
El Taref **[8]**	25 fevrier 2012	3 dead and more than 200 affected families
Tamanrasset **[9]**	5 aout 2018	3 people perish and another missing
Jijel province **[10]**	21 December 2020	17 people to reach
M'sila **[11]**	02 Mai 2021	1 person died in floodwaters

4. State of art:

4.1. Existing Proposed Solutions:

a) In Bosnia and Herzegovina:

Being predominantly a mountainous country, in Bosnia and Herzegovina natural disasters periodically occur, especially floods, which can cause extensive material damage and human casualties. The existing flood defense system is focused on monitoring the situation on major rivers. By collecting data from characteristic points on the terrain and analyzing them, it is possible to detect a situation which could cause torrential floods further in the river basin. Automated aggregation of such data by the competent services could provide timely organization of flood defenses. By integrating hardware components, sensors, microcontrollers with a web server and custom-built software, an early warning system was created capable of providing timely alerts to the risks of pouring of the rivers, as well as the emergence of torrential streams or landslides. The system is based on a network of automatic meteorological stations (AMS), which submit data at regular intervals to a central server, where this data is further processed and displayed to persons with appropriate authorization level to access the system. **[12]**

b) In Malaysia:

The Flooding is one of the major disasters occurring in various parts of the world including Malaysia. To reduce the effect of the disaster, a flood warning and monitoring are needed to give an early warning to the victims at a particular place with high prone to flood. By implementing the IOT technology based on NodeMCU based technology integrated using Blynk application. The wireless sensor node can help the victims by detecting the water levels and rain intensity while giving an early warning when a flood or heavy rain occurs. Data detected from the sensors are sent to the Blynk application via wireless connection. The victim will get to know the current status of flood and rain by viewing the interface and receiving a push notification that available in Blynk application via IOS or Android smartphones. The flood level's data sent to the email could help various organizations for further improvement of the system and flood forecasting purposes. As a test result had been conducted, it founds that this prototype can monitor, detect and give a warning with notification to the victim earlier before the occurrence of floods. **[13]**

c) In Indonesia:

Indonesia is one of the tropical countries with high rainfall. It causes a flood disaster that with the loss of property and life. Currently handling flood disasters in developing countries are still using many conventional ways. IOT is smart technology which has capability to send data in real time, connected to the smart phone, sensor and web service. This ability can be used for smart application to control and manage an early warning system. In this research we also use IOT technology to monitor and control the early detection system of flood disaster. By using IOT technology, sensor data can be sent in real time from sensor to smartphone through internet network. The sensor data contains the water characteristics data on the dam that will be processed in the data base. The processing data of water characteristic will be a decision of hazard level. That decision will be sent to users as notification into the user smartphone application. This research will be useful for deeply research on disaster management system and flood early detection system in Indonesia**. [14]**

We resumed the research of related work on **table 2**.

4.2. comparative study on the proposed solutions:

Table 2: Ressmé of the state of the art

Article	Hardware	Software	Sensor	Result
• In Bosnia and Herzegovina: Automatic Meteorological Station (AMS) **[12]**	• Arduino microcontroller • AMSs for data acquisition and transfer	• programming in the Arduino • Web and DB servers publicly available via internet domain, • Web site / Web application as presentation, analytics and alert layers	• Ultrasonic sensor • Atmospheric temperature, pressure and humidity sensor • Vibration sensor • Power supply and storing unit • GSM module	•this early warning system is designed to function autonomously, thanks to its automatic weather stations. It incorporates standard sensors and microcontrollers that can be purchased on the market at affordable prices, ensuring quick and easy fabrication, installation and commissioning
• In Malaysia Blynk IoT-cloud **[13]**	•NodeMCU •ESP8266 microcontroller	• programming android application (Blynk application) • programing in the Arduino or raspberry pi	•ultrasonic sensors •Rain sensor	• smart flood monitoring system using ultrasonic sensors with NodeMCU and Blynk application. The results offer flexibility, efficiency and low cost. Wireless sensor node based on Blynk platform is an ideal platform to monitor flash floods and also as early warnings. The working of allow-cost ultrasonic sensors and rain sensor integrated with NodeMCU are able to detect and provide efficient and accurate sensing data for monitoring and alerting purposes. Through the experiment conducted, it shows that this system can be used for detecting, monitoring and alerting the community in Selangor in case of flash flood.
• In Indonesia **[14]**	•ESP-8266 microcontroller	• programming in the ESP8226 • programming web server • programing Android application	• ultrasonic sensor • Water flow sensor	• That water characteristic can be coming an important parameter for flooding warning information. Although the quantity of sensor will be influence to the accretion of detection. In the next research the quantity of sensor needs to be added to get more accurate data of flooding.

Related to these states of art we conclude that using a more powerful controller with raspberry pi we would take to import sensors and the way the information will be posted on web page using on IOT platform.

5. Proposed Solution:

On this occasion, we offer a solution that will have the results spirit as the solutions present on the market but which costs less, with flexibility in the installation. The proposed solution must allow to monitor the weather conditions (humidity & temperature and pressure) and control on node there to evolution of rain and level of water, the information is processed and visualized on IOT platform.

Of this place from anywhere in the world on the Internet, this not only displays the current data, but can also display the past values in the form of graphs that allows information to be presented in a clear and informative way via curves and data tables.

This project concerns the realization of an online flood status monitoring system using a <<Raspberry Pi>> board, to detect the water level, in order to warn against the dangers of flooding.

We can say that the proposed solution is based on:

- A low-cost SBC
- Set of adéquate sensors
- IOT platform

We will discuss these parts in next paragraphs.

6. Comparative study of IOT platforms:

6.1. The IOT platform:

An IOT platform makes it easier to connect all kinds of objects to the network as well as developing applications to control and manage these objects. All the complexity of the connectivity is task entrusted to IOT platform.

The definition of an IOT platform varies according to the publishers, an IOT platform allows:

- Connect objects to an IS.
- Authenticate and secure connected objects.
- Manage the data and orders to be sent and received.
- Collect, visualize and analyze data.
- Integration with other web services.

These platforms and IOT application development tools are:

a) Microsoft Azure IOT :

The Azure IOT is an extensive collection of Microsoft-related cloud services with which you could connect and handle many IOT assets. In short, IOT is the solution would contain more than one IOT gadget with a capacity of communicating with several back-end services hosted by the cloud.

Could develop and secure more IOT apps securely. Having a decade-long experience with Micros could develop and secure more IOT apps securely. Having a decade-long experience with Microsoft enterprise, that Azure is the greatest choice for any type of companies and enterprises. Azure IOT can control any type of device, tool, security feature, and data analytics to meet the IOT objects.

Azure IOT can control any type of device, tool, security feature, and data analytics to meet the IOT objects.

Microsoft focuses on creating more IOT products. Azure IOT is working on a new business invention, lowering waste through Machine Learning and AI, and boosting business productivity constantly.

A few features of this platform incorporate identity registry, device shadowing, data monitoring, and a set of the rule's engine. Azure IOT suite integrates with Azure Stream Analytics for processing a large amount of data created by the sensors. **[15]**

b) Google Cloud :

This IOT platform is a properly handled and combined IOT solutions provider. This platform helps in comprehensive IOT app development and the handling of IOT devices connected across the globe. It features an advanced analytics tool that allows the companies to receive intuitiveness in a real-time way.

Aside from such great capabilities, Google Cloud also offers combines services with cloud, end-to-end security, advanced data analytics, business process optimization, and a completely managed infrastructure**.[16]**

c) Cisco IOT Cloud Connect :

Created by Cisco, this IOT development platform allows the developers to encounter secure and easy solutions for IOT along with different other purposes. The list incorporates data analytics, network connectivity, app enablement, automation, and management.

Cisco believes in offering its clients a safe platform for connecting several devices globally, regardless of their geographical locations. This platform assists smart city, power management, transportation system, industrial automation, and more. **[16]**

d) IBM Watson IOT :

IBM Watson IOT is a Pass-Based development platform that is offered by IBM. The platform is capturing and investigating data for machines, devices equipment and search the understandings for taking better decisions. Also, the IBM Watson IOT platform will allow optimize the operations and resources. **[16]**

- It will help in building and modernizing and connecting devices with apps on the cloud - without any efforts

- It analyzes the unstructured data and understands the data-pattern for extracting the valuable insights.

- It provides a dashboard for enhancing the visualization.

- It provides analytics service as an add-on service.

e) ThingSpeak :

ThingSpeak is great open source IOT platform for build IOT prototype rapidly. ThingSpeak provide HTTP and MQTT APIs for sending IOT device data to ThingSpeak cloud. Allows analyze and visualize IOT device data on ThingSpeak with MATLAB widgets. ThingSpeak also provide feature for trigger any action based on data input. ThingSpeak support many types of IOT device like Arduino, Raspberry and Nodemcu. Allows export out IOT device data from ThingSpeak cloud for deep analysis. **[17]**

f) Amazon AWS IOT Core :

Amazon AWS IOT Core connect diverse devices to the cloud. Amazon AWS IOT core is a managed cloud service. It will permit devices for connecting with the cloud and communicating with other devices and cloud apps. It will provide huge support for MQTT, lightweight communication protocol and HTTP. **[18]**

- It can process a large number of messages

- It is a trustworthy and safe platform for routing the messages till AWS endpoints and other devices

- It can track apps and communicate even when we are not connected

- It will allow secure access for devices

- Using this platform, will be able to make use of other AWS services like Amazon Kinesis, Lambda and Amazon Quick Sight and more such.

g) Oracle IOT :

Oracle IOT connect diverse to the cloud, perform the analysis of data from the devices in real-time and perform integration of data with the enterprise apps or web services. It supports the integration with oracle and non-oracle apps and different IOT devices with the help of REST API. **[19]**

- It will assist in extending the supply chain, HR, ERP, and customer experience apps

- It offers operational efficiency and worker productivity to be increased and improved

- For analyzing the data, it offers features like data enrichment and stream processing

- With the help of REST API, integration can be done using Oracle and non-oracle apps and different IOT devices.

We made a comparative study summarized it on **table 3.**

Table 3: Comparative Stady of IOT Platform

	Microsoft Azure IOT	**Google Cloud**	**ThingSpeak**	**IBM Watson IOT**	**Amazon AWS IOT Core**	**Oracle IOT**
Protocol	Http, AMQP, MQTT	MQTT, http	HTTP, MQTT, CoAP, Web sockets	HTTP, MQTT	HTTP, MQTT, Web Socket	HTTP, MQTT
Certified Hardware	Intel, Raspberry Pi, Freescale, Texas Instruments	Arduino	Hardware agnostique	ARM med, Texas Instruments, Raspberry Pi, Arduino Uno	Broadcom, Marvell, Renesas, Texas Instruments, Microchip, Inte	Intel, Raspberry Pi, Freescale
SDK/ Langage	Net and UWP, Java, C, NodeJS		Python, Node.js MQTT, Node.js HTTP, Node.js CoAP, Jailed Node	C++, C Python, Java, NodeJS	Java, NodeJS	Java, python, Android, iOS, C Posix, C, Apache Felix
Connection	Easy configuration	Easy configuration	Easy configuration	Difficult configuration	Easy configuration	Easy configuration
Intégration	AI, and Real-time	REST API	Real-time API	REST and Real-time APIs	REST API	REST API

Security Information	TLS/ (X.509), Handshake and Encryption, Authorization, key vault	Link Encryptions (TLS)		Link Encryptions (TLS), Authentiquassions (IBM Cloud SSO), Identity management (LDAP)	Link Encryption (TLS), Authentication (SigV4, X.509)	

After a comparative study between the IOT platforms, we chose the ThingSpeak platform because it is free to start up, easy to use and rich in possibilities and features. Thus, is an open data platform for the development of IOT applications. It also offers the ability to integrate your data with a variety of third-party platforms, systems and technologies. this ThingSpeak platform is more secure.

7. Les single board computer comparative study:

7.1. single board computer:

a. Raspberry Pi :

The Raspberry pi is a single computer board with credit card size, that can be used for many tasks that your computer does, like games, word processing, spreadsheets and also to play HD video. It was established by the Raspberry pi foundation from the UK. It has been ready for public consumption since 2012 with the idea of making a low-cost educational microcomputer for students and children. The main purpose of designing the raspberry pi board is, to encourage learning, experimentation and innovation for school level students. The raspberry pi board is a portable and low cost. Maximum of the raspberry pi computers is used in mobile phones. In the 20th century, the growth of mobile computing technologies is very high, a huge segment of this being driven by the mobile industries. The 98% of the mobile phones were using ARM technologie. **[20]**

- **Raspberry Pi Technologie :**

The raspberry pi comes in two models, they are model A and model B. The main difference between model A and model B is USB port. Model A board will consume less power and that does not include an Ethernet port. But the model B board includes an Ethernet port and designed in china. The raspberry pi comes with a set of open source technologies, i.e. communication and multimedia web technologies. In the year 2014, the foundation of the raspberry pi board launched the computer module, that packages a model B raspberry pi board into module for use as a part of embedded systems, to encourage their use.

- **Raspberry Pi Hardware Spécifications :**

The raspberry pi board comprises a program memory (RAM), processor and graphics chip, CPU, GPU, Ethernet port, GPIO pins, Xbee socket, UART, power source connector. And various interfaces for other external devices. It also requires mass storage, for that we use an SD flash memory card. So that raspberry pi board will boot from this SD card similarly as a PC boots up into windows from its hard disk.

Essential hardware specifications of raspberry pi board mainly include SD card containing Linux OS, US keyboard, monitor, power supply and video cable. Optional hardware specifications include USB mouse, powered USB hub, case, internet connection, the Model A or B: USB WiFi adaptor is used and internet connection to Model B is LAN cable.

- **Raspberry Pi 3 modèle B+ :**

The Raspberry Pi 3 Model B is an evolution of the B model by bringing some additional changes and features, very appreciable on a daily basis. The Broadcom BCM2837B0 processor earns 200 MHz compared to its predecessor for even smoother computational performance.

MAIN FEATURES:

Raspberry Pi 3 Type B Motherboard

Broadcom POC BCM2837B0 Cortex-A53 64-bit SoC - 1.4 GHz

RAM: 1GB LPDDR2 SDRAM

Wireless connections: Bluetooth 4.2 BLE, Wi-Fi Dual Band b/g/n/ac

Wired connection: Gigabit Ethernet

Decoding and encoding H.264 1080p30

PoE Support (PoE HAT not provided)

Micro-SD card reader

Header GPIO 40 pins

PXE boot support

Port CSI camera to connect the Raspberry Pi camera

DSI display port to connect The Raspberry Pi touchscreen

4 x USB 2.0

Compatible with Pi 3 Model B accessories

5V / 2.5A power (uncured transformer)

b. Espressif System :

Espressif Systems is a multinational state-of-the-car semiconductor company established in 2008, headquartered in Shanghai with offices in China, Singapore, India, the Czech Republic and Brazil. The team is made up of passionate engineers and scientists from around the world, focused on developing state-of-the-art WiFi and Bluetooth low-energy IOT solutions. They created the famous series of chips, modules and development maps ESP8266, ESP32 and ESP32-S. By taking advantage of wireless computing, they offer eco-friendly, versatile and economical chipsets. They have always been committed to providing secure, robust and energy-efficient IOT solutions. Their vision is to enable developers to use Espressive technology worldwide and create smart connected devices. **[21]**

- **Espressive ESP32**

ESP32 is a series of low-cost, low-energy systems on smart microcontrollers with built-in Wi-Fi and dual-mode Bluetooth. The ESP32 series uses a Tensilica Xtensa LX6 microprocessor with dual-core and monocoque variants and includes built-in antenna switches, an RF balun, a power amplifier, a low-noise reception amplifier, filters and power management modules. Manufactured by TSMC using their 40 nm process, it can be considered a successor to the ESP8266 microcontroller.

The Technical Characteristics of ESP32:

Processor: Xtensa dual-core (or mono-core) LX6 32-bit microprocessor, running at 160 or 240 MHz and running up to 600 DMIPS

Ultra-low power coprocessor (ULP)

Memory: 520 KiB SRAM

Wi-Fi: 802.11 b/g/n

Bluetooth: v4.2 BR / EDR and BLE (shares radio with Wi-Fi)

Peripheral interfaces:

ADC SAR 12-bit up to 18 channels

2 × 8-bit DAC

10 × touch sensors (capacitive-sensing GPIO)

4 × SPI ,2 × I2S interfaces, 2 × I2C interfaces, 3 × UART

SD / SDIO / CE-ATA / MMC / eMMC host controller

SDIO / SPI Slave Controller

MAC Ethernet interface with support for dedicated DMA protocol and IEEE 1588 Precision Time

CAN Bus 2.0

Infrared remote control (TX / RX, up to 8 channels)

Hall Effect Sensor

Ultra-low-power analog preamplifier

Food management:

Low-stall internal regulator

Individual Power Domain for RTC

Deep sleep current of 5 A

Awakening after GPIO interruption, timer, ADC measurements, capacitive touch sensor interruption.

c. Rock Pi :

ROCK PI is a Single Board Computer (SBC) in an ultra-small form factor that offers class-leading performance while leveraging outstanding mechanical compatibility. The ROCK PI offers makers, IOT enthusiasts, hobbyists, PC DIY enthusiasts and others a reliable and extremely capable platform for building and tinkering their ideas into reality. {

Rock Pi has a modern and powerful hexa-core ARM-based processor, RK3399 inside, it offers significantly improved performance versus other popular SBC boards. All models are equipped with LPDDR4 3200Mb/s RAM and optional high-performance eMMC modules, boost all applications.

He exist several type for this SBC: Rock Pi 4 , Rock Pi S , Rock Pi E , Rock Pi X , Rock Pi N10 **[22]**

d. Jetson Nano:

Jetson Nano is a small, powerful computer for embedded applications and AI IOT that delivers the power of modern AI in a $99 (1KU+) module. Get started fast with the comprehensive JetPack SDK with accelerated libraries for deep learning, computer vision, graphics, multimedia, and more. Jetson Nano has the performance and capabilities you need to run modern AI workloads, giving you a fast and easy way to add advanced AI to your next product. To get started with your development process, check out the Jetson Nano Developer Kit. **[23]**

we made a comparative study summarized **deferent SBC** on **table 4**.

Table 4:Comparative Study of deferent SBC

	Raspberry Pi 3B+	ESP32	Rock Pi	Jetson Nano
Processor	Broadcom BCM2837B0, Cortex-A53 64-bit SoC @ 1.4GHz	Xtensa dual-core (or single-core) 32-bit LX6 microprocessor	Dual Cortex-A72, frequency 1.8Ghz with quad Cortex-A53, frequency 1.4Ghz	Quad-core ARM Cortex-A57 MPCore
Memory	1GB LPDDR2 SDRAM	520 KiB SRAM, 448 KiB ROM	LPDDR4@3200Mb/s, 4GB	4 GB 64-bit LPDDR4, 1600MHz 25.6 GB/s
Storage	Micro SD card slot	Flash memory	USD card 128G M.2 SSD	16 GB eMMC 5.1
Wifi	2.4GHZ and 5GHZ 802.11 b/g/n/ac	802.11 b/g/n	802.11 ac	802.11 ac
Bluetooth	4.2, BLE	v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)	5.0	4.2
CPU	1.4 GHZ	160 or 240 MHz and performing at up to 600 DMIPS	1.8Ghz and 1.4Ghz	1600MHz
GPU	Broadcom video core-IV	VGA Board video	Mali T860MP4	NVIDIA Maxwell architecture with 128 NVIDIA CUDA® cores
Architecture	64 bits	32 bits	64bits	64bits

After studying the singles board computer, we chose the raspberry 3b+ is the most versatile, powerful and successful nano computer in the foundation. Currently sold at around €35, it incorporates improvements that allow its users to benefit from a reliable product, even when used as a desktop computer to browse the internet or use various software.

Thus, aimed at taking over the Raspberry Pi 3 released two years ago, this 3B model features a slightly more powerful SoC, the BCM2837B0, which allows the 64-bit Cortex-A53 quad core CPU to go from a frequency of 1.2 to 1.4 GHz, all with a RAM of 1 GB DDR3.

Will be delighted to discover a small metal plate with a small engraved raspberry (the Raspberry Pi logo) that covers the network components and allows to take advantage of the good compliance of the equipment

8. Conclusion:

In this chapter, we have presented the issues that motivated us to implement this project. We did a study of existing solutions. This study allowed us to propose a solution that respects the state of the art but that tries to avoid the problems that we noticed in the other solutions. Finally, we explained the choice of the methodology chosen in order to carry out this work. In the next chapter we will present the hardware and software implementation of our solution.

CHAPTER II
MATERIALS AND METHODS

1. Introduction:

In this chapter, we will determine all the software and hardware needs for our project, then we present the synoptic diagrams of the different sensors and how they work.

2. Synoptic design:

In the figure below we have the architecture that we used in our project.

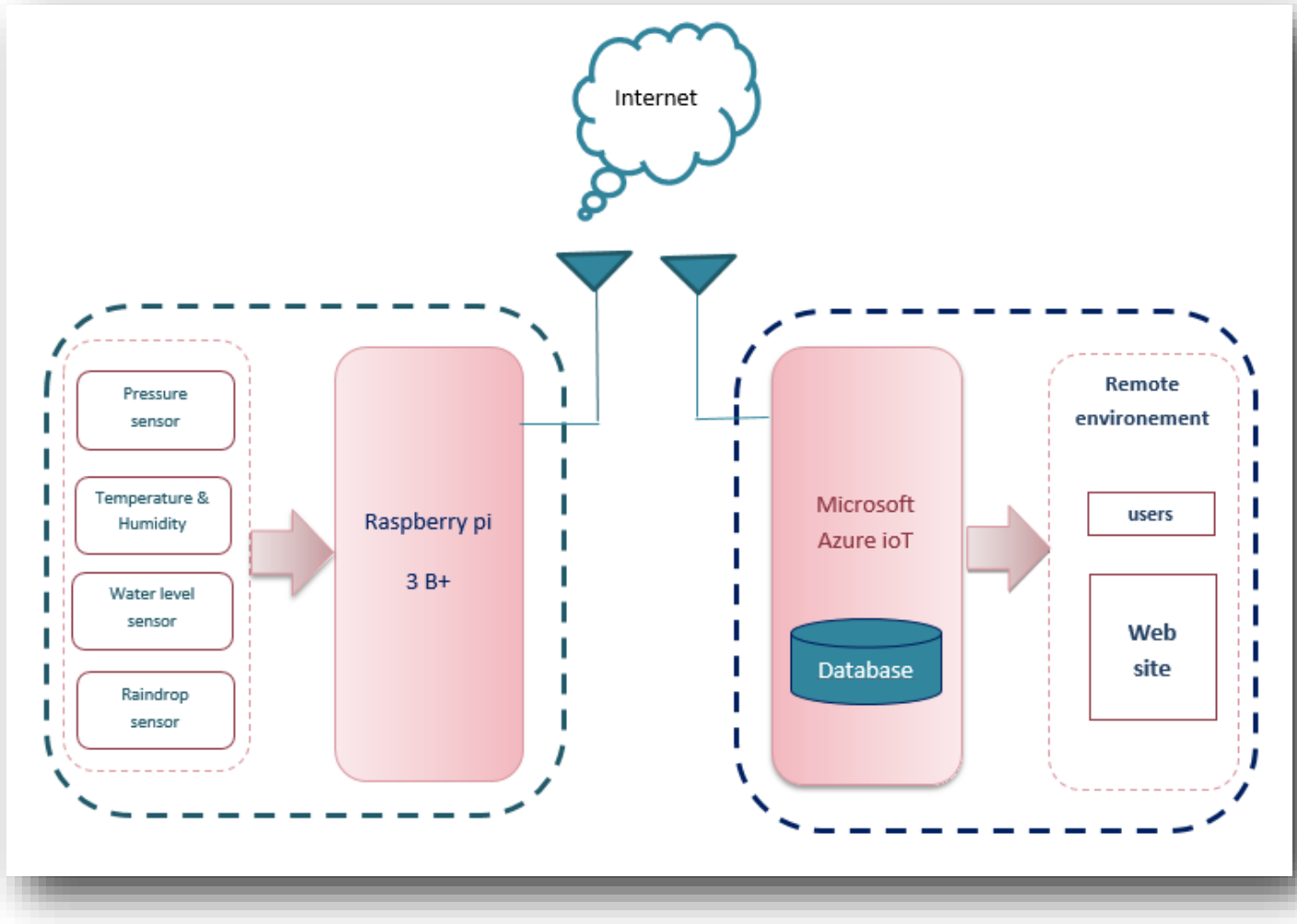

Figure 3: "Synoptic of the design"

As noticed in this synoptic we have to implement hardware solution based on good choices for sensors and better SBC. In IOT, the radio frequency transmission is a main. The SBC we selected the raspberry pi has two wireless transmission Bluetooth BLE and WiFi.

3. Prototype design:

This figure prisent the prototype wich we used in our project.

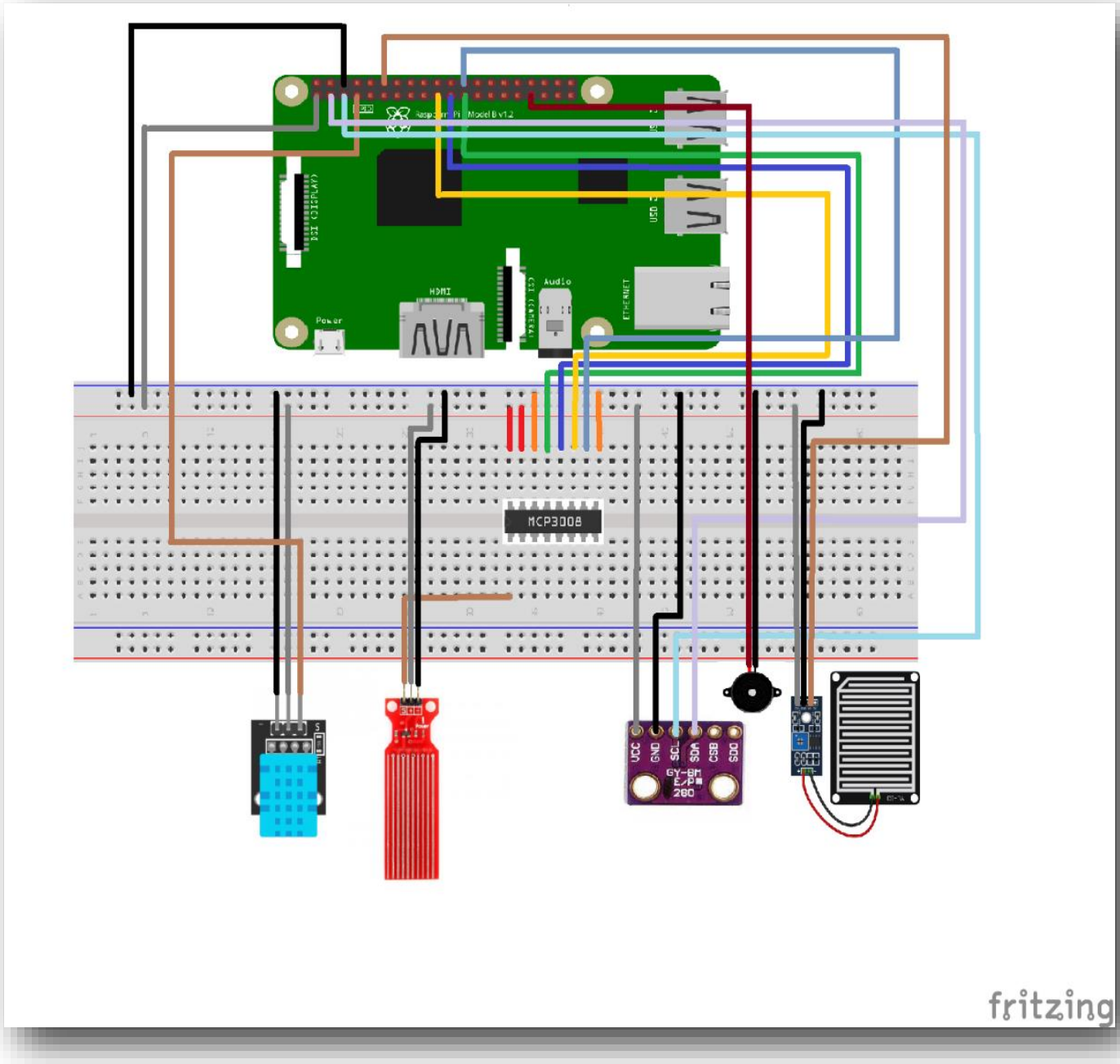

Figure 4: "Hardware electronic schematic with sensor and ADC computer"

4. Assembly:

Mounting the raspberry pi 3b + board and sensors (dht11, bmp280, raindrop, water level)

4.1 Installing sensors:

Figure 5: " Installing sensors in the sensor node and gateway node"

4.2 Connection of each component with its port in the Raspberry pi board:

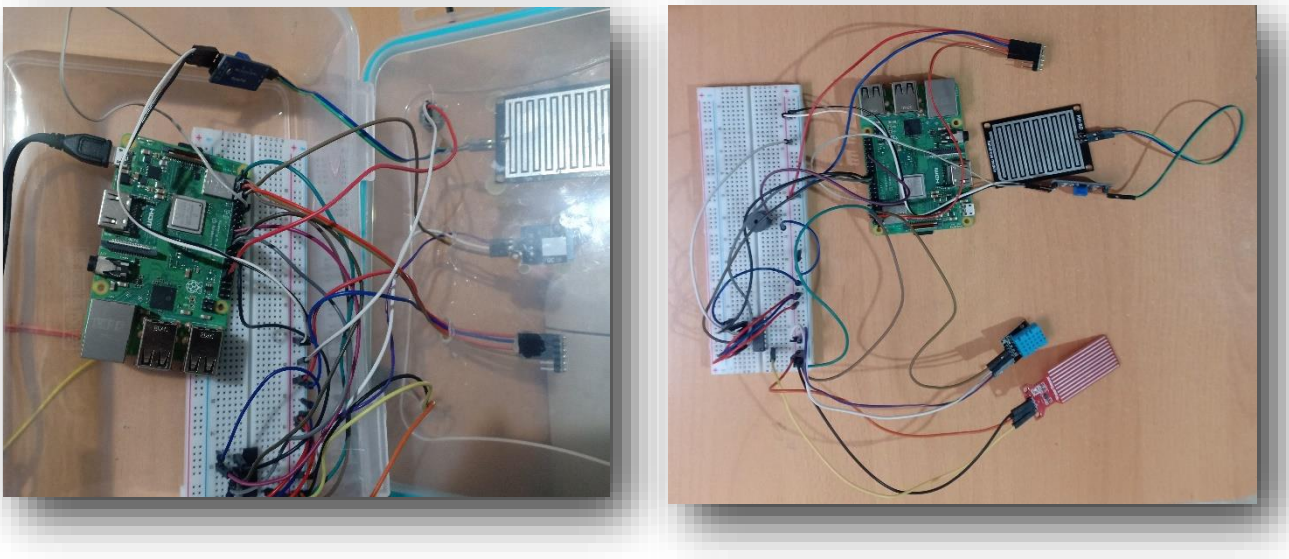

Figure 6: "Connecting components with raspberry pi"

5. Elements of the design:

5.1 Components “Hardware ”:

The montage consists of:

1. A Raspberry 3b+
2. Temperature and Humidity Sensor (DHT11)
3. Pressure Sensor (BMP280)
4. Micro SD card (for RPI-OS)
5. power for the system (Battery)
6. cables

5.2 Software Tools:

1. python programming language
2. Python IDLE (Python 3)
3. an Internet of Things platform (ThingSpeak IOT)

6. Hardware description:

6.1 Microcontrolists (“Raspberry 3b+ ” card):

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and the Raspberry Pi 3 Model B.

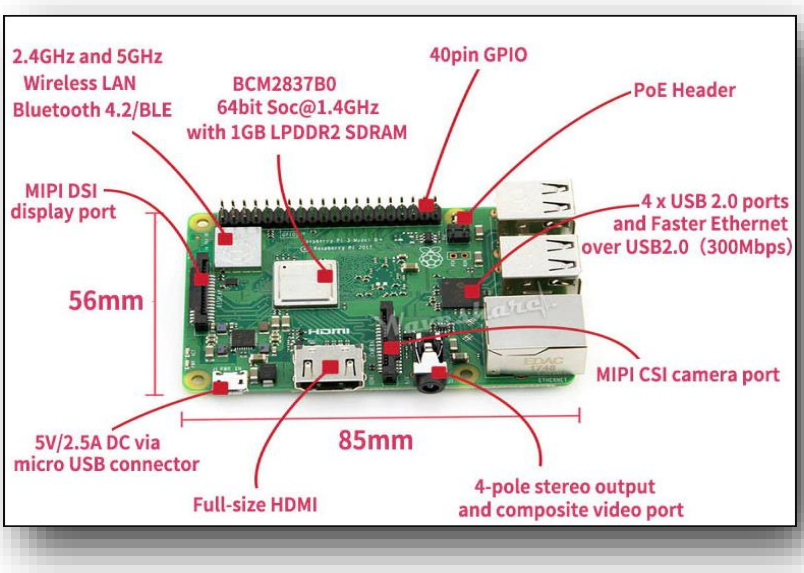

Figure 7: “Raspberry 3b+ card”

6.2 Sensors:

6.2.1 Temperature&Humidity Sensor (DHT11):

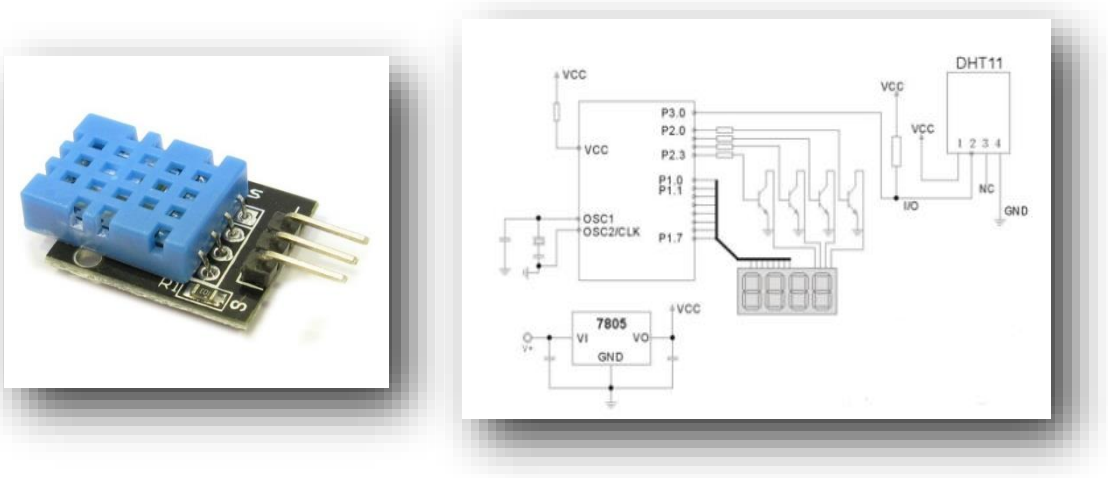

Figure 8: "Temperature-Humidity Sensor (DHT11)"

It is a temperature and humidity sensor highly regarded for its simplicity of implementation and low cost. It only requires a draw resistance and a 3V or 5V power supply to work, its programming is easy.

The digital module DHT11 delivers and receives a digital signal on a serial input/exit unique. Its two analog sensors are a resistance that determines the humidity and NTC -type thermo-resistance (Negative Temperature Coefficient) to measure the temperature. **[23]**

DHT11 is characterized by :

Power: 3-5.5V DC

Release Signal: Digital Signal via single-bus

Sensor: Polymer Resistance

Measurement range: Humidity: 20-90%HR; Temperature: 0-50oC

Accuracy: Humidity --4%HR (Max --5%HR); Temperature - 2.0 degrees Celsius

Resolution: Humidity 1%RH; Temperature 0.1oC

Hysteresis - 1%RH

Stability - 0.5%HR/year

Measurement period: 2s

Dimensions : 12x15.5x5.5

6.2.2 Pressure Sensor (BMP280) :

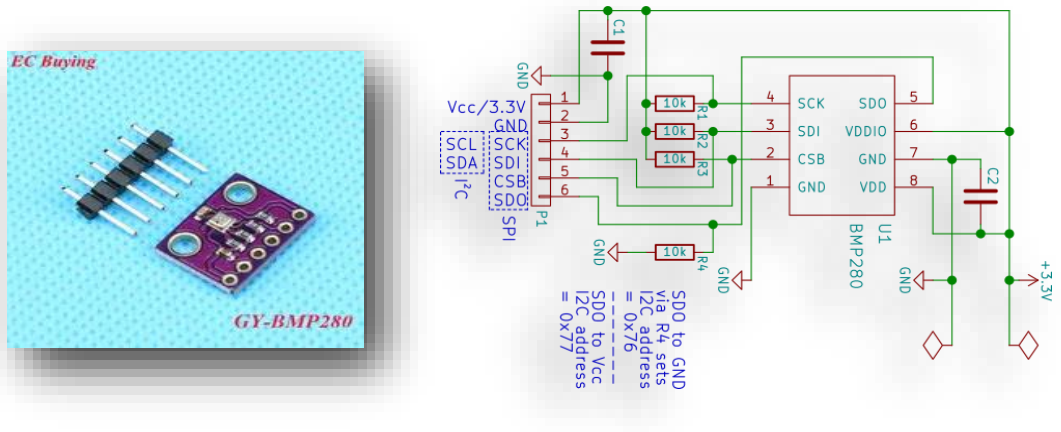

Figure 9: "Pressure Sensor (BMP280)"

The BMP280 is an absolute barometric pressure sensor specially designed for mobile applications. The sensor module is housed in an extremely compact case. Its small size and low power consumption allow for implementation in battery-powered devices such as mobile phones, GPS modules or watches. **[24]**

- Improved GPS navigation (e.g., improved time of first correction, esteem, slope detection)
- Inland navigation (ground detection, elevator detection)
- Navigation, recreation and outdoor sports applications Weather forecast
- Health care applications (e.g. spirometry)
- Vertical speed indication (e.g., up/down speed)

6.2.3 Water Level Sensor:

Water Sensor water level sensor is an easy-to-use, cost-effective high level/drop recognition sensor, which is obtained by having a series of parallel wires exposed traces measured droplets/water volume in order to determine the water level. Easy to complete water to analog signal conversion and output analog values can be directly read Raspberry Pi development board to achieve the level alarm effect.

This is simple and small portable water level/water droplet identification, detection sensor water that have high cost performance. Complete water yield and analog conversion, the output value apply to your custom function. It is low power consumption and high sensitivity. It can make better performance with raspberry Pi and sensor relay shield.

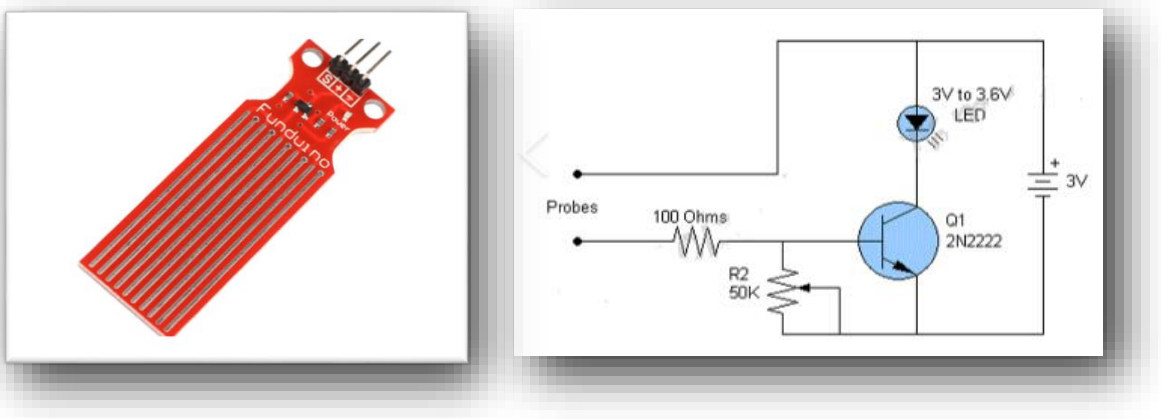

Figure 10: "Water Level Sensor"

It characterized:

- Working Voltage: DC 3-5V
- Working Current: <20mA
- Sensor Type: Simulation
- Detection Area: 40 mm x 16 mm
- Manufacturing Process: FR4 double spray tin
- Fixed Hole Size: 3.2 mm
- Humanized Design: Half-moon sag nonskid treatment
- Working Temperature: 10 °C to 30 °C
- Work Humidity: 10% to 90% without condensation
- Size: 65 mm x 20 mm x 8 mm
- Optional Accessories: 3 pin sensor connecting line, Arduino 328 controller, Sensor relay shield. **[25]**

6.2.4 Rain drop sensor:

Raindrop Sensor is a tool used for sensing rain. It consists of two modules, a rain board that detects the rain and a control module, which compares the analog value, and converts it to a digital value. The raindrop sensors can be used in the automobile sector to control the windshield wipers automatically, in the agriculture sector to sense rain and it is also used in home automation systems.

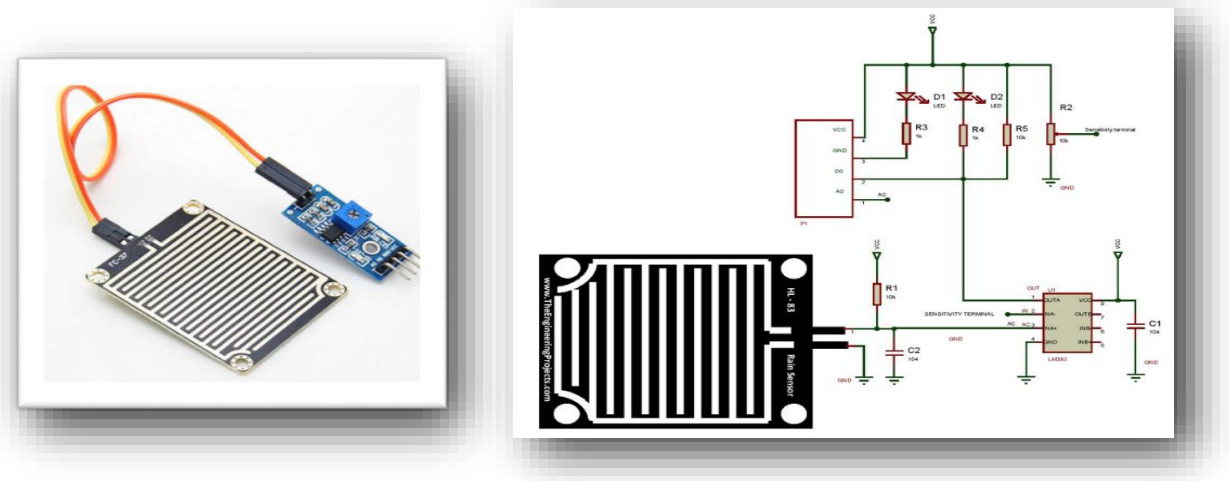

Figure 11: "Rain drop Sensor"

It characterized:

- Working voltage 5V
- Output format: Digital switching output (0 and 1), and analog voltage output AO

- Potentiometer adjust the sensitivity
- Uses a wide voltage LM393 comparator
- Comparator output signal clean waveform is good, driving ability, over 15mA
- Anti-oxidation, anti-conductivity, with long use time
- With bolt holes for easy installation
- Small board PCB size: 3.2cm x 1.4cm **[26]**

7. Software description:

7.1 Introduction to Python:

Figure 12:" Python 3"

Python is a widely-used programming language with an easy, beginner-friendly syntax (arrangement of words, phrases, in sentences). Due to its wide adoption, it has a huge community, and it giving access to libraries, frameworks, and tools to get started.

For Python to run any platform, it requires a Python Interpreter, and since Linux, an OS for the Raspberry Pi has been written for it, running of Python Interpreter has no issues. Hence, it is used for the Raspberry Pi, starting off as a scripting language to a full-fledged programming language option for software configurations.

Since Python is a multi-purpose programming language, it can be used for many useful applications in different industries as such:

- Web development and applications
- Creating GUI applications
- Game development, programming, and computing
- Automation
- Machine learning and Artificial Intelligence
- Raspberry Pi projects such as turning LED on and off, etc.

Some of the applications sound complex, therefore we chose Python is simply solve complex problems or applications with fewer lines of code, saving both time and effort. **[27]**

7.2. Installing Python on RPI:

Most distributions of Linux come with Python 3 already installed, but they might not have IDLE, the default IDE (interactive development environment), installed.

Use apt to check whether they are installed and install them if they aren't. Open a terminal window and type:

- Sudo apt update
- Sudo apt install python3 idle3

7.3. Python application overview:

To run the application Python , must to clicking on the Top left **Pi icon -> Programming -> Python 3 (IDLE):**

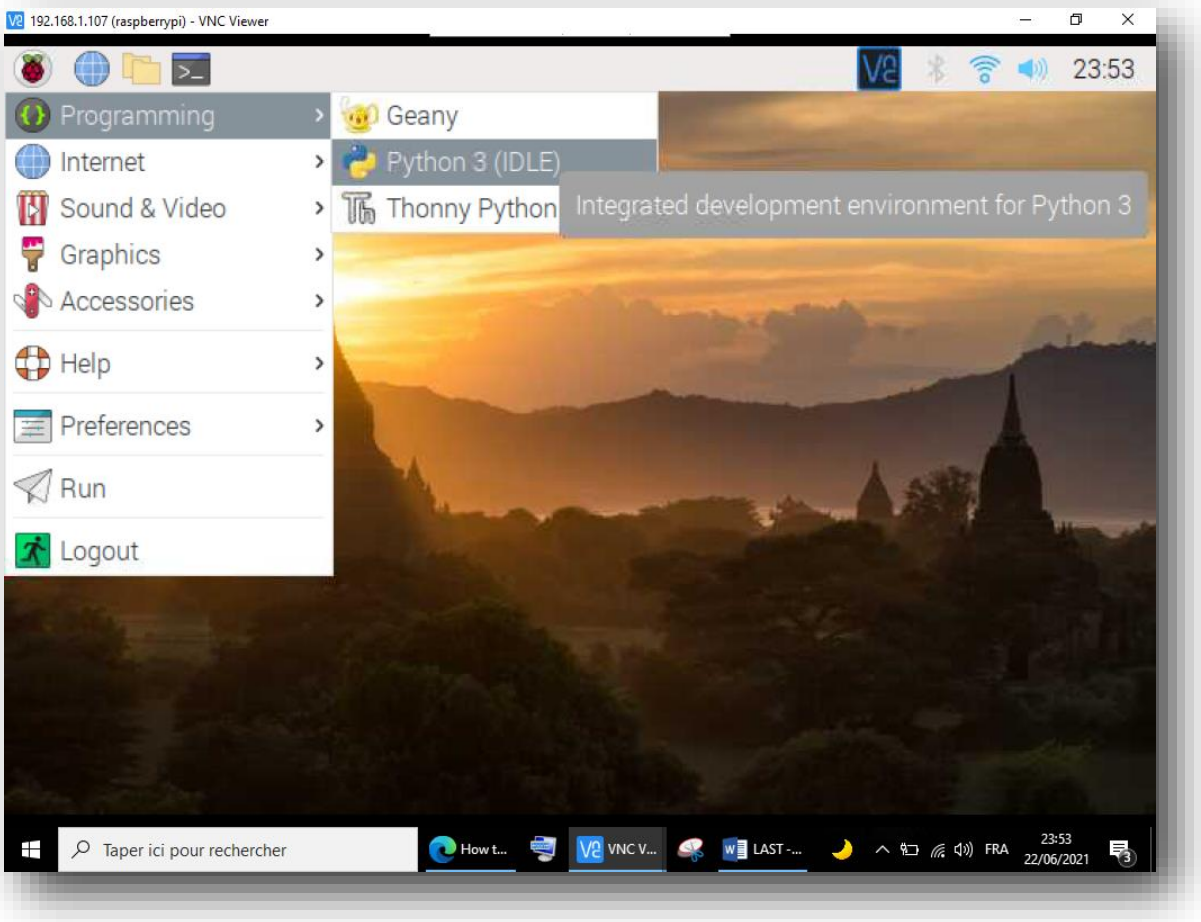

Figure 13: "Python application overview"

7.4. ThingSpeak IOT Platform:

On chapter one, we made research on different IOT platform we started using Azure IOT platform hoever we found that on structure version (free) , there are limitation on number of sensors and also number of access to platform. So we preferred to choose ThingSpeak IOTplatform wich more flexible.

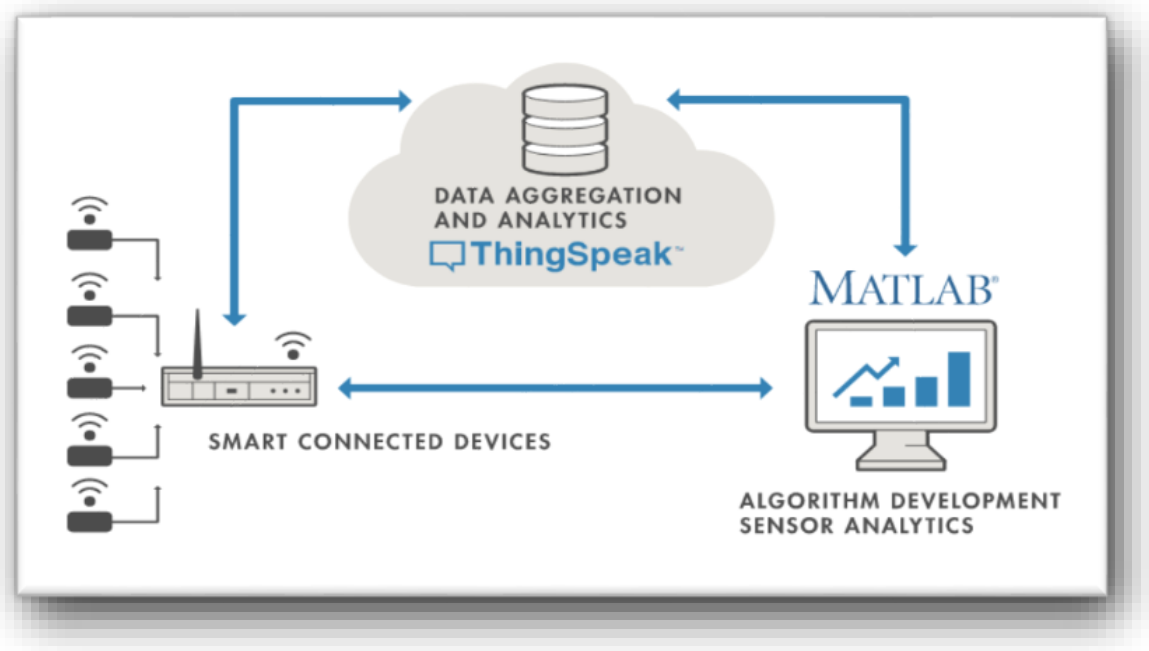

Figure 14: "ThingSpeak IOT platform diagram"

ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates". **[28]**

ThingSpeak serving as a bridge between edge node devices such as temperature and pressure sensors to collect data and software (MATLAB) exploratory data analysis to analyze data.

ThingSpeak is an IoT analytics platform service that allows to aggregate, visualize, and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of the data published by your devices on ThingSpeak. Some of the key features of ThingSpeak are:

• Open API

• Real-time data collection

• Geolocation data

• Data processing

• Data visualizations

• Circuit status messages

• Plugins

8. Conclusion:

In this chapter we have presented the design of our Surveillance System in detailing all modules used. We will now present the work done and the results achieved during the period of the study of the transformers and the realization of our system.

CHAPTER III
TESTS AND RESULTS

1. Introduction:

After determining the software and hardware requirements and determining the various obstacles in the system, we will now begin the real part of the project, which is the realization.

2. Presentation:

The objective of this project is to monitor and track the state of flooding online and risk prevention using an electronic card <<Raspberry pi>> and sensors (water level, raindrop, DHT11, pressure BMP280) to make the detection of the entrance the water level for and to avoid severe flooding, also saves human lives.

3. Electronic schematic diagram:

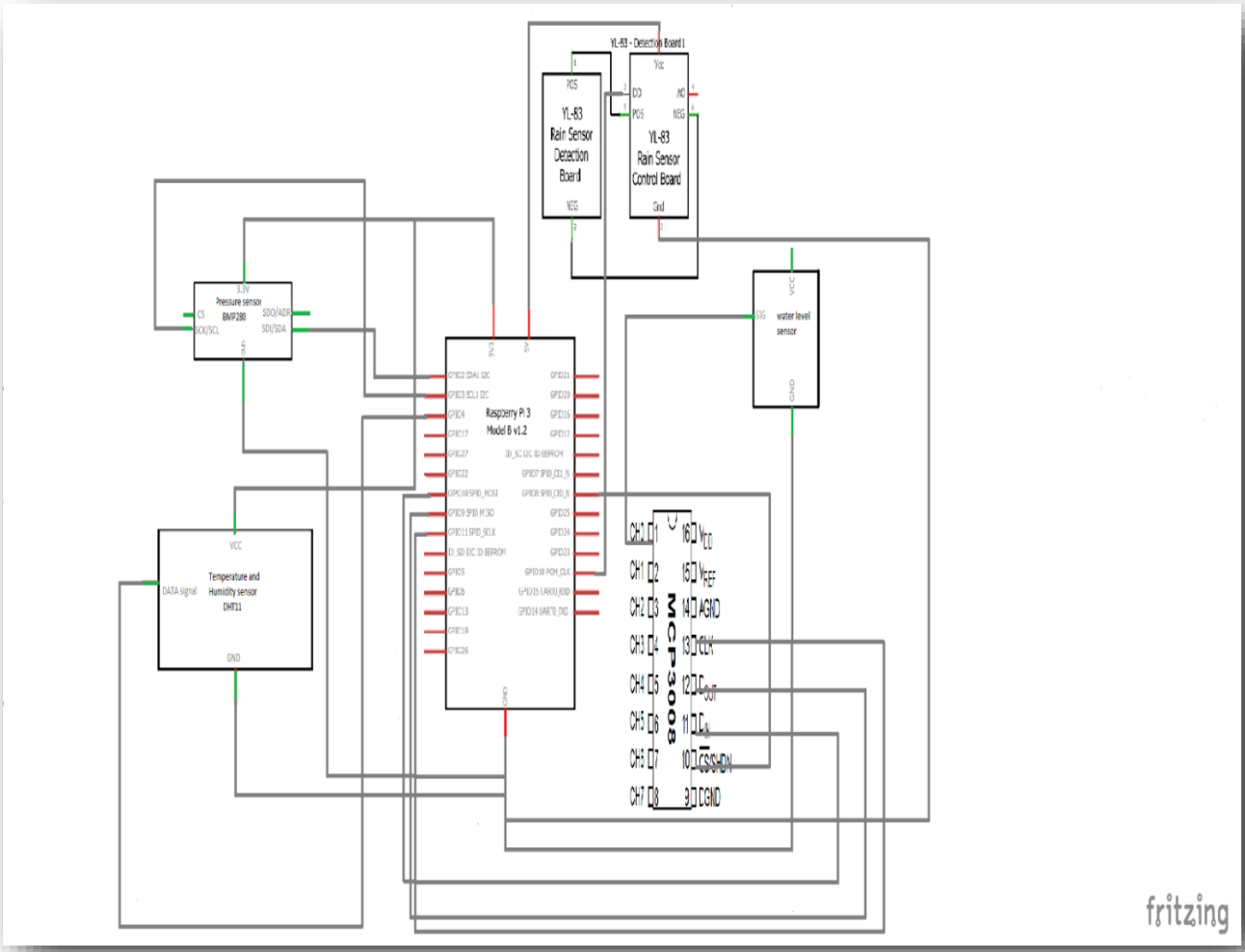

Figure 15: "Electronic schematic diagram"

4. Sensor Testing:

4.1. DHT11 Sensor Test:

DHT11 is probably best suited for projects where fast data reads are not required and where the environment is not expected to undergo sudden changes in temperature or humidity. A weather station would be a project idea.

We used the DHT11 sensor in our project since it gives us the percentage humidity and their ambient tem-

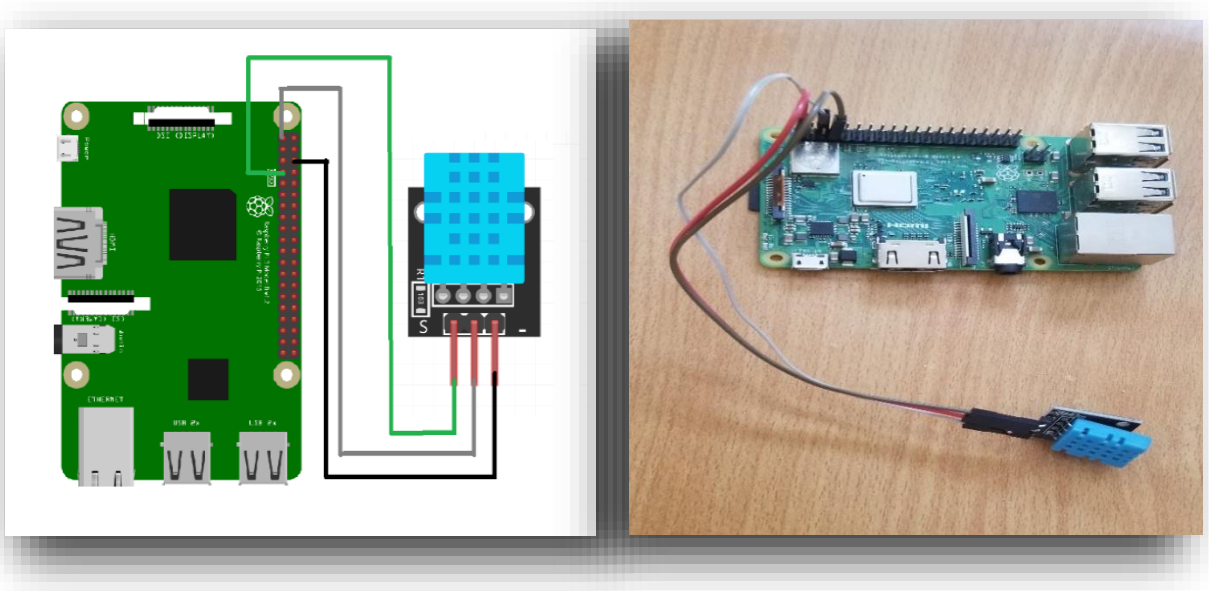

Figure 16: "DHT11 sensor connection diagram"

perature with a good variation accuracy in a short time.

Before you can use the DHT11 on the "Raspberry pi" board, you must install the Adfruit library. Because it has all the necessary functions to obtain the statements humidity and temperature of the sensor.

After running the program on the "Raspberry pi" board we obtained values in °C for temperature and in (%) for humidity on python IDLE software platform.

4.2. Rain drop sensor Test:

Rain Sensor or detector is simple and easy to use the module for rain detector. The module works as a switch when rain falls on the module and also measures rain intensity.

So, in this assembly, we used a raspberry pi, a raindrop sensor and a buzzer to alert when it rains. Thus, you can devote yourself to something useful instead of watching the weather.

To receive an alert when it starts to rain, we will install this sensor on a Raspberry Pi 3B+ and trigger a buzzer. While the setting of the potentiometer will change the sensitivity of the digital trigger.

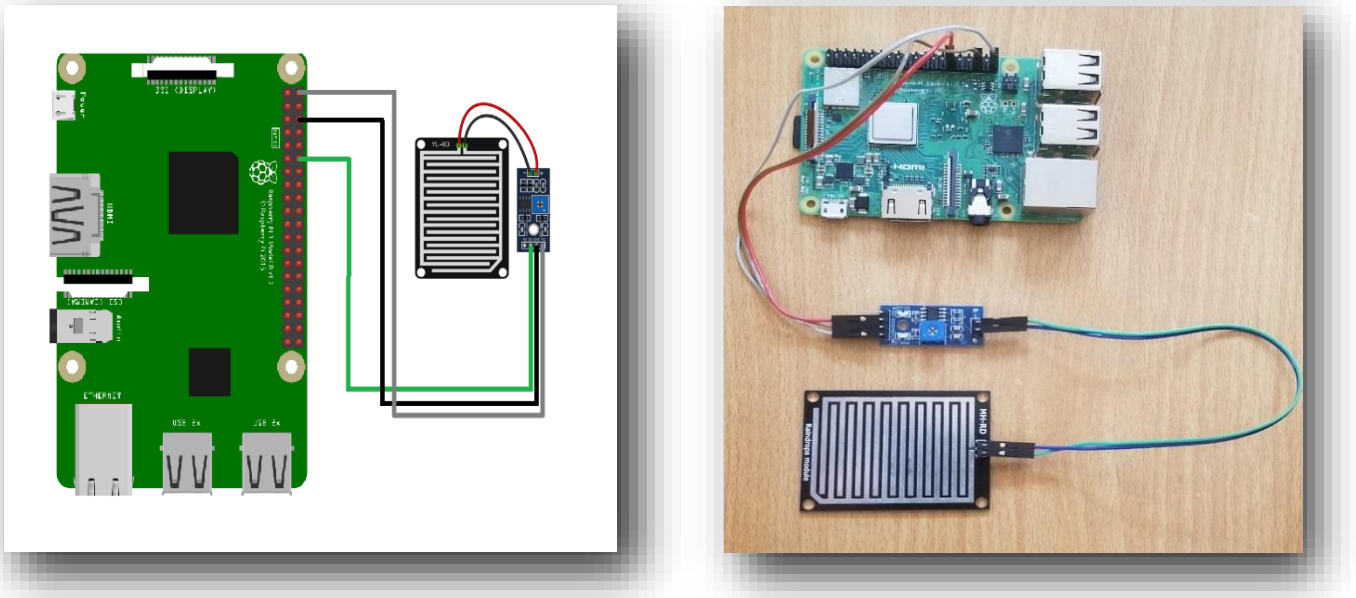

Figure 17: "Raindrop Sensor Connection Diagram"

After the assembly is carried out When no raindrop is on the sensor, the DO pin (digital output) of the sensor controller is High. From another case When raindrops are detected, it changes to Low. By connecting Due to the raspberry pi pine (GPIO18) and the buzzer triggers the orsque the rain is detected. Thus, the buzzer sounds 5 times ... until has that the raindrops are no longer detected. Finally, after all it to test this sensor gets results will also be printed on the screen .

4.3. Water level sensor Test:

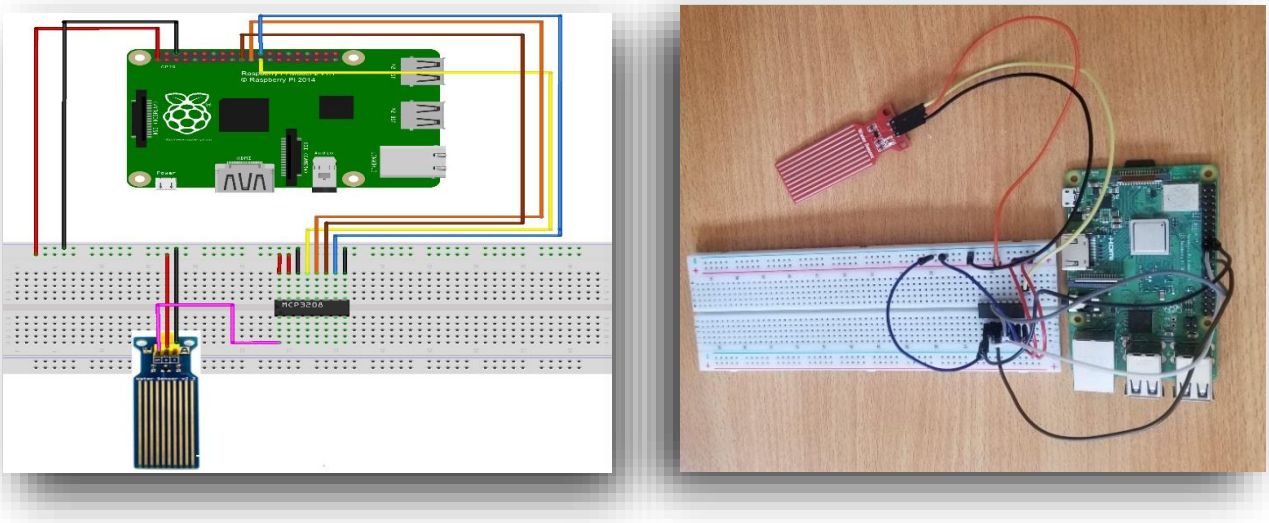

Figure 18: "Water Level Sensor Connection Diagram"

By using the water level sensor to identify the amount of water, it is a detection sensor that have monitor the performance of different levels. It is beginning to measure the water level with its predefined measurement values, by bound this sensor directly via ADC (analog-to-digital converter) to process the analog signal of the water level sensor. The operating voltage of this sensor is DC 3v-5v is used 3.3v in this assembly.

Therefore, once our projects and its implementation are assembled, we detect and monitor flood related disasters by testing our water level sensor. For this reason, we tested the sensor in a glass of water and got these results on **table 5**.

Table 5: Test on Level Sensor

Level	Voltage
0	0 – 1 v
0.3 cm	2.0 v
1 cm	2.3 v
2 cm	3.1 v
3 cm	3.3 v

4.4. Pressure Sensor (BMP280) Test:

Generally, this sensor is ideal for weather and environment detection. Thus, is the best low-cost precision detection solution to measure barometric pressure with absolute accuracy with absolute accuracy of ± 1 hPa and temperature 1.0 ± 1 hPa C. While the BMP 280 sensor works on the I2C communication or SPI protocol. Raspberry pi supports I2C, SPI and Serial communication protocols. Raspberry Pi GPIO pins can be used with a variety of alternative functions, we are interested in the I2C protocol. I2C pins of the raspberry pi emission.

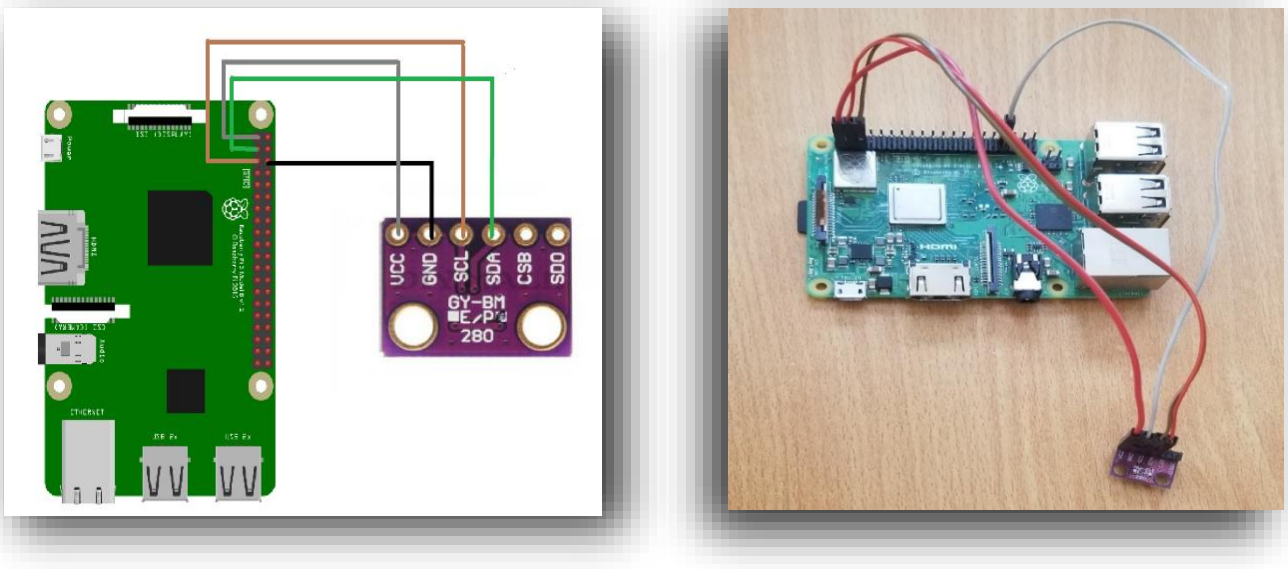

Figure 19: "BMP280 Sensor Connection Diagram"

5. IOT platform test:

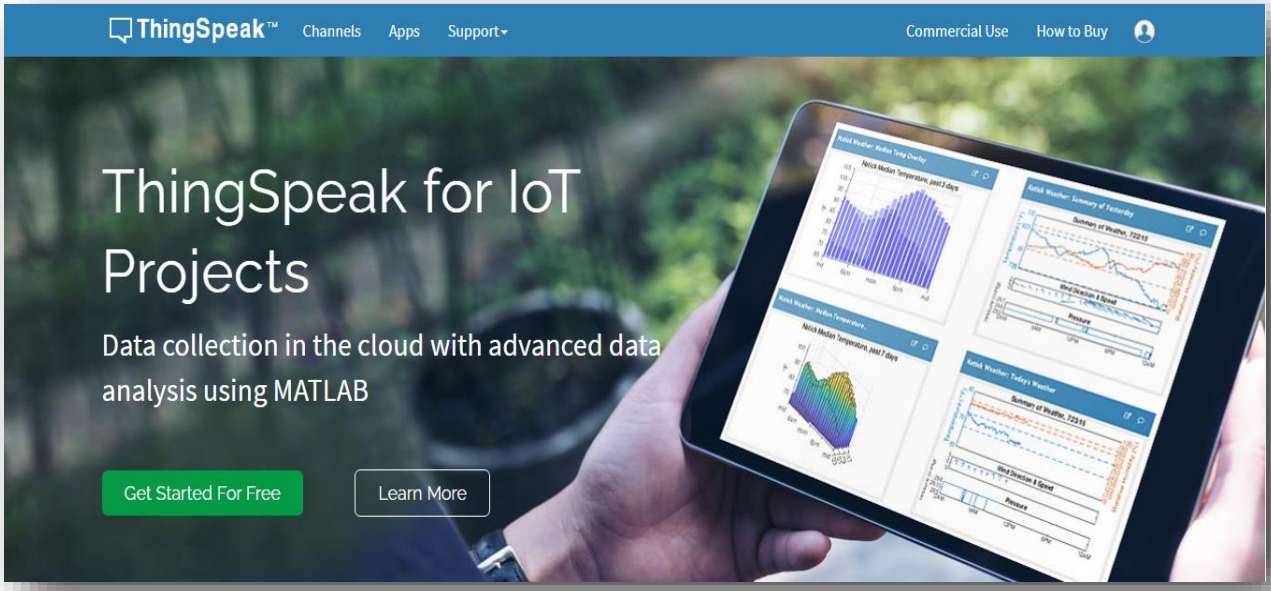

Figure 20: "ThingSpeak platform illustration"

Before choosing ThingSpeak IoT, we tested several IoT platforms Use it in our projects and these platforms My Devices (Cayenne), Things Board, Blynk ...)

Each platform has its own interface, programming language, quantity of equipment to control, types of protocols supported, storage, processing and methods the data indicate... and there are free and other platforms to provide Free trials for a short period of time.

The benefits and reasons for choosing ThingSpeak as your IoT platform are:

- Supports a variety of devices and modules, such as Arduino, Raspberry Pi, ESP, particles, ...
- Use MATLAB's powerful functions to analyze and process your data.
- It allows sensors, instruments and websites to send data to cloud, store them in private or public channels according to our choice.
- Provide us with real-time data visualization from tables, graphs and gauges sensors.
- Automatically trigger a reaction based on the acquired data abnormal situation.
- It is an open and free IoT platform.

5.1. Getting started in ThingSpeak using Python :

To be able to download the data on ThingSpeak we follow its steps:

1. **Create an account :**

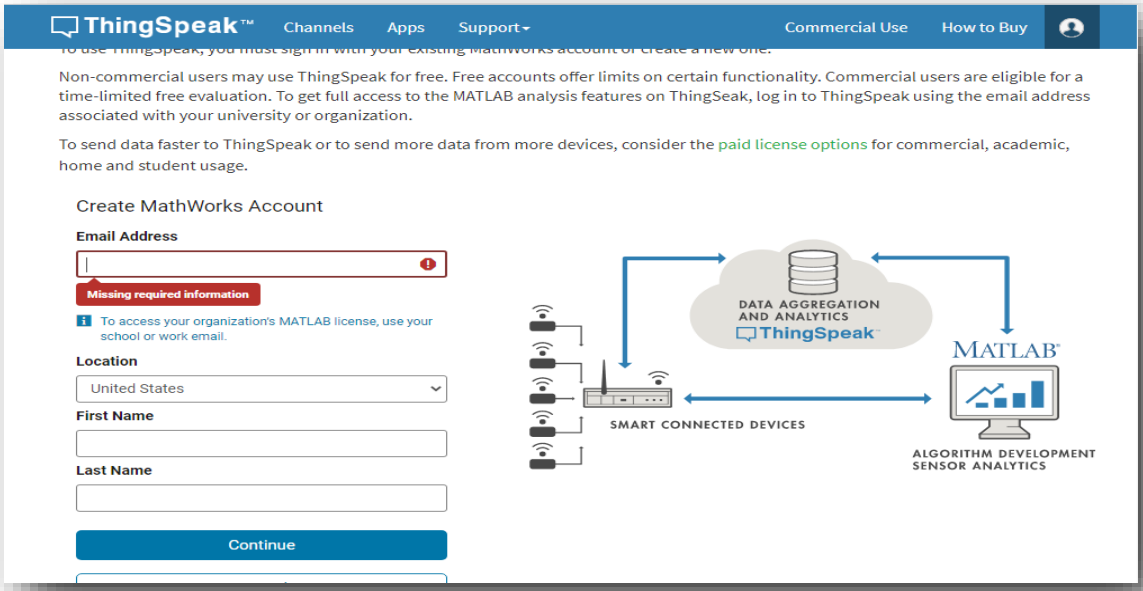

Figure 21: Create a new account on ThingSpeak platform

2. **Create a new channel (Channel) and configure:**

3. It that represents a set of data grouped together and which comes from a connected object, another "Channel" or a web service.

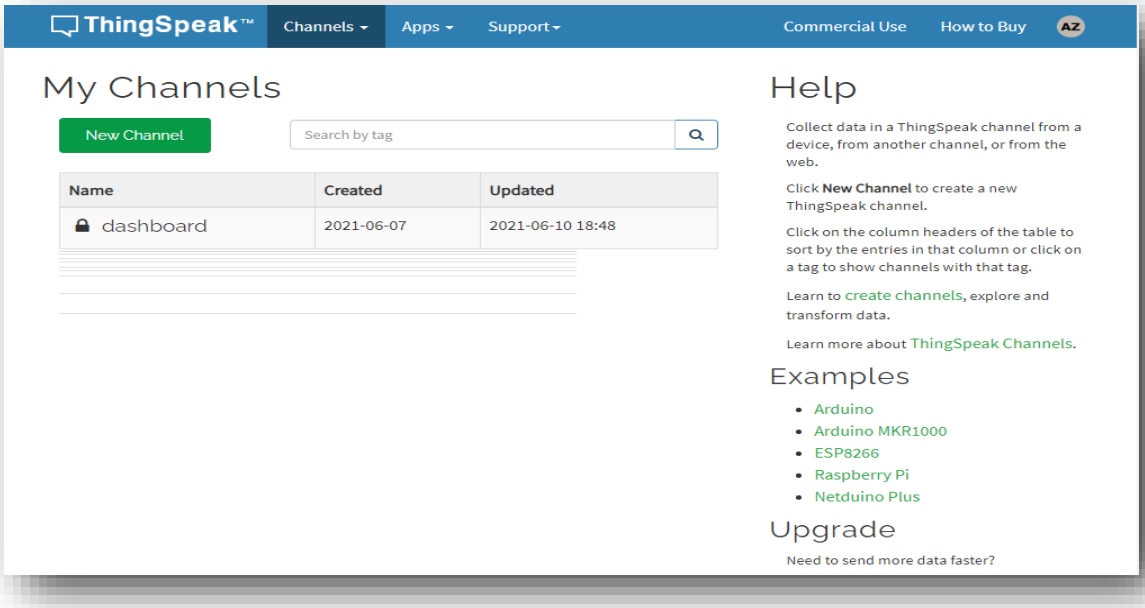

Figure 22: Create a new channel

4. **Channel Name and Description :**

Field #: which represents a data Check the box to activate the field and enter its name. Each ThingSpeak channel can have up to 8 fields.

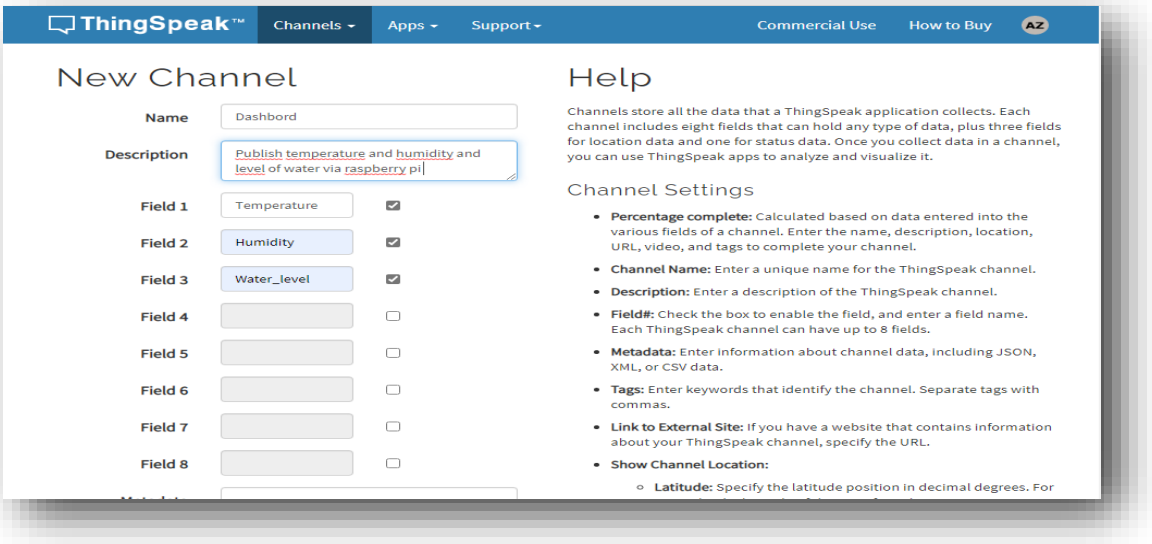

Figure 23: Coonfiguration interface of the ThinkSpeak channel

5. **Using the API key corresponding to our channel:**

Write API Key: this key is used to program our Python 3 platform to write the data on a channel

Read API Keys: this key is used to allow other people to see the feeds and graphics of your private channels

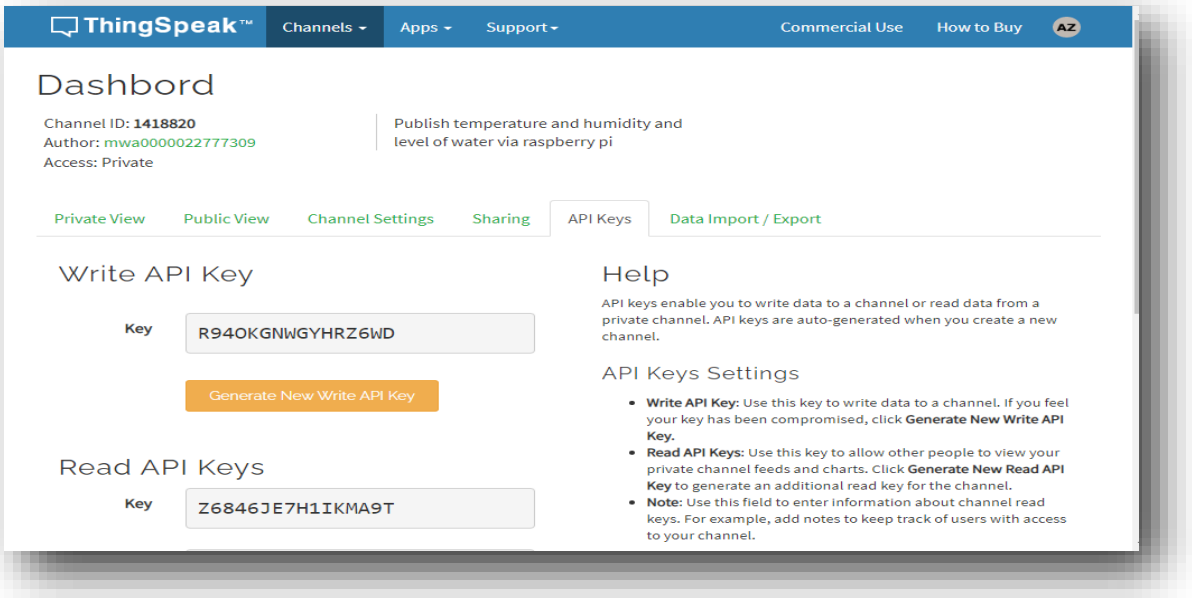

Figure 24: Read and write data keys on ThingSpeak

After we finish setting up our ThingSpeak platform and program at level of the IDLE (Python 3) we managed to receive the data from the sensors using the "Raspberry Pi" board.

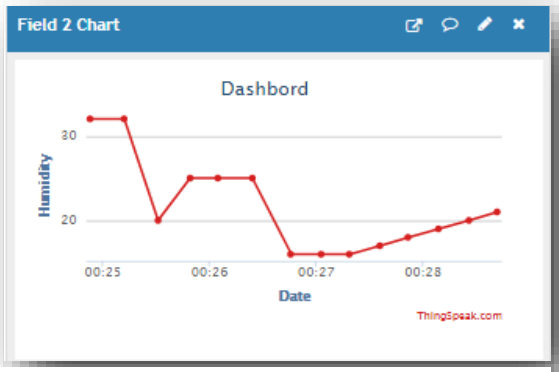

Figure 25: "Showing temperature data"

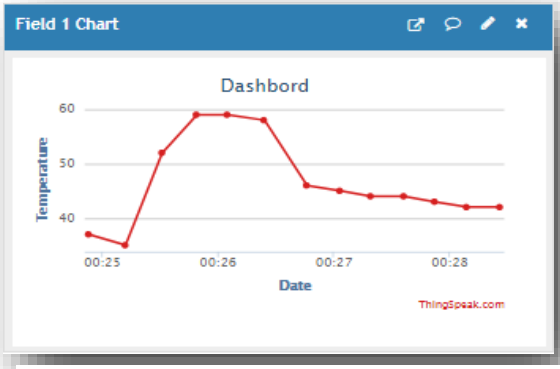

Figure 26: "Showing humidity data"

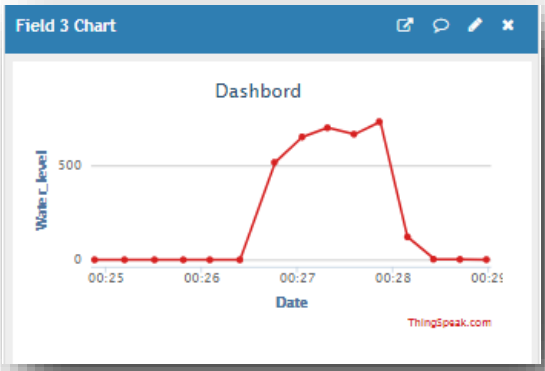

Figure 28: "Showing water level data"

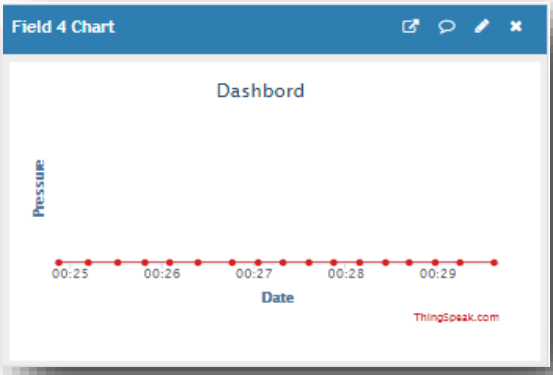

Figure 27: "Showing prussur data"

The ThingSpeak platform uses HTTP and TCP for data exchange with our project that makes data transmission more reliable and secure and offers an application for Smartphones with the possibility of changing the read and write keys if you think your key has been compromised.

Finally, reactions and alerts can be programmed when anomalies are received and export the log for receiving data to the Excel, json, CVS file. [29]

6. Code Flowchart :

6.1. Code flowchart on raspberry pi:

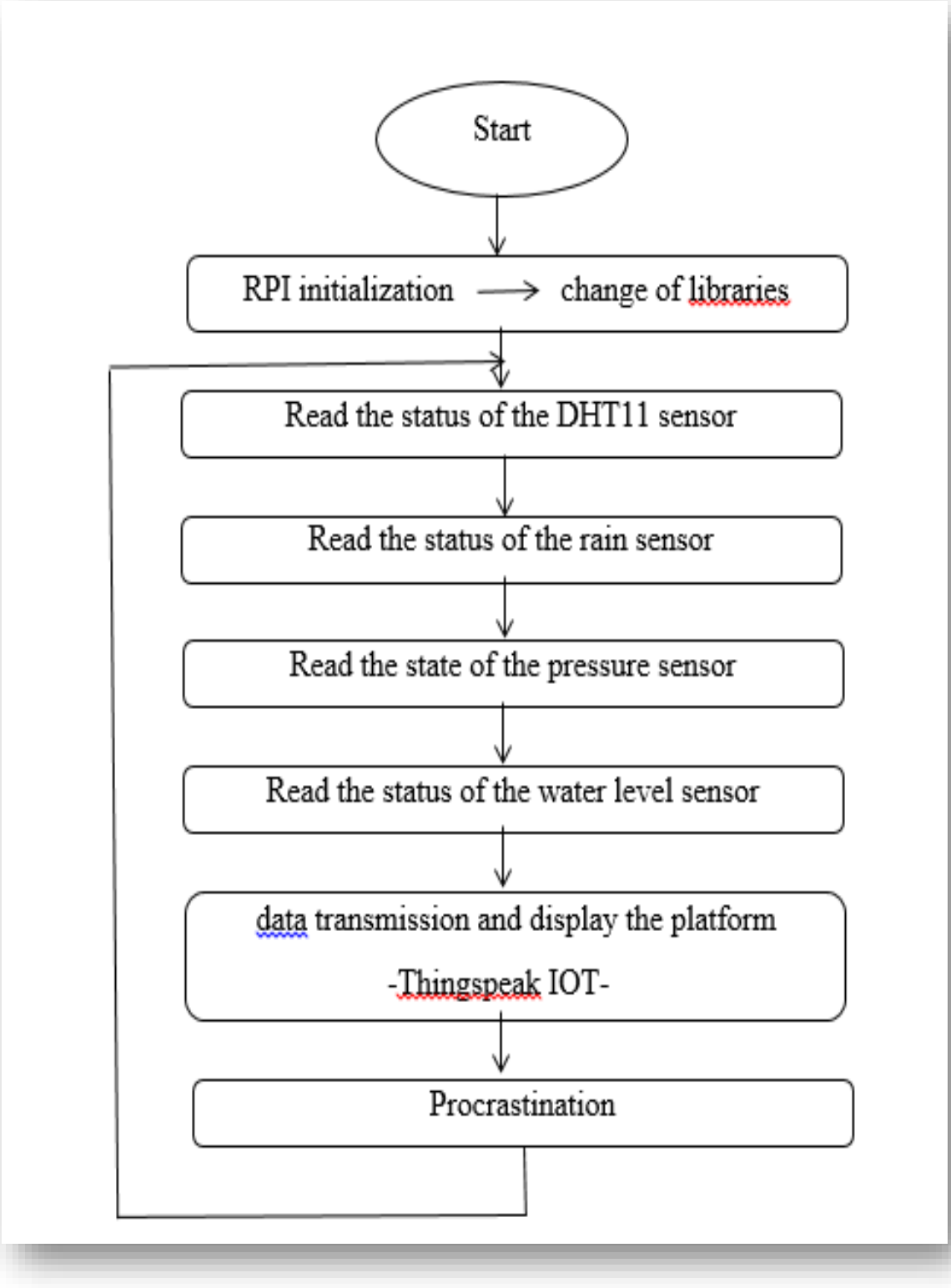

Figure 29: "operating flowchart of our program in raspberry pi"

6.2. Platform IOT (ThingSpeak) code flowchart:

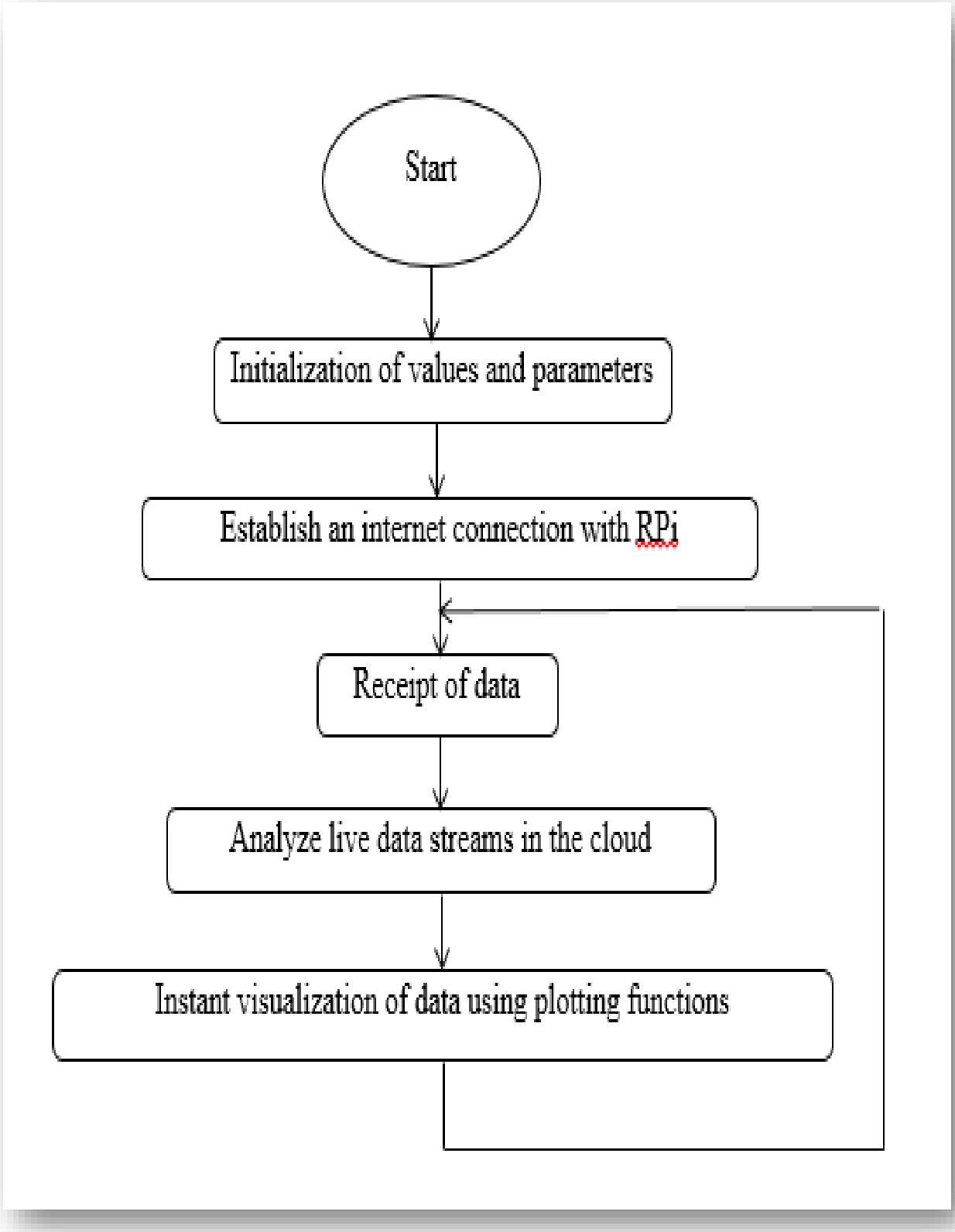

Figure 30: "Operation chart of our platform on thinkspeak"

7. Discussion of results:

7.1. Sensor accuracy:

The sensors (water level, bmp280) are very accurate in the reading data and does not have problems of operation in harmful environments.

The DHT11 sensors are quite imprecise in general and especially the DHT11 which are virtually unusable as a humidity sensor because the measurement is so imprecise. The DHT11 can not measure (and withstand) negative temperatures or temperatures above 50 ° C " is why you must be careful so when used outdoors! which involves replacing them with other sensors of good
quality and more resistant to avoid defects and false data.

The Raindrop sensor are not reliable when using because Sometimes salinity is an issue with these units, this one worked fine with filtered, bottled water, but in some instances, you may have to add a bit of salt to increase the waters conduction.

8. Conclusion:

In this chapter we have presented the work done and the results obtained.

We tried to create a product that is simple to use, flexible and easy to modify in view of

it is a work in progress.

GENERAL CONCLUSION

General Conclusion:

The adoption of new techniques could reduce the chances of loss of human life as well as damage to large-scale infrastructure from natural and man-made disasters. For flood prone areas or countries, flood management is an essential part of their governance, and largely depends on how flood related data can be collected, managed and used. In this case, floods are one of the most common natural disasters that occur anywhere. Thus, they cannot be predicted easily.

But so, we have a potential and economical solution and to develop a system that tries to detect flooding and give an early indication to people nearby. For this, it is important to have a common architecture that specifies how the different components fit within the system plus Lange and interact with each other.

Our project represents an optimal solution with a low cost, with this system we can easily detect and monitor these floods, based on the IOT to save the lives of people by reducing the rapid intervention of man in the event of "emergency".

The use of satellites, lightning observing systems, radar and rain gauges will increase the need for this type of monitoring, bringing relief to people in communities ravaged by persistent flooding.

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