Study and design of a local weather station with smart sensors

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Abstract: These sensors will retrieve metrological information such as: temperature and humidity of air, soil, wind, sun, rain etc. The presence of rain and the detection of day and night. All this retrieved information will be sent to a Firebase database via a Wi-Fi Shield. Numerical weather prediction models use the laws of fluid dynamics and atmospheric chemistry to assimilate available meteorological data onto a grid and project their evolution over time. We have developed a mobile application with Ionic that allows us to ensure access to information in real time. The user has access to this information everywhere with low cost because it is one of the advantages offered by the technologies that we have chosen for the realization of the platform, in order to improve the resilience to climate change compared to the classic weather station.

Keywords: design and realization of weather station, smart sensors, Firebase, Ionic, Wifi Shield

Introduction

Meteorological observations begin in the 20th century with progress in forecasting [1]. From 1960, observations are made from satellites [1] [2]. And weather data is archived and stored in databases. To be used in numerical models of weather forecasting or climate change. The weather station is therefore a collection of devices (sensors) that record and provide physical measurements and meteorological parameters related to climate variations.

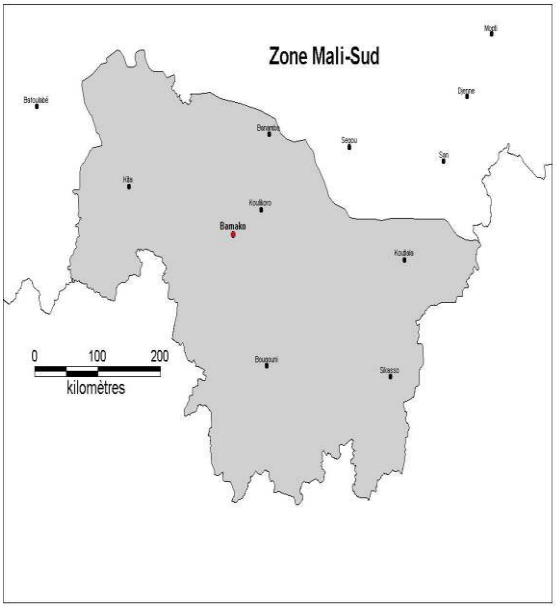
Meteorological stations are used in the fields of agriculture for the monitoring of crop-friendly climatic parameters, road safety for the monitoring of the adherence conditions of vehicles on the roadway, meteorological obstacles to traffic etc. [1] [3]. It quantifies the water cycle, predicts weather, simulates complex environmental processes, and predicts natural hazards such as hurricanes and tornadoes. [2] [3]

In this project, we studied a weather station in order to build an autonomous platform to measure existing physical phenomena in real time. This station is connected to WIFI to the Internet. Thanks to several intelligent sensors, the station retrieves the data and sends them to Firebase (set of hosting services) through a WIFI Shield. The user has access to this information in real time on his smartphone through a developed application on the Ionic.

This article begins with a description of the study area, then the materials and methods of data analysis are described, a design of the station and databases are performed and the data received by the local station are processed and analyzed. , the results obtained by **the** processing and data analysis are discussed and we will end up with a conclusion**.**

II Description of the study area also the place of the tests

Mali-Sud or cotton zone is the main agricultural region in Mali. It covers the administrative region of Sikasso, the southern regions of Ségou and Koulikoro, the southeast of the region of Kayes on about 150 000 km2. Mali-sud is under agricultural supervision of the Compagnie Mali for the Development of Textiles (CMDT) and the Office of the Upper Valley of Niger (OHVN) since the 1970s. [4]



Source CIRAD (February 2012) " A report from the Observatory of World Agricultures " p.12

We chose Sikasso the third administrative region of Mali and With an area of 71790km2 or 5.8% of the national territory [4]. Sikasso is the first cotton-producing region in Mali, more specifically Yorosso, the largest cotton producer in Sikasso. The local station gives a precision on the periods of use of the herbicide because it tells us about the moisture status of the plant ground.

III. Material and Methods of Data Analysis

III. 1 Materials

The equipment included in a weather station depends on whether it is manual or automatic [5]. An automatic station has a number of instruments connected to a preprogrammed central processor. The latter stores the data in a data logger or to transmit it by cable or radio waves to one or more places of operation more or less distant. The number of sensors varies according to the needs. Intelligent Sensors are hardware devices in which sensors and processing circuits coexist, and their relationships to higher processing layers go far beyond simple "signal transduction" [9]. Intelligent sensors make the industrial logic of system integration to make them more compact (reduction of volumes and weight), more reliable, better distributed (possibility of digital communication or not) and also better markets. [9]

To realize our automatic platform, we used:

- ✓ an ArduinoUno card,
- ✓ a wifi module,
- ✓ a clock module RTC
- ✓ a temperature and humidity sensor
- ✓ A rain detection sensor,
- ✓ a soil moisture sensor, a photoresistor.

III. 2 Method

The methodology used consists of measuring the five (5) key parameters to determine the climate in real time collected data are stored in a Firebase database via a WIFI Shield. Finally a telephone application is developed on Ionic, which displays the information to real time. The five (5) key parameters to be measured are:

- ✓ The temperature of the air
- ✓ Humidity.
- ✓ Atmospheric pressure
- ✓ Precipitation
- ✓ Sunshine

VI. Station and database design

In this part we used the Arduino IDE software, an open source and free software to perform the various tests of sensors and communication modules and the establishment of a database.

Figure:Arduino Software Interface

1. Establishment of Database

To send data to Firebase first of all, it would be necessary to connect the ESP to the router. Then follow the following instructions to manage the sending of data from Arduino to Firebase :

• Go to the Site and access the console to create a new project;

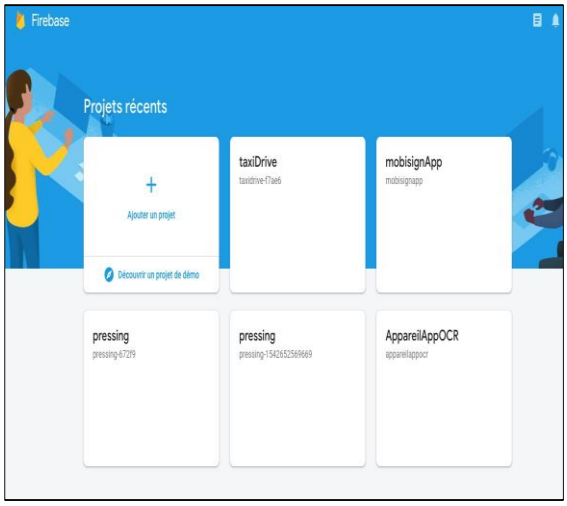


Figure 2: Firebase Console

This console allows you to create a new project on Firebase but also taxidrive, mobisignapp pressing and appareilappOCR.

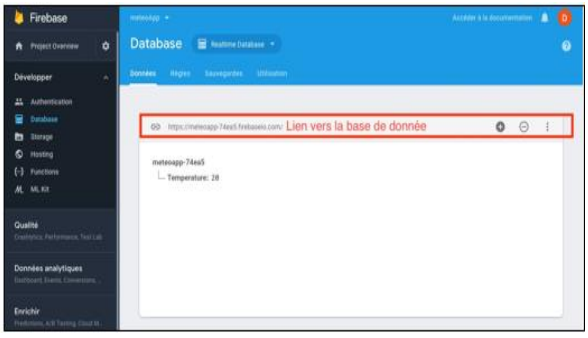


Figure 3: Link of the database

Figure 8 shows the location of the database for the new project created on the ferebase console. This action allows the creation of the new database for our application of the local weather station.

• Then create the database to retrieve the API key and the link to the database;

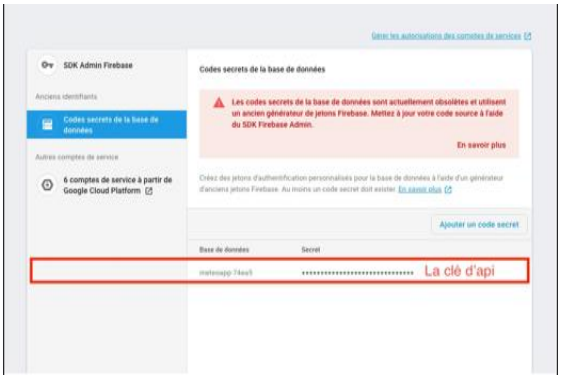


Figure4:key of the API

Figure 9 permits to retrieve the API key and link to the database created in Figure 8 and downloads and installs the ArduinoFirebaseet ArduinoJson package.

2. The model of the weather station

After the installation of our database and the different tests carried out, we obtain the following model:

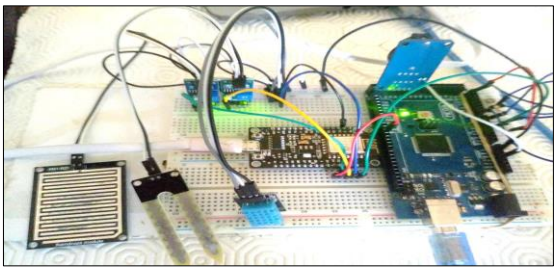


Figure 5: Photo of the final montage

2.1 Description

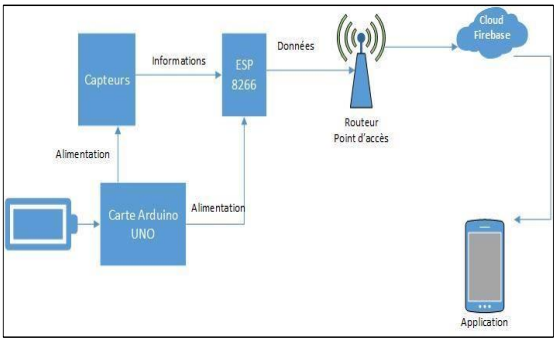


Figure 6: functional scheme

The sensor-based ESP card retrieves the information and sends it to the Firebase database by connecting through an access point. And once this information is stored in Firebase, the mobile application has access to it. An ArduinoUno board powered by an external battery provides power to the sensors and the ESP board.

V. Realization of the application by users in real time

Access to the real-time platform is a necessity, we have developed a mobile application, which gives the user access to the information provided by the platform in real time. [3]

Figure 7: Mobile application interface

In this part we are interested in Firebase technologies which provides the database where information is stored online and Ionic which allows us to develop a single executable application on all mobile platforms (Android, IOS, Windows phone, etc. .).

VI. Discussion

1. force

- ✓ **A low realization cost**

For the realization of our station, the essential components being the ESP card and the sensors cost us about 25 €.According to the siteune basic weather station costs between 40 € and 50 €.

- ✓ **Easy maintenance**

Our station is designed with Arduino boards and sensor which are an easy-to-use platform.

- ✓ **Data accessible everywhere and in real time.**

The measurements taken by the sensors as soon as they are stored in the database can be consulted at any time of the day from a smartphone, tablet or computer, even remotely. Offline data access with Firebase.

- ✓ **Accepts the integration of new components.**

The addition of the new components (sensors) does not require any major modification.

- ✓ **Interaction with other connected objects in the house.**

Like any Connected Weather Station, our station can also be integrated into an existing home automation system. This opens up possibilities for scenarios such as the interaction with electric windows that open when the temperature rises or the indoor air quality is poor ...

- ✓ **No need for additional infrastructure**

We do not need to buy servers for storage and data security.

- ✓ **Multi-use**

This station is multi-purpose because its use depends on its user. He can install it in his house or even in his garden.

2. Weakness

- ✓ **Offset at the send level of information retrieved by the sensors in Firebase.**

The Arduino boards are programmed in C (C ++) language which executes sequentially more in the program we use timers to give the card time to read each sensor.

- ✓ **Local station therefore limited in terms of area covered**.

The coverage area is limited to a few meters.

- ✓ **Internet connection required.**

Storage is provided by Firebase which is a set of online hosting services so internet is needed for data storage.

- ✓ **Non-autonomous power supply**

VIII. Conclusion

This project is one of the many aspects of rich applications of the computer tool coupled with electronics. It presents a more modern and innovative technology in the ecological meteorological field at a lower cost, and allows users to have a personalized weather more efficient. But it has some weakness. We can therefore propose the following perspectives to overcome some weaknesses of this project:

- ✓ Design an autonomous power system.
- ✓ Use the GSM module to send the data.
- ✓ Create personalized alerts for special weather reports.
- ✓ Change programming language to NodeJS

Références

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