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OPTIMIZATION OF THE METEOROLOGICAL STATION IN THE EXPERIMENTAL FARM OF THE SURCOLOMBIANA UNIVERSITY

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ABSTRACT

The article presents the construction of an electronic system for the experimental farm of the Surcolombiana University, which allows the capture, transmission and processing of the following variables: temperature, atmospheric pressure, relative humidity, soil moisture, precipitation, radiation, speed and direction of the wind; in real time regardless of the distance where the weather station is located, which allows detailed access of all the variables through a web page (http://estacionusco.xyz/) and which can be seen by anyone for the development of statistical studies related to climate and new projects. The system is the basis for making a mobile station in order to have global information in different points or desired areas.

Keywords: electronic system, transmission, measurement, variables, weather station, mobile station.

1. INTRODUCTION

Meteorology is the interdisciplinary science of the physics of the atmosphere, which studies the state of time, the atmospheric environment, the phenomena produced and the laws that govern it. In this project, the meteorological station located in the Experimental Farm of the Surcolombiana University was put back into operation, totally replacing the control module and at the same time improving its operation both in processing and in the number of variables to be studied, in order to able to take exact measurements and monitor the following atmospheric variables: temperature, luminosity, wind speed, wind direction, atmospheric pressure, relative humidity, soil moisture and precipitation.

The objective of this project was to design and build the module of a remote and modular meteorological station. The design is sustainable, which corresponds to minimizing energy consumption in order to be energetically autonomous through a solar panel.

It is important to note that the design of the weather station is low cost, with the primary objective of obtaining reliability for the study of meteorology. Therefore, the sensors and components that were used are suitable for the measurement of the variables.

A web page was made in order to show detailed information of each variable, which has enough samples to provide information that is sufficiently valid for the study of the different meteorological phenomena.

2. APPLICATION SCENARIO

The experimental farm of the Surcolombiana University, has a meteorological station, which found itself counting temperature, wind speed and humidity, this being little information for an objective and complete climate analysis. However, in order to obtain the information, payment to third parties was required, which causes economic losses to the university.

It was decided to optimize this station, which included the maintenance and adaptation of this and at the same time an easily accessible website for the constant monitoring of the variables that will be acquired from the experimental farm, which is located via Palermo, crossing the Reedbed. To make a record of the climatological variables, it was necessary to have the adequate equipment to automate the measurement process, a programmed Microcontroller was essential for the processing of the data.

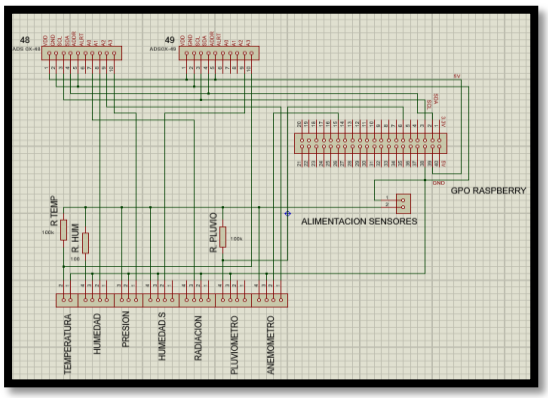

Figure-1. Data acquisition circuit.

3. MATERIALS AND METHODS

For this process, it began with the investigation of the processing device which is the main part of the whole module, which was intended to support the entire load of the different transducers and at the same time be resistant to the type of use that will be submitted. After being clear that the processing system was going to be in charge of the Raspberry pi computer, the analysis and operation of the different sensors was continued, both those that were already and those that were added, being clear that each one of these has a technical table where it specifies feeds,

outputs and the different equations that must be applied to find the real value that is desired. Afterwards it must be clear that the Raspberry Pi device only has digital inputs, therefore, the ADS1115 digital analog converter that works under the I2C communication protocol which works in series bidirectionally is suitable.

Having the converters and the sensors interconnected with our Raspberry, a code was implemented in the Python programming language where the different conversions are made by means of the value obtained thanks to the transducers and where at the same time the variables are visualized through a graphic interface.

The sending of alerts to the different emails of the respective personnel in charge is conditioned so that they take immediate action in case of anomalies in the environment or in the operation of the system and of course the sending of information to our database, all these established in scripts different but that are called or interconnected in the acquisition or main script.

The feeding stage consists of a lasting source of energy, the use of alternative energies nowadays is an option that is considered among the most efficient; the solar panel capable of supplying a certain electrical energy from solar energy will be used to supply the need that the system requires; causing this to be constantly being supplied with energy; the power dissipated by the prototype is relatively low, for this reason the solar panel used has the following characteristics: the supplied voltage is two outputs of 12VDC to 24W of power, ensuring the efficiency of the system.

Finally, the design of the board, the assembly and installation of the module and the sensors were carried out, with which the final tests were made.

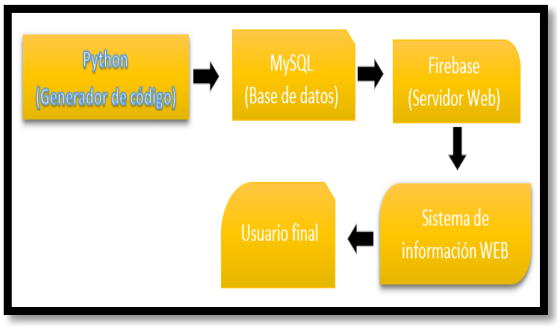

Figure-2. Tools used in the development of the system.

3.1 Design method

For many years, man became aware of the way in which climatic changes affect him, the periodicity of the seasons, the behavior of the winds and the rains; he tried to anticipate them by making forecasts based on their totality on an empirical basis. It was after taking a more analytical attitude that he was interested in measuring and keeping a record of climate changes. This is how different ways of measuring climatic variables emerged, which have been adjusted to the needs as required. Currently there are organisms that regulate these measurements and establish standards to maintain a congruence of information, such as the World Meteorological Organization and the American Society for Testing and Materials.

A complete service that goes from the acquisition of data in the station (analog and digital inputs), processing, management and deployment of information remotely. The following diagram allows exemplifying the flow of information:

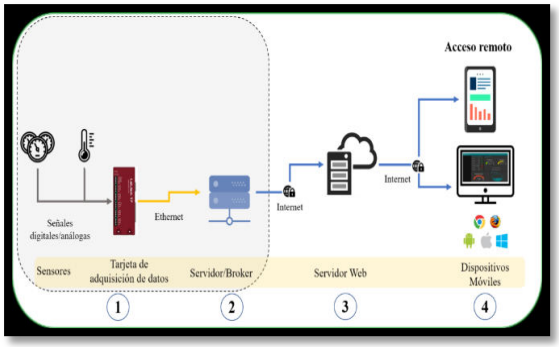

Figure-3. Schematic of obtaining and displaying meteorological information.

The main design method of an information system consists of diagrams and diagrams, which allow analyzing all the information previously, to then implement rules that must be met in the development. (Silberschatz *et al,* 2002).

The diagram in Figure-2 contains a general explanation of the tools and the process that must be followed so that the user can view and manipulate the data, which can be accessed from any type of machine, whether it is a computer, cell phone, tablet, etc.

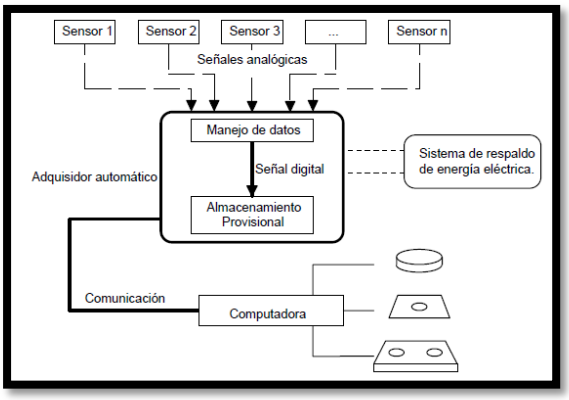

Figure-4. General schematic diagram of an automatic data acquisition system.

Figure-4 shows the main design diagram for an automatic information system, according to the diagram the system must have a backup of storage, to ensure the information and a backup system of energy so that its operation is 24/7, preventing falls of electric power.

It is important to note that WEB access to the site is allowed to all types of users, the system must ensure the information, and it is not necessary to access the information with the respective login information (user and password) since the data is also they can be downloaded without restriction, except if you want to enter directly to the server.

3.2 Data acquisition

The first step is to read the signals acquired by the sensors. The sensors are divided into two types: analog (a digital analog converter is used) and digital, it stands out that our Raspberry Pi card works only with digital signals. Depending on the information that you wish to visualize, it is the sensor that is used, in this case for: temperature, radiation, precipitation, wind speed, relative humidity, soil humidity, pressure and wind direction.

The data acquisition card is used to read the signals from the sensors and send it to the "Server" where the information will be processed and stored. This card is installed directly in the structure, in the place where you wish to make the weather records.

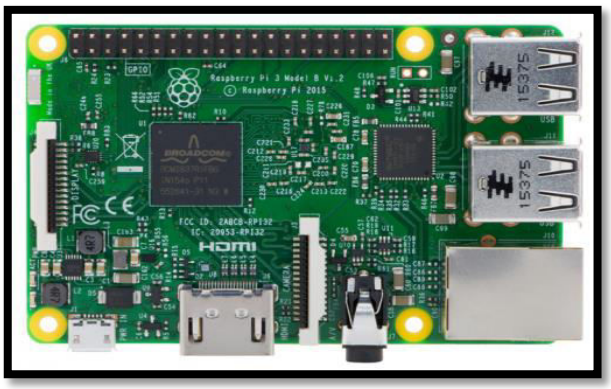

Figure-5. Raspberry Pi 3 data acquisition card.

3.3 Processing of information

The information coming from the sensors are electrical signals, which must be processed to transform them into daily information and easy to understand for all users (° C, mbar, rpm, percentage, cm2, meters, etc.). This is done in the "Server" that is included with the WEB server (Firebase). This serves to store the information and thus generate a history that can be accessed remotely through any mobile device, since it is directly linked to the Gmail platform.

The information is sent to the web information system where it can be visualized in a simple and practical way.

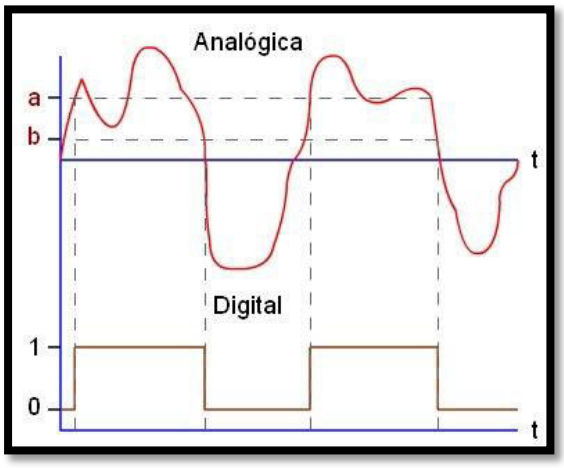

Figure-6. Analog and digital electrical signals.

3.4 Database

Firebase is a web service that provides a backend in the cloud with a real-time NoSQL data source and libraries to access the database from Web, IOS or Android applications.

The data stored in Firebase is synchronized with the clients in real time. It is with a remote database that responds in real time to the changes made in the data. In this way, you can write applications that store or update data in Firebase and all clients that use this database will be notified in real time of the changes made.

3.5 User-Web information system interaction

The interaction of the users with the Web information system (Web page), has access to a certain amount of data directly from the database, these will be the last thousand records so that they can have updated information and at the same time download it if so if desired, the information is filled in a data table for each of the measurements taken by the teams, these tables are created in such a way that each row or column complies with the requirements of the data that are entered which are length of characters, coding or format. The information site is designed in such a way that each user has unlimited access, in the link http://estacionusco.xyz/, shows the web interface which is linked to the database.

3.6 Connection database and data acquisition card.

To make the connection of the database with the Raspberry Pi, some lines of code were added where the data is initialized and the two keys, both private and public, to be able to show the data registered by the module.

There will be only one master or administrator user that can make any type of query of any type or specific area, and generate a PDF, Excel or Json document in which you can view all the information of the respective or general area that has been stored from its operation to the present. Via the supplied e-mail stacionusco@gmail.com and its respective password, any type of modification or desired query can be made in the database.

4. OPERATION

The modes of operation or operation provided by the WEB information system allow the differentiation of the different climatic variables in independent windows and download it in Excel format.

The administrator account allows other functions such as entering observations according to the eventuality required, to see in detail the information in each operation area with its main characteristics, as well as to implement an alert system if required.

4.1 Variables

In the items or sub-menu you will find the detailed information of each climatic variable (Graphs and detailed information), which are represented in bar graphs, lines and shadows, but special graphics are also used for the humidity variables , soil moisture and precipitation.

For greater understanding of the information expressed in the different graphs, information tables and images alluding to the measurement ranges are added, in order that any user can easily interpret the recorded data.

In the submenu of statistics, all the variables related to the project are displayed in a table; here we can visualize a range of one thousand data of each one of the variables

4.2 Tests and results

To perform the respective tests, it was put into operation for several days, checking the stability of the system, as well as the data it is registering when compared to other sites or stations.

The results of this test are satisfactory; the reports generated correspond to real data such as energy stability. Likewise, network drops or sudden power failures are taken into account, which is why an automatic restart of the system and the execution of the code was implemented.

5. CONCLUSIONS

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The results of this test are satisfactory; the reports generated correspond to real data such as energy stability. Likewise, network drops or sudden power failures are taken into account, which is why an automatic restart of the system and the execution of the code were implemented.

Those in charge of the farm of the Surcolombiana University and other administrative and student personnel have felt comfortable with the purpose of the project, since they have again a service that did not lend much.

The problem is solved by which the idea of creating this project arises in the Experimental Farm of the Surcolombiana University.

The staff begins to keep a daily climate control and even more accurate with the new alarm system.

It removes all types of ties or contracts with any entity or company that is managing the information collected, as it will now be administered directly by the university.

It was possible to restore the functioning of the meteorological station located in the Experimental Farm of the Surcolombiana University, with a new main module, reducing the size, increasing the level of processing and minimizing the cost of support.

The operating mode of the system is fully open and can be modified or improved if desired, since it is intended to be scalable.

The bases for a mobile meteorological station are left, reducing the size of its processing module, making it more compact, open to the possibility of using any sensor or transducer that is desired and being able to use the weather station for a specific or general use.

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