DESIGN AND IMPLEMENTATION OF A SELF-SUSTAINING WEATHER STATION WITH VIRELESS COMMUNICATION FOR REAL-TIME ENVIRONMENTAL MONITORING

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Abstract

Meteorological stations collect environmental data to inform environmental and energy-related decisions in a region or locality. However, in hard-to-reach areas, the lack of this real-time information hinders decision-making in topics related to research, risk management, and land-use planning. This paper reports on the design, development, and implementation of a low-cost, self-sustaining meteorological station for real-time monitoring in urban and restricted-access areas.The station integrates a modular architecture based on embedded systems. It includes sensors for measuring temperature, relative humidity, air quality, and wind speed and direction. The system operates autonomously using renewable energy sources (solar/wind). Energy is stored in rechargeable batteries, allowing for continuous operation without reliance on the conventional power grid. This enabled the integration of the weather station's sensor system, connecting it to the embedded system to log and display its data, which is transmitted via ThingSpeak. It implements a secure, long-range, point-to-point wireless communication architecture, ensuring the integrity and reliability of real-time data. Environmental parameters are processed and visualized through a data acquisition platform, allowing for immediate analysis of the monitored environment's weather conditions. The results obtained demonstrate the system's functionality for the reliable acquisition and transmission of real-time meteorological data. It is a scalable, self-sustaining, and low-cost.

Keywords: Embeded system, self-sustaining system, monitoing, smart city

Introduction.

A weather station is a device that is used to collect data about atmospheric conditions in a specific area. It has sensors that measure several climatic variables, such as temperature, pressure, relative humidity, wind speed and wind direction. These variables are gathered, recorded, and analysed to forecast future atmospheric changes [1].

The developed weather station records the climate variations in areas within the Magdalena Contreras borough in México City. It is designed with the objective of obtaining real-time information and assessing its impact on the region in order to support future predictions related to building management, irrigation system activation and other domotic applications. The system uses four sensors and two antennas configured in a point to point (PtP) communication scheme to enable data exchange with another nearby weather station, thereby extending coverage over a larger area at a low cost. Additionally, it is powered by solar panels, making it a self-sustaining system.

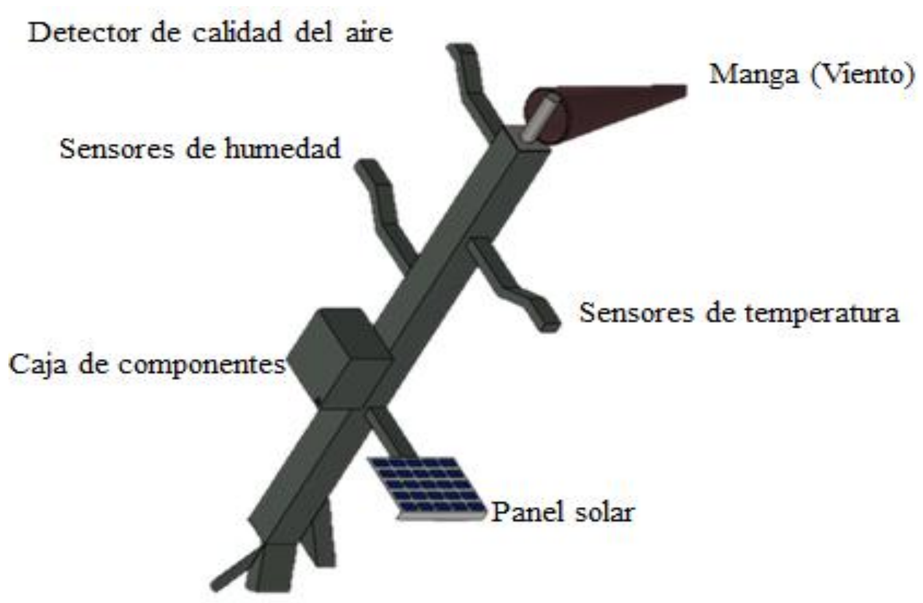

Figure 1. Scale drawing (side view).

Methodology

The methodology includes conceptual design, protptype instrumentation, control system design, protptype construction, contro system programming, system programming and prototype validation (Fig 2).

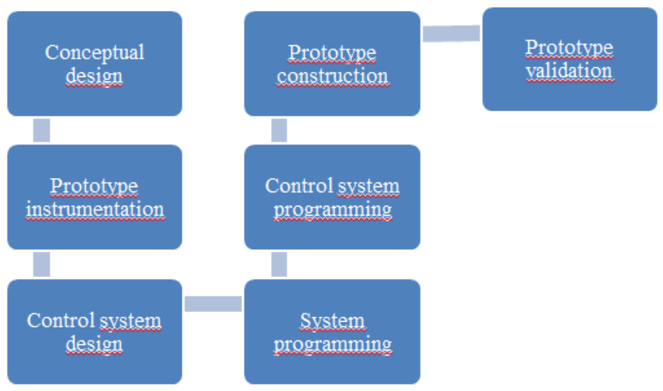

Figure 2. Methodology stages..

The Figure 3 shows the electronic diagram of the monitoring system based in an opensource platform.

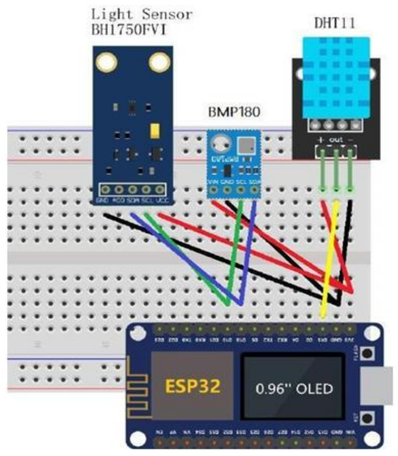

Figure 3. Conexión de los sensores al ESP32

For the communication scheme PtP, a bandwith of 20/40 MHz and WPA2-AES encryption were configured to ensure stable communication and to enable customize the security settings for the antenna network.

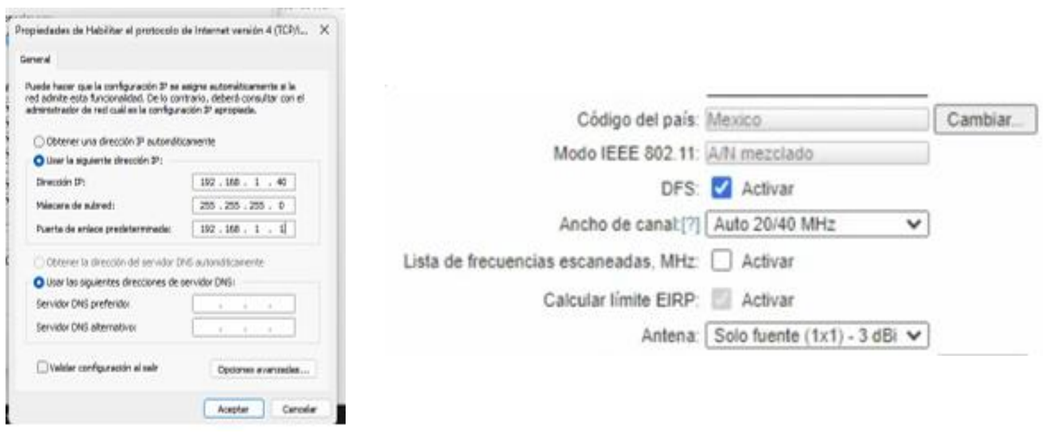

Figure 4. Antenna confuguration.

Results

The system was programmed by integrating an interface that connects to a server to obtain real-time data. Adiditionally, the antennas were configured and a PtP communication link was established. This setup facilitates communication between two weather stations, enabling remote data acquisition from both stations for subsequent comparison. It allows data collection over a wider area throug a stable communication link.

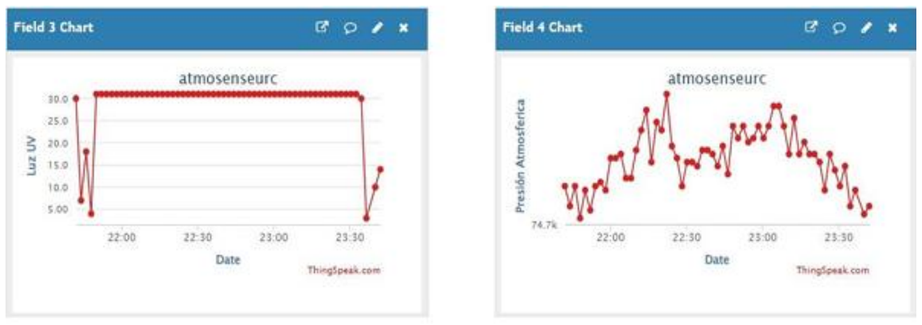

Figure 5. Real- time data.

Conclusion

In this project, an embeded system was developed for the acquisition of weather variables with the aim of use it in hard-to-reach areas in Mexico, such as Magdalena Contreras. This system is also self-sustainig. It includes an interface that enables real-time tata visualization, as well as a communicatin link beween two stations using antennas to extend data acquisition over a wider area. In this project additional stations can be integrated in order to increase data coverage in the monitored region, with the aim of making timely decisions and avoiding risks to the population.

References

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