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IOT NODE FOR MONITORING METEOROLOGICAL VARIABLES THROUGH LORAWAN TECHNOLOGY

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ABSTRACT

Relative humidity, temperature, atmospheric pressure, and altitude are essential weather factors that influence atmospheric dynamics and climate in various regions of the world. These variables are interconnected and can have a significant impact on human health, as well as sectors such as agriculture, industry, and the economy. The development of an Internet of Things (IoT) node has been implemented for the monitoring of these weather variables. This IoT node consists of a microcontroller and a LoRa node chip for data transmission and reception through LoRaWAN technology. The IoT node allows the measurement of temperature, humidity, atmospheric pressure, and altitude variables; with the use of this node, precise and real-time information about weather conditions can be collected for more detailed analysis and informed decision-making related to climate and its impacts on various sectors. Furthermore, a communication gateway is used to enable data transfer between the node and The Things Network platform for processing and online visualization.

KEYWORDS: Internet of Things, LoRaWAN, temperature, humidity, atmospheric pressure, altitude.

1 INTRODUCTION

Atmospheric dynamics refers to the study of the movements of air in the atmosphere and how these movements affect climate and long-term weather patterns. This scientific discipline focuses on the interaction between the atmosphere and other natural systems, such as oceans, land, and the biosphere. Understanding atmospheric dynamics is crucial for comprehending the formation and evolution of weather and climate phenomena, including hurricanes, storms, and global temperature changes. It is also fundamental for understanding how human factors, such as pollution and climate change, are impacting atmospheric dynamics and how this, in turn, influences our environment and daily lives.

Since industrialization, a significant amount of greenhouse gases has been released into the atmosphere, causing a gradual but constant increase in global temperatures. Combustion is the main source of pollutants released into the atmosphere, and it has increased greatly due to the growing demand for energy, population growth, and industrial activity, especially in highly industrialized cities like Saltillo, Coahuila, Mexico. This phenomenon has generated a problem of pollution in the local population. That is why it has been decided to precisely determine the weather conditions at key points in the Saltillo Institute of Technology, to know when to take action and ensure that these measures are correct when monitoring them. The Internet of Things (IoT) will be the tool that helps us monitor these key points, through the development of a node integrated with humidity, temperature, atmospheric pressure, and altitude sensors. This node will be connected to a communication gateway that will receive information in real-time via radio frequencies, which will be sent to a web page on The Things Network, where the information will be processed and sent through a communication protocol called MQTT to Node-RED platform for visualization, which is an open-source, visual programming platform.

2 MATERIALS AND METHODS

2.1 MATERIALS

For the develop the IoT node, it was necessary to acquire several materials, among which the BME280 sensor stands out, capable of measuring temperature, humidity, atmospheric pressure, and altitude. In addition, the implementation of a microcontroller with the transceiver called "Heltec" was carried out, responsible for connecting the BME280 sensor and sending the collected data to the Gateway. The Gateway, in turn, receives data from Heltec via radio frequencies and sends it to The Things Network for processing and decoding, in order to improve legibility and comprehension. For this purpose, the MQTT protocol was used, designed for lightweight messaging in IoT devices, which employs a publish-subscribe model for clients to publish messages. Once sent to The Things Network, the data is received by Node-RED, an open-source platform that allows for the visualization and graphical representation of information. The choice of these components enabled precise and effective management of the collected data, which can be analyzed and used later in making informed decisions.

2.1.1 Wi-Fi LoRa 32(V2.1).

Wi-Fi LoRa 32 is a classic IoT dev-board designed & produced by Heltec Automation (TM), it's a highly integrated product based on ESP32 + SX127x, it has Wi-Fi, BLE, LoRa functions, also Li-Po battery management system, 0.96″ OLED are also included. It's the best choice for smart cities, smart farms, smart home, and IoT makers.[1] The microcontroller with the transceiver is shown in Figure 1.

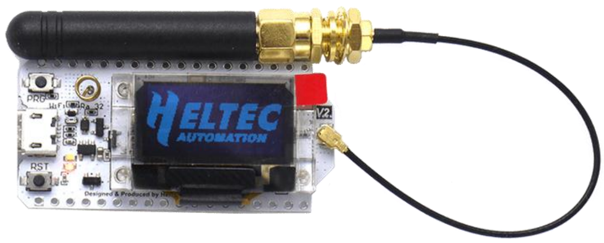

Figure 1: Wi-Fi LoRa 32(V2.1).

2.1.2 BME280 SENSOR

The BME280 sensor is as combined digital relative humidity, atmospheric pressure and temperature sensor based on proven sensing principles. As the atmospheric pressure changes with altitude, it can also measure approximate altitude of a place. The BME280 achieves high performance in all applications requiring humidity and pressure measurement. The humidity sensor provides an extremely fast response time for fast context awareness applications and high overall accuracy over a wide temperature range. The integrated temperature sensor has been optimized for lowest noise and highest resolution.[2] Operating range: atmospheric pressure (300-1100hPa), temperature (-45 to 85C) and relative humidity (0-100%). High accuracy, absolute accuracy of ±1.0 hPa for pressure, ±1 accuracy for temperature and ±3% for humidity.[3] This module can be connected to the IoT device with I2C protocol. The Sensor is shown in Figure 2.

Figure 2: BME280 sensor.

2.1.3 Gateway MultiTech

This MultiTech Conduit® IP67 Base Station is a ruggedized IoT gateway solution, specifically designed for outdoor LoRa® public or private network deployments. This highly scalable and certified IP67 solution is capable of resisting the harshest environmental factors including moisture, dust, wind, rain, snow and extreme heat, supporting LoRaWAN® applications in virtually any environment. The enhanced Conduit IP67 solution can support thousands of LoRaWAN certified end nodes, including the MultiTech mDot™ * and xDot®*.

This flexible solution provides durable, low-power, wide area connectivity in support of M2M and IoT applications for both LoRa service providers and individual enterprises wanting to expand their LoRa network coverage.

Designed for easy deployment, the solution includes a MultiTech Conduit with a LoRa MultiTech mCard™, IP67 enclosure, LoRa antenna to improve outdoor range and Ethernet or optional 4G-LTE backhaul. It can be deployed as part of an existing telecommunications tower, individual stand or wall mount.[4] The Gateway is shown in Figure 3.

Figure 3: Gateway MultiTech Model MTCDTIP.

2.1.4 The Things Network

TTN is a low-cost and low-power communication network for Internet of Things (IoT) devices. TTN uses LoRaWAN (Long Range Wide Area Network) technology to enable connectivity of devices in a wide geographical area with minimal energy consumption.

The TTN network is an open and collaborative network that allows anyone or any company to create IoT devices and connect to the network to securely and reliably transmit data. The network is completely free and non-profit, making it accessible to anyone or any company who wants to develop IoT devices.

TTN also offers an online platform that allows users to register and manage their IoT devices, visualize real-time data, and analyze collected data. The platform is compatible with a wide range of devices and sensors, making it suitable for a variety of IoT applications, such as environmental monitoring, asset tracking, and industrial automation.[5]

2.1.5 Node-RED

Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways.

It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

Node-RED provides a browser-based flow editor that makes it easy to wire together flows using the wide range of nodes in the palette. Flows can be then deployed to the runtime in a single-click.

JavaScript functions can be created within the editor using a rich text editor.

A built-in library allows you to save useful functions, templates or flows for re-use.

Built on Node.js

The light-weight runtime is built on Node.js, taking full advantage of its event-driven, non-blocking model. This makes it ideal to run at the edge of the network on low-cost hardware such as the Raspberry Pi as well as in the cloud.

With over 225,000 modules in Node's package repository, it is easy to extend the range of palette nodes to add new capabilities.[6]

3 RESULTS AND DISCUSSION

3.1 RESULTS

The node is composed of the Heltec device (microcontroller + transceiver), the BME280 sensor, and the antenna. The Heltec device features a microcontroller that connects to the BME280 sensor, allowing for the measurement of variables such as temperature, humidity, atmospheric pressure, and altitude. Subsequently, the device's microcontroller internally connects to the transceiver to transmit data to the Gateway via radiofrequency, and the Gateway, once it has the data, sends it to the server of The Things Network over the internet. Once there, the information is processed and sent via the MQTT protocol to the open-source visualization platform Node-RED, as illustrated in Figure 4.

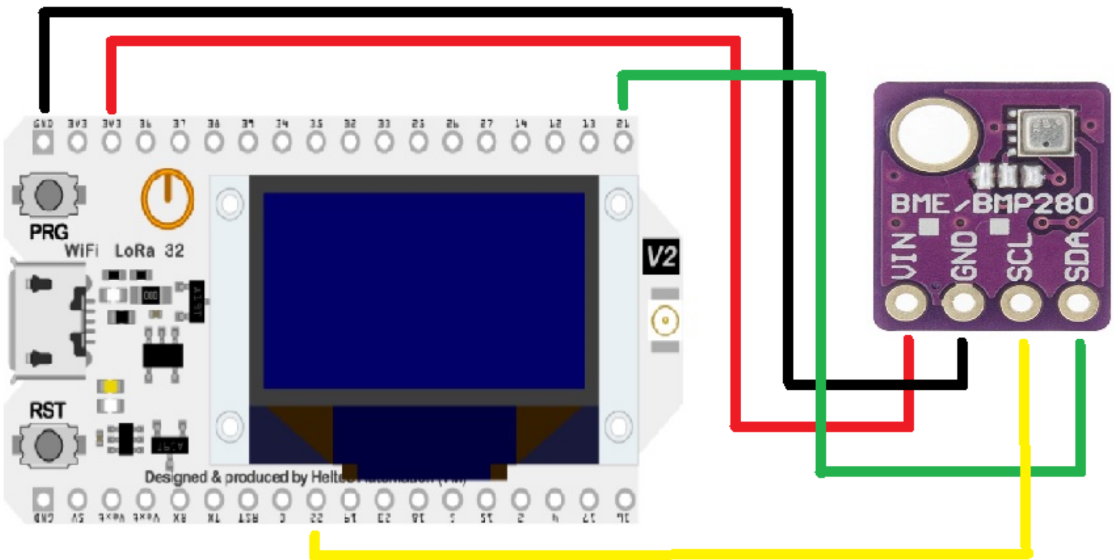

Figure 4: Graphic representation of the transmitter subsystem.

Figure 5 is shown the real-time temperature monitoring

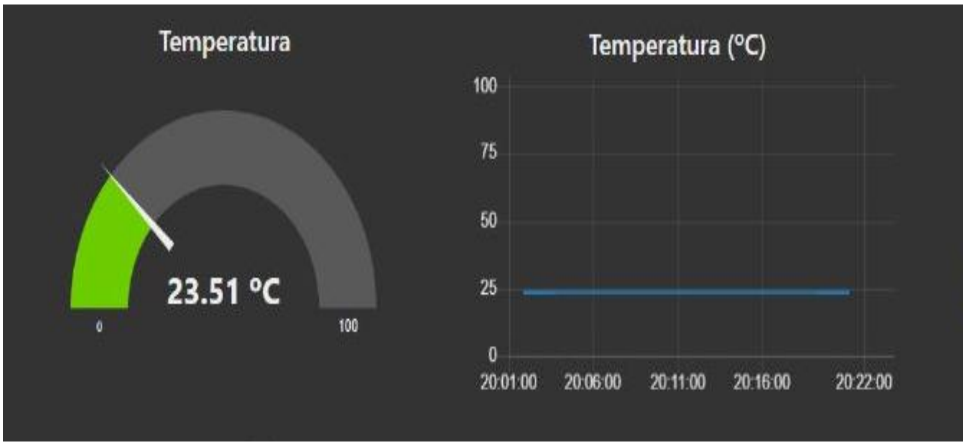

Figure 5: Temperature graph, where the x-axis represents time in minutes and the y-axis represents temperature in degrees Celsius (°C).

In Figure 6 is shown the real-time humidity monitoring.

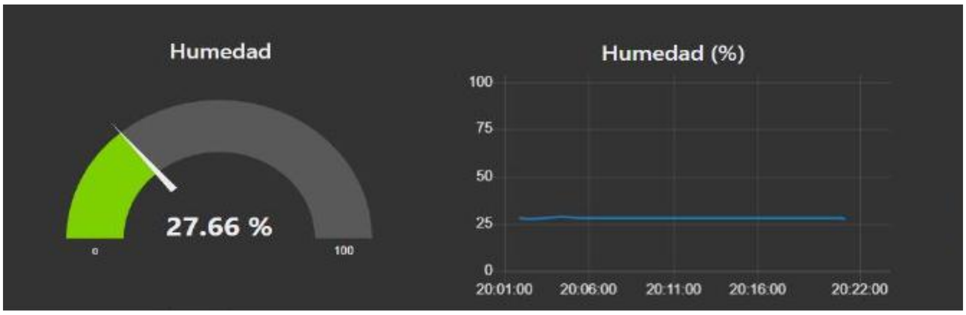

Figure 6: Relative humidity graph, where the x-axis represents the time in minutes and the y-axis represents the percentage of relative humidity (%).

In Figure 7 is shown the real-time atmospheric pressure monitoring.

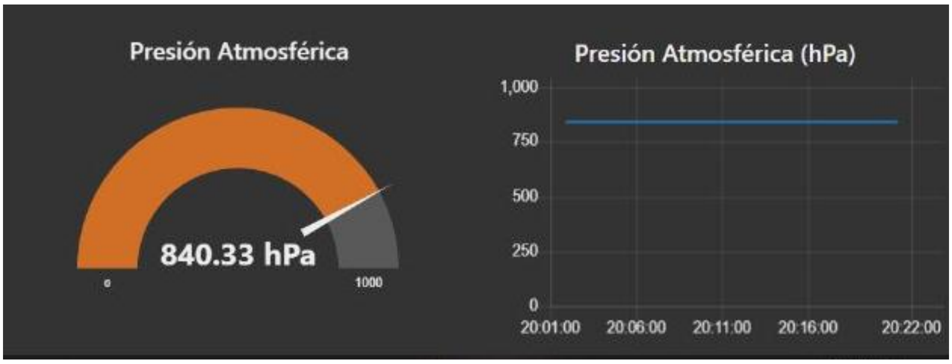

Figure 7: Atmospheric pressure graph, where the x-axis represents time in minutes and the y-axis represents atmospheric pressure in hectopascals (hPa).

In Figure 8 is shown the real-time altitude monitoring.

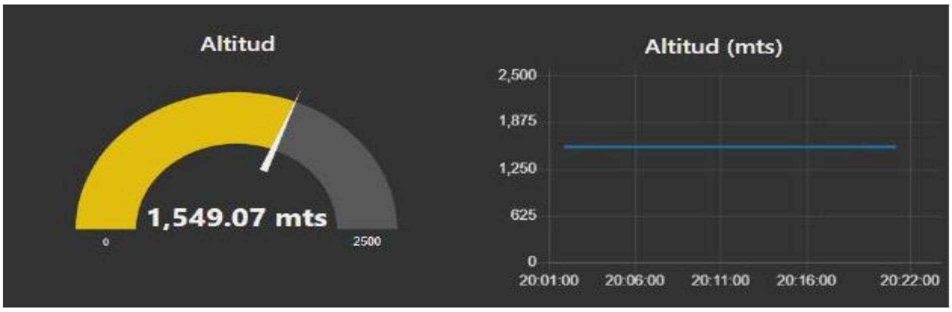

Figure 8: Altitude graph. Where the x-axis represents time in minutes and the y-axis represents altitude in meters above sea level (m).

In Figure 9, we can observe the graphical representation of the entire page created using node-RED.

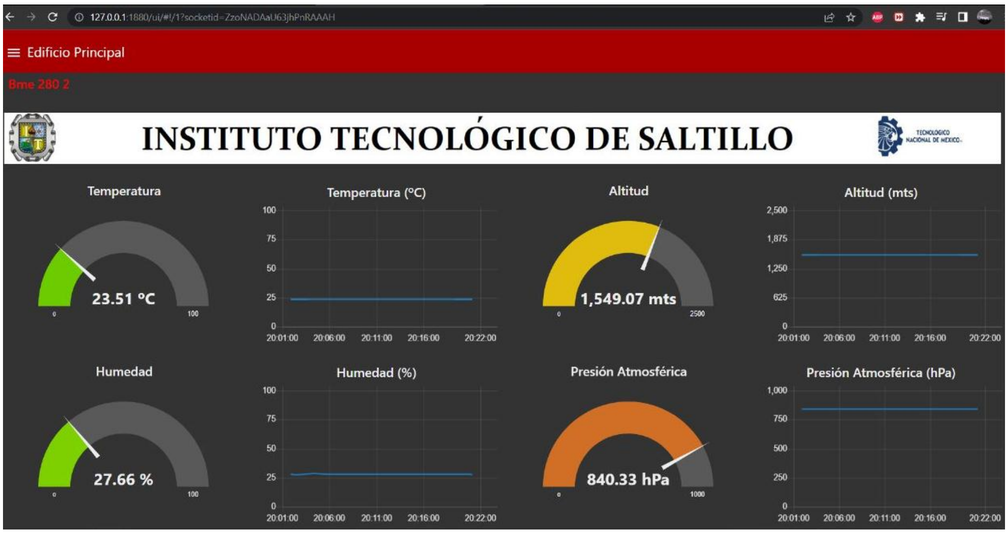

Figure 9: The graphical representation of the entire page created using node-RED.

CONCLUSIONS

A real-time IoT node has been developed capable of monitoring weather variables such as temperature, relative humidity, atmospheric pressure, and altitude. The obtained data is stored in a database and presented in a graphical user interface via an open-source visual programming platform called Node-RED, allowing the end-user to visualize the data in real-time.

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