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REVIEW PAPER ON LORA BASED WEATHER STATION SYSTEM

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Abstract:
This article proposes a system based on a microclimatic region distance communication system with low economic and energy costs that allows connectivity and a cutting-edge solution to a local weather monitoring system from the existing weather station coverage in that area. Weather forecasting is becoming increasingly unreliable as the climate changes dramatically. As a result, Weather Station Systems are commonly used to monitor the constantly changing climatic and weather conditions over controlled areas such as houses, industries, agriculture, and so on in real-time. A weather station is an instrument or device that provides us with accurate weather information in our surrounding environment. For example, it can tell us about the surrounding temperature, barometric pressure, humidity, and so on. As a result, this device detects temperature, pressure, humidity, light intensity, and rain value. The prototype contains a variety of sensors that can measure all of the previously mentioned parameters. It can be used to monitor the temperature or humidity of a specific room or location. We are creating a prototype of a weather station system using LoRa wireless technology in this project. LoRa is a long-range, low-power wireless telecommunications system promoted as an infrastructure solution for the Internet of Things: end-devices communicate with gateways connected to the Internet via LoRa across a single wireless hop, which acts as transparent bridges and relay messages between these end-devices and a central network server. This technology is an alternative to other popular wireless connectivity modules such as GSM modules, Zigbee modules, Wi-Fi Modules, and Bluetooth (BLE). The LoRa network is used to extend the range of wireless cells, which can reach distances of up to 10-15 kilometres while consuming little power. A single LoRa network cell can connect hundreds of nodes. Internal temperature, humidity, barometric pressure, rain detection, wind speed, and wind direction are among the weather parameters measured.
Keywords: Microclimatic region, Barometric pressure, LoRa, GSM module, Bluetooth(BLE), Zigbee.

Introduction:

A group of devices used to monitor conditions or shifts in the climate, environment, and other factors could be referred to as a weather conditions station. A data logger stores the recorded data so that it can later be examined by consumers or researchers. An automatic weather station is a device that uses sensors to measure and log meteorological information. This sensor acts as a measuring tool, detecting changes in the weather. After collecting measurement data from the weather station, the process can be carried out locally at the weather station's location, or the data can be collected at the acquisition data centre unit, after which the data collected is automatically forwarded to the data processing centre and processed as needed.

Many IoT-based weather stations with GSM, WiFi, Bluetooth, and Zigbee modules have been developed. However, few studies in Indonesia discuss the use of LoRa technology. LoRa is distinct from other technology modules like GSM, WiFi, Bluetooth, and Zigbee. Unlike other technology modules like GSM, WiFi, Bluetooth, and Zigbee modules, LoRa is unique. In summary, LoRa offers a longer range than WiFi, Bluetooth, and Zigbee—up to 10 km—and uses less power than GSM/LTE modules. In this study, a wireless LoRa infrastructure prototype for a network of weather stations is created. Measured weather

variables include air temperature, humidity, pressure, precipitation, and wind speed. The prototype developed contains two end nodes. In practice, however, it can be multiplied by dozens of end nodes if necessary. End nodes comprised of various sensors will be deployed in a LoRa-capable area to process weather monitoring data. The data collected by these sensors will
then be wirelessly transmitted via a LoRa gateway device linked to the cloud server.

Literature Review:
A weather station is a technology that collects weather and environmental data using various electronic sensors. Measuring climatic conditions is an important task in a variety of scientific and practical fields. Weather variables vary depending on location and time, particularly in tropical areas with no seasons [1]. The sun, water, and wind are the three main components that influence weather conditions. Because environmental conditions are so powerful in human activity, it is especially important to continuously quantify environmental conditions. The environmental data will be used for climate forecasting and agricultural planning, prosperity, the travel industry, and so on. During the time spent on environmental discernment, several instruments are expected to be placed in a specific area to address the normal states of the surrounding region [2]. There are two types of weather stations: those that have sensors and those that pull data from weather station servers. Our weather station has designed us for this project. We are all aware that a weather station is not a single device, but rather a collection of many small tools.
The centre of the undertaking is the ESP32-based Nodemcu which is a minimal-expense wifi module and a wide range of various sensors are associated with this gadget. The C code is written in Arduino IDE and transferred to the ESP32 through a sequential transport. When the code is transferred then the board is associated with a Wifi and the gadget begins working. The code must be transferred just once [4]. Essentially, this weather conditions station can screen the Climate boundaries like Temperature, Dampness, Tension, Elevation, Dew Point, Precipitation and Light Power.
The role of data transmission technology and network protocols used in communication networks in reducing data transmission failures is critical. The need for communication in areas without cellular coverage motivates this work. There are several options for implementing this type of communication [5]. Many IoT-based weather stations with GSM, WiFi, Bluetooth, and Zigbee modules have been developed. The main idea behind the Internet of Things (IoT) is to connect various electronic devices via a network and then retrieve data from these devices (sensors), which can be distributed in any way, and upload to any cloud service where it can be analysed and processed. These data can be used in the cloud service to alert people in various ways, such as using a buzzer, sending them an e-mail, sending them an SMS, and so on [4]. The availability, reliability, and flexibility of the communication network are required to support the convenience offered by the Internet of Things technology for Machine-to-Machine communications. However, this network has a significant level of unreliability, which reflects the high latency in data transmission, particularly in mountainous and rural areas, with the availability of connectivity that is volatile and tends to be unstable. As a result, we require a monitoring technology that is dependable and efficient in terms of energy costs and consumption [6]. LoRa is distinct from other technology modules like GSM, WiFi, Bluetooth, and Zigbee. In short, LoRa modules use less power than GSM/LTE modules and have a longer range of up to 10km than WiFi, Bluetooth, and Zigbee [7]. Long Range (LoRa) is a LoRa modulation technique that uses physical layers to communicate wirelessly under the LoRa Alliance standard. It is part of Semtech's proprietary spread spectrum modulation. The use of the Chirp Spread Spectrum (CSS) technique, resistance to interference, and a very low minimum Signal Noise Ratio (SNR) on the receiving side, so that the receiver can properly demodulate the signal, are the advantages of the LoRa modulation technique compared to other modulation techniques. The chirp signal contains a linear

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frequency pulse that is modulated on a wideband, and the frequency pulses vary depending on the information encoded. Maintaining identical time and offsetting frequencies on the transmitter and reception sides, can increase the receiver's sensitivity and decrease interference brought on by the Doppler effect [6].
LoRa communication technology is an unlicensed Internet of Things (IoT) technology with low bandwidth, a limited number of messages, low power requirements, long-distance communication, and higher penetration power. LoRa has a greater range of up to 8km development than Wi-Fi, Bluetooth, and Zigbee. This research creates a model of a weather station network using a remote Long Range (LoRa) Module framework/framework. The LoRa physical layer uses chirp spread spectrum (CSS) modulation to enable long-distance communication [8]. LoRaWAN technology is used in this work. This technology is not intended to be used while moving, but it does have advantages such as low energy consumption and low long-distance communication costs. This technology has never been used before in person-to-person communications[5]. LoRaWAN is a network protocol that employs the modulation scheme of LoRa. Both are distinct standards with interconnected relationships. LoRa is located on the physical layer, whereas LoRaWAN is located on the MAC layer. The LoRaWAN protocol specifies how to construct a scalable network using the LoRa modulation scheme, including what components are required to form a network, the appropriate architecture, how the PHY-payload on a LoRa packet should be formatted, how to channel access is controlled/handled, and what frequencies are used for transmission. [9].
The parameters are used to build the weather station, and the value is logged into the cloud platform (ThingSpeak)[10]. This research creates a weather station network prototype using wireless LoRa infrastructure. Air temperature, humidity, pressure, rainfall, and wind speed are all measured weather parameters. The prototype developed contains two end nodes. In practice, however, it can be multiplied by dozens of end nodes if necessary. End nodes comprised of various sensors will be deployed in a LoRa-capable area to process weather monitoring data. The data collected by these sensors will then be wirelessly transmitted via a LoRa gateway device linked to the cloud server[4]. Organizations can use the cloud platform to develop cloud-native applications, test and build applications, and store, back up, and recover data. It also enables businesses to analyse data.

Related Works:
IoT Technology: The Internet of Things (IoT) system is a network of many nodes that form a Low-Power Local Area Network (LP-LAN) or a Low-Power Wide Area Network (LP-WAN) for larger elements and areas. Low power is used because the requirements for the IoT system are machine-to-machine communication (M2M), which does not require high data rates. With enough data speed, bandwidth efficiency will be achieved, allowing it to support more node elements. The system protocols in the IoT technology module, on the other hand, are simplified to achieve efficiency in the case of low power consumption requirements [6]. Low-power wireless connectivity modules are used to communicate between nodes in the IoT LP-LAN / WAN network. Wireless modules can be divided into two categories based on the wireless access media used [7][8]. 1) Modules with a short range of fewer than 100 metres. This category includes the following: a. Proximity NFC (EMV), IrDA, with a very short distance of 0-10 m. b. Wireless personal area network (WPAN) RF modules such as Zigbee, 6LOWWAN, Bluetooth LE, Z-Wave, ANT, and WirelessHART. c. Low-power Wi-Fi (IEEE 802.11) chips such as G2M5477, QCA4004, GS1011M, and ESP8266. 2) Modules with a much greater range than 100 m. LoRa, NB-IoT, Sigfox, and DASH7 are among these technologies. With this remote reach module, LP-WAN networks can be compared to low-power versions of cellular networks, with each cell containing thousands of node devices.

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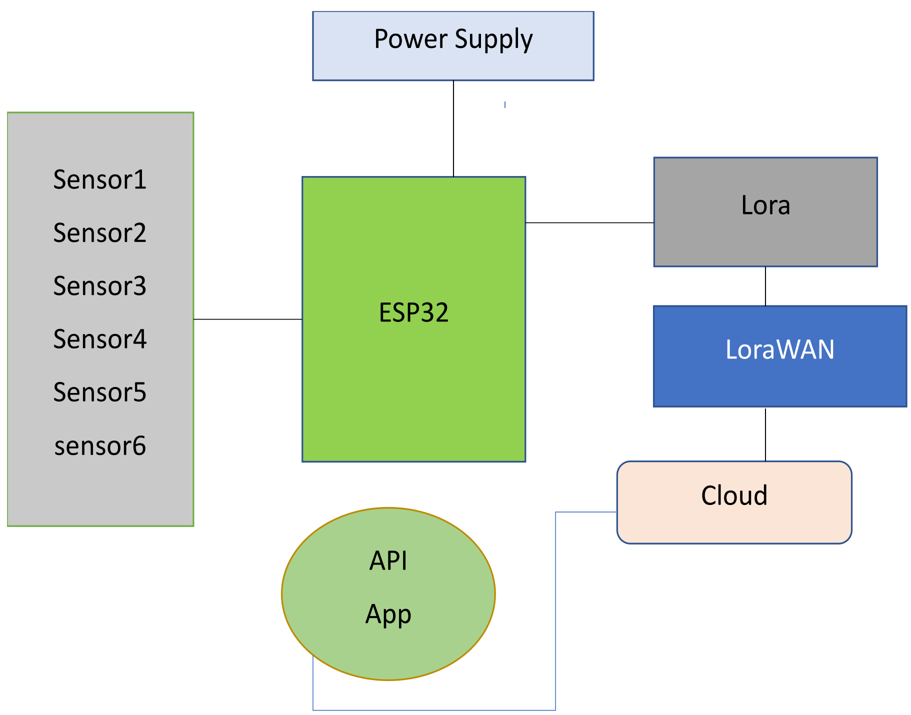
Sensors for the Weather Station System:

Rain Detector Sensor:- A rain detector is a component with a working principle that can detect and determine the magnitude of rain. The conductivity of rainwater is used to create a rain detector sensor, which activates when the part is exposed to rainwater.

DHT11 sensor:- DHT11 is a temperature and humidity sensor[15]. The DHT11 sensor sends 40 data bits to the microcontroller, with the first 16 bits being binary humidity data, the next 16 bits being temperature binary data, and the last 8 bits being the sum of temperature and humidity values.

Sensor BMP180:- BMP180 is a parameter and sensor that measures the compressive strength of the air around it in the environment.

Block Diagram:



Using software technologies:

1. Lora - This physical, unique radio modulation method (low range). Based on chirp spread spectrum (CSS) technology, it uses spread spectrum modulation techniques.

2. Lora Wan - LoRa WAN networks are commonly set up in a star-of-stars topology, where gateways 1 285 relay messages between end devices 2 286 and a central Network Server 287, which then routes packets from each device in the network to the corresponding Application Server. The LoRa-WAN protocol uses symmetric cryptography 289 with session keys obtained from the device's root keys to protect radio broadcasts. LoRa supports data speeds of 0.3 kbps to 50 kbps.

3. Arduino Cloud - To allow access to manage and work on a project, you utilise Identity and Access Management (IAM). Applications can authenticate and access Google Cloud resources and services with the help of service accounts. A unique class of service account known as a service agent represents an Arduino Cloud service.

4. Micro-Controller -ESP32 is a single 2.4 GHz Wi-Fi and Bluetooth combo chip that was created utilising the TSMC ultra-low-power 40 nm technology. It is the microcontroller that we are employing. With resilience, versatility, and dependability in a wide range of applications and power circumstances, it is made to achieve the best power and RF performance.

5. Anemometer- An anemometer is made up of three cups that are connected to an arm that is mounted on the drive shaft. As a speed reading counter, a one-degree dish is mounted on the cup shaft. First, the anemometer must be calibrated. The first step is to use the equation to determine the sensor's revolutions per minute value: - RPM = [(Count /n) 60] /(10000 /1000), where RPM = revolutions per minute, Count = counter value in one reading, and n = number of gaps in the disc.

Proposed work

The sensors in the proposed framework are linked to the MicroController, which is linked to LoRa. We planned and formed the entire concept into a device, where we coordinated all of the expected parts into a single unit. The Sensors connected to the Microregulator will identify climate boundaries such as temperature, humidity, air pressure, dew point, rainfall, and altitude and present them on the Seri al screen and in the WebServer. We connect the recipient LoRa/Gateway Lora to the ESP32, which then sends the data/information to the server.

A. To provide a more precise horticultural land region at that specific location.
B. To continuously observe the climatic conditions of a specific area from afar.
C. Create a low-cost framework for screening weather conditions.
D. With ongoing information, clients can learn about the environment and design their works accordingl y.
E. To programme the system and make it wireless.
F. The goal is to automate and create a framework that provides long-term weather forecasting.
G. As a result, more precise monitoring weather stations are being developed, which will be available at a low cost.

Scope of project

In the future, we encourage the use of long-distance specialised techniques to increase the range of distance for sending information. Similarly, we recommend using the weather station to forecast the wea ther for the coming days rather than just the current time. We are eager to continue developing the equip ment framework to improve energy efficiency and extend the transmission distance.

We also need to incorporate elements of remote actuator control into the administration programming. I n addition, we need a more adaptable connection point plan for future weather stations, as well as more a daptable extra modules that can be randomly consolidated by the design.

Conclusion:

The new frontier for more precise and reliable weather forecasting is data on localised weather, often known as microclimates. As a result, weather data collecting is getting progressively smaller and gridded. The prototype of a LoRa-based weather station, consisting of a LoRa gateway and ten functional nodes, can function properly because the value read by the sensor can be displayed precisely and accurately on the Cloud interface using a LoRa module that transfers data without the use of the internet or LoRaWAN technology that transfers data with the use of the internet. LoRaWAN essentially takes LoRa wireless technology and adds a networking component to it, as well as node authentication and data encryption for security. The LoRa platform provides an opportunity and alternative for constructing sensor networks that require a big number of nodes in one cell and low consumption; LoRa-based systems may be used to implement sensor networks with a large cell radius and a large number of nodes. These IoT gadgets use little bandwidth and may operate for months or even years on battery power.

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