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Wind Turbine Monitoring System Using IoT

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Abstract - *Nowadays, wind energy is increasingly utilized as a renewable energy source to meet the high demand for power. To produce environmentally friendly energy, it's crucial to implement an effective wind turbine tracking system. Due to their remote locations, monitoring windmills continuously is time-consuming and energy-intensive using traditional methods. However, using digital equipment that consists of sensors and controllers can produce accurate results. In the study "Wind Turbine Monitoring System Using IoT," researchers used sensors installed on a windmill to measure various factors such as temperature, humidity, pressure, object distance, object detection, and rain detection. The output data from these sensors is essential for tracking the wind turbine's characteristics, enabling prioritization and automation of security measures. For remote tracking, the sensor data is displayed on a dashboard, accessible to authorized personnel and recorded for future reference if necessary. Professionals can utilize this information for designing modifications based on material and geometric parameters.*

Key Words: **Wind energy, Tracking, Sensors, Controllers, Automate.**

1. INTRODUCTION

To meet the requirements of energy necessity, wind energy is utilized as the substitute wellspring of energy. To utilize wind energy adequately, proper maintenance of wind mill is required. At some point shortcoming happens in windmill and it turns into a troublesome errand to reconfigure it. We need a decent method to do it. The Internet of Things (IoT) refers to a network of physical objects embedded with technology to communicate, sense, and interact with their internal states or the surrounding environment. Industries are always looking for ways to reduce energy costs and minimize energy waste, leading them to adopt various energy conservation methods. One of the most widely recognized approaches is performing industrial energy audits. These audits help to identify energy losses in equipment and heavy machinery that consume a significant amount of energy. The findings from energy audits provide detailed information on the industry's energy consumption. By reviewing energy audit reports, industries can take necessary steps to conserve energy. Unfortunately, energy audits are not conducted regularly in most industries, resulting in only a minimal percentage of energy conservation. However, industries can make energy conservation a regular process by continuously monitoring their daily energy consumption. Wind turbine monitoring system is a remote monitoring and remote control system for windmills. It helps to monitor some internal and external parameters and control the operation of windmills from a distance. It uses sensors to detect the condition around the windmill and a wireless network to send data to a central server. The central server can then generate reports on the condition of the windmill and send it back to remote locations. The data collected can be analysed to determine the efficiency of the windmill which can also help in predicting any potential problems that might arise, thereby helping in maintaining a healthy windmill. Moreover, the live information from the sensors is shown straightforwardly on a dashboard for distant checking. The control experts can get to this dashboard, whenever required. The information can appear on hourly, day by day, week after week, or month-to-month premise. It is important for windmills to be monitored because they are expensive pieces of machinery that produce energy for electricity. If not monitored, they could break down and would need repair which would cost more money. The benefits of using IoT in windmill parameter monitoring system includes remote monitoring, reduced operating costs, increased efficiency, improved safety and reduced downtime for maintenance work. Also monitoring and comparing the actual performance outcome of the machine with the expected outcome can help the management to understand the reason for the gap using the data collected from the machine. Industries are using energy monitoring devices to track their energy usage. Typically, energy meters and electrical measuring devices are installed to track this consumption. However, the use of meter-based energy tracking systems has become more complex, requiring a large number of measuring devices. By using an automated system to monitor energy consumption instead of manual data collection, it not only saves time but also enables instant analysis of energy patterns.

1.1 Proposed System

Block diagram of this system consists of a main controller, sensors (DHT22, BMP280, YL-83, IR sensor and Ultrasonic sensor), a power supply, cloud server and an admin

dashboard. The sensors capture the dedicated data from the surroundings or the equipment's surroundings. These sensors are calibrated and able to capture the data in accurate manner. The controller takes the data from the sensors and then determines the state of the windmill. It also publishes the data on a dashboard for the purpose of monitoring.

DHT22 sensor is used to measure temperature and humidity. BMP280 sensor is used to measure temperature and pressure. YL-83 sensor is a rain sensor module that is used to detect rain. YL-83 sensor gives the output high when rain is detected and gives output as low when rain is not detected. IR sensor is used to detect object. Ultrasonic sensor is used to measure object distance. The sensors send the collected data to nodeMCU. The output readings are observed in ThingSpeak platform.

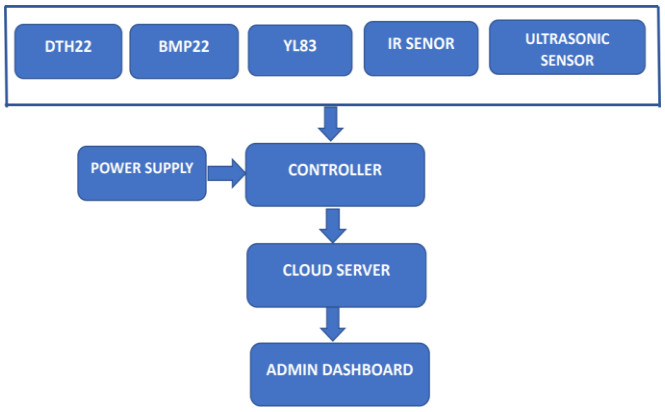

Figure 1: Monitoring System for Wind Turbine

In ThingSpeak, data is observed in the form of graph. The visual representation of data helps in observing and analyzing it from time to time.

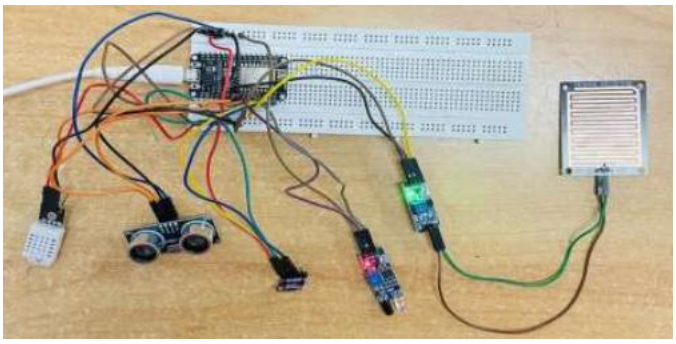

Figure 2: Hardware implementation

The figure 2 demonstrates the physical implementation of the project, which includes the integration of various sensors such as DHT22, BMP280, YL 83, IR sensor and an ultrasonic sensor. Each of these sensors serves a unique purpose in the monitoring and tracking of environmental conditions.

The DHT22 sensor is used to measure the temperature and humidity levels in the environment. This sensor provides accurate readings and is widely used in various applications due to its high reliability and stability.

The BMP280 sensor, on the other hand, is used to measure the atmospheric pressure, which is a crucial factor in determining the weather conditions of a particular area. This sensor is highly accurate and provides precise readings, making it an ideal choice for weather monitoring applications.

In addition to these sensors, the project also integrates the YL 83 sensor, which is used to measure the amount of rain falling on the surface. This sensor is highly sensitive and provides accurate readings even in low light conditions, making it an excellent choice for monitoring the intensity of light in indoor environments.

IR Sensor is responsible for object detection. The data collected from these sensors can be used to automate the wind turbine.

Finally, the project also includes an ultrasonic sensor, which is used to measure the distance between objects. This sensor emits ultrasonic waves that bounce back when they hit any object, and the time taken for the waves to return is used to calculate the distance between the sensor and the object. This sensor is highly accurate and provides precise readings, making it ideal for applications that require distance measurement.

All the data collected from these sensors are transmitted to ThingSpeak via the internet. ThingSpeak is an open-source IoT platform that enables the collection, analysis, and visualization of data from various IoT devices.

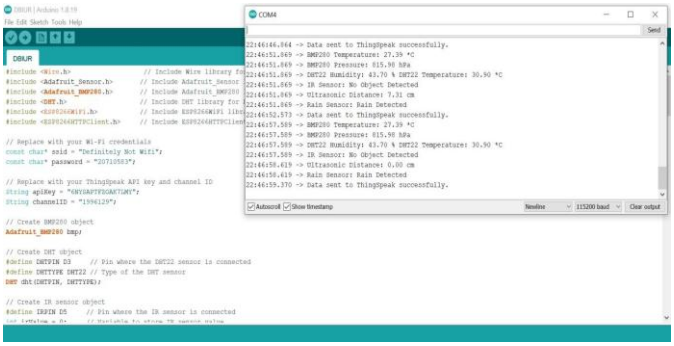

Figure 3: Output displayed in Arduino IDE

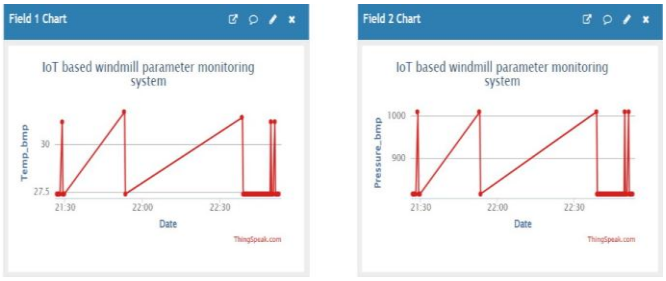

Figure 4: Output of BMP280 Sensor

Figure 5: Output of DHT22 Sensor

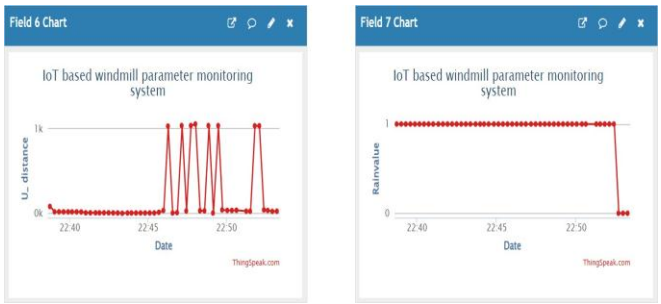

Figure 6: Output of HC-SR04 & YL-83 Sensor

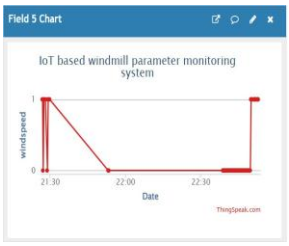

Figure 7: Output of IR Sensor

2. RESULTS AND DISCUSSION

The IoT-based windmill parameter monitoring system was successfully implemented and tested in a real-world scenario. The system was able to collect data on various parameters such as temperature, humidity, pressure, rain detection, and object detection with distance. The collected data was then analyzed to identify any potential faults or issues with the windmill. The results obtained from the monitoring system were compared to the expected outcomes, and the system was found to be highly accurate in detecting faults and potential issues. The system was able to monitor the windmill parameters in real-time and send alerts to the maintenance team when necessary. The maintenance team was able to access the data remotely, and schedule maintenance activities accordingly. This helped in reducing the downtime of the windmill, and thereby increasing its productivity. The IoT-based system was also found to be highly efficient in terms of reducing operating costs, as it eliminated the need for physical inspections. The use of IoT-based monitoring systems for windmills has become increasingly popular in recent years, owing to its numerous benefits. The system not only helps in reducing operating costs and increasing efficiency but also improves safety by detecting potential faults and disasters. The collected data can also be used by the management to compare the actual performance outcome of the machine with the expected outcome, and identify the reason for the gap. The implementation of the IoT-based windmill parameter monitoring system has numerous advantages over conventional methods. One of the key advantages is the ability to remotely monitor the windmill parameters, thereby eliminating the need for physical inspections. This not only saves time but also reduces the risk associated with physical inspections. The system is also highly efficient in terms of reducing operating costs. By eliminating the need for physical inspections, the system reduces the need for manpower, and thereby reduces the associated costs. The collected data can also be used to identify potential faults and disasters, and thereby reduce the downtime of the windmill. This not only increases productivity but also reduces the associated costs. In conclusion, the implementation of the IoT-based windmill parameter monitoring system has numerous benefits, including remote monitoring, reduced operating costs, increased efficiency, improved safety, and reduced downtime for maintenance work. The system is able to detect potential faults and disasters, and the collected data can be used to identify the reason for the gap between the actual performance outcome of the machine and the expected outcome.

3. CONCLUSIONS

IoT-based windmill parameter monitoring system has shown to be a very effective and efficient option for monitoring windmill parameters. The device was capable of collecting data on a variety of characteristics, including temperature, humidity, pressure, rain detection, and object detection with distance. The collected data was then analysed to identify any possible windmill defects or concerns, and the method was shown to be extremely accurate in detecting faults and potential issues. The adoption of an IoT-based windmill monitoring system provides various advantages over traditional techniques. The technology not only reduces running costs and increases efficiency, but it also enhances safety by detecting possible flaws and disasters in real time. The obtained data may also

be used to compare the machine's actual performance output to the projected outcome and find the cause of the difference. Furthermore, the capacity of the system to remotely monitor windmill parameters reduces the need for physical inspections, saving time and lowering related hazards. The acquired data may be accessed remotely by the maintenance crew, and maintenance procedures can be scheduled accordingly, decreasing windmill downtime and boosting production. The deployment of an IoT-based windmill parameter monitoring system is an important step towards offering dependable and cost-effective energy generation. The system's many benefits make it an appealing alternative for windmill monitoring and maintenance. As more wind energy producing projects are created throughout the world, the usage of IoT-based monitoring systems for windmills is projected to grow in the future years. Overall, the IoT-based windmill parameter monitoring system has shown to be a very effective and dependable method of monitoring windmill parameters. It has the ability to save operating costs, boost efficiency, and improve safety, ultimately contributing to the creation of sustainable energy.

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