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Fault Diagnosis and Monitoring of Small Wind Turbine Using IOT

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Abstract

Electrical energy is the most reliable energy forms. Out of which the development in technology is claiming for energy in large quantities. But the conventional energy sources are causing pollution also the fossil fuels are been depleting day today, thus the path have been led for Renewable energy sources. The most dependent renewable energy source includes the wind energy. But the maintenance of wind turbine is complex, continuous monitoring becomes tough due to its location at great height and they are installed in rural areas. So, a reliable condition monitoring system is essential for wind turbine to minimize downtimes and to increase the productivity. The aim of this project is to monitor the wind turbine parameters and to improve the early fault detection. Here, sensors are used to monitor the condition of wind turbine. The three sensors used are temperature sensor, vibration sensor and voltage sensor. If any sensor gives an abnormal value, the data is updated to IoT cloud for every 15 seconds. For this project, we use Arduino UNO and Node MCU esp8266. Arduino UNO collects sensor values from different sensors of wind turbine and Node MCU esp8266 sends the data to IoT cloud of ThingSpeak. Working of Kit and the performance check is done on the proposed system.

Keywords: Arduino UNO, DC Gear motor, esp8266, Fault Diagnosis, IOT ThingSpeak cloud, Wind turbine.

1. INTRODUCTION

Due to the negative environmental effects of fossil fuels, both quantitatively and qualitatively, the globe is quickly switching to renewable energy. To utilise these natural resources as clean energy, however, a number of additional steps are necessary. Due to major advancements in power electronics and gearbox systems, photovoltaic and wind energy are currently the most common energy sources. In comparison to wind turbines, solar panels occupy a larger space. As opposed to solar systems, wind turbines have an advantage in terms of area, hence monitoring them is crucial. One of the newest forms of energy in use today is the wind turbine. Therefore, reliable and economical distribution of green energy depends on proper operation and maintenance. Typically, wind turbines in remote places undergo routine maintenance is a challenging task. Therefore, novel measurement and recording methods are required for crucial parameters. To save downtime and increase production, condition monitoring is a common method for the early detection of problems and malfunctions.

Commercial, predictive, and preventative maintenance are becoming more and more necessary as offshore wind farm building increases. Inadequate generator and gearbox bearings are among the factors that contribute significantly to wind turbine downtime. Installing a vibration sensor will fix this. Due to the high failure rate of offshore wind turbines, it is crucial to develop a highly reliable condition monitoring system to increase maintenance effectiveness. From the main station, the following applications can be submitted. Update, manage, and monitor PLC programmes. Additionally, the central station's IP address and the SCADA program's port number can be entered in the web browser's address bar to monitor the system from any internet-connected computer. SCADA monitoring and control systems are more expensive, SCADA systems are more complicated, require more regular maintenance, and are very difficult to implement. Additionally, installation space is needed. Large wind turbine blades cause significant damage if the turbine is unbalanced, which might result in dangerous circumstances.

Wind turbines come in a variety of topologies, architectures, and design features. some options. The wind turbine topology is: Adjusting the rotor axis: horizontal or vertical; Rotor position: to the wind or to the tower; Rotor speed: fixed or variable; Hub: Fixed blade, oscillating blade, gimbal blade, or pivot blade; Number of blades: one, two, three or more; Capacity control: stall, pitch, yaw, or aerodynamic planes. When designing a wind turbine for a particular location, there are some important considerations to consider into account. These include: Machine selection, Rated speed and operating speed, Maximum speed ratio, Cooling device, Weight and size, Protection of marine environment, Capital cost and maintenance.

Wind turbine speed must be controlled to Generate electricity efficiently maintaining turbine components within design speed and torque limits. Centrifuge This is achieved because the force acting on the rotating blade increases in proportion to his square of the rotational speed. Structure sensitive to the overspeed. The stronger the wind, the stronger the wind force, so at higher speeds, turbines must be built to withstand much higher wind loads (such as gusts) that can generate electricity. Wind Turbines Have Reduction Opportunities torque in high winds. Wind turbines are designed to generate electricity at different wind speeds lighting speed about 3-4 m/s for most turbines, stopping at 25 m/s. When the nominal wind speed is exceeded, Power must be limited. A control system consists of three basic elements measure the sensor actuators and controls that manipulate process variables, energy generation and component loads

Algorithms that adjust actuators based on information collected by sensors all the wind turbines are designed for maximum wind speed, called survival speed be damaged. Survival velocities of commercial wind turbines are in the range of 40 m/s (144km/h) to 72 m/s (259 km/h). The most common survival speed is 60 m/s (216 km/h). The speed is designed to be 80 meters per second (290 km/h). The suggested IoT-based wind turbine monitoring and control system, WTMCS, can readily overcome these restrictions. The experimental configuration for an Internet of Things-based monitoring and control system for wind turbines are described.

1.1 Vibrational Analysis

Wind turbine vibration analysis involves the study and evaluation of vibrations present in wind turbine structures and components. This analysis is very important to understand the dynamic behaviour of the turbine and identify potential problems such as increased wear, increased noise, decreased efficiency and safety concerns. High vibration levels can make it difficult to diagnose problems within the turbine. Vibration can mask other problems, making it difficult to identify the cause of the problem.

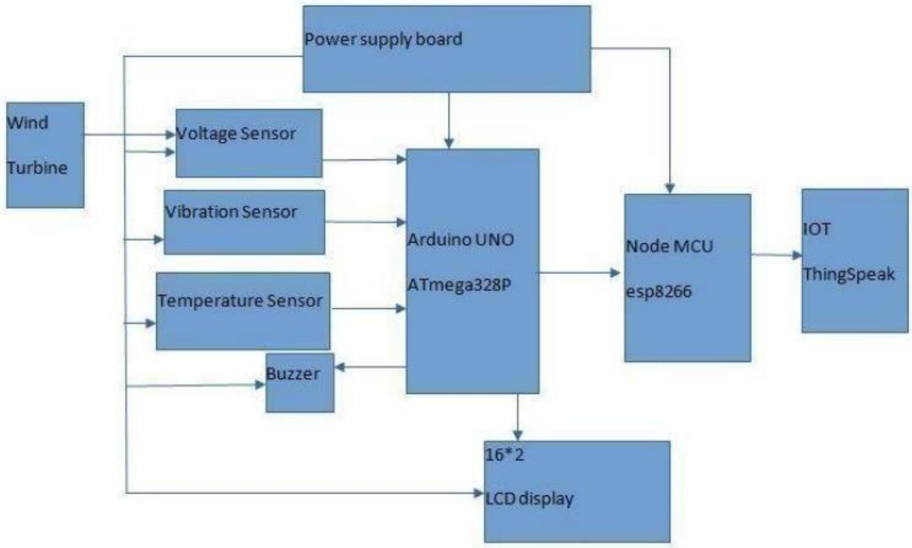
1.2 Temperature Impacts

Temperature can have different effects on wind turbines, both in terms of performance and structural integrity. Some of the most important effects of wind turbine temperature include power output, mechanical stress, blade performance, lubrication, cooling. To mitigate temperature-related effects on wind turbines, manufacturers need materials with the right thermal properties, insulation, cooling mechanisms, monitoring systems to prevent overheating and ensure optimal performance under varying environmental conditions, etc. incorporates the design considerations of Regular maintenance and inspections are also important to identify and resolve temperature-related issues in a timely manner.

2. IOT THINGSPEAK

ThingSpeak is an Internet of Things (IoT) platform and cloud service by MathWorks. It allows the user to collect, analyse and visualize data from her IoT devices and sensors. ThingSpeak provides an easy-to-use interface and set of APIs for sending and retrieving data from connected devices. Thingspeak's monitoring capabilities help with data collection by enabling the collection of data from various IoT devices and sensors. It supports a variety of protocols including HTTP, MQTT, and ThingSpeak's own REST API. These protocols allow your device to send data to ThingSpeak, and the platform stores the data for further processing and analysis. When it comes to data visualization, it provides built-in tools to visualize and analyze the collected data. Users can create customizable charts, graphs and gauges to display data in real time. This helps you understand trends, patterns, and anomalies in your data.

3. BLOCK DIAGRAM



4. WORKING PRINCIPLE

Here, the temperature is sensed using a thermistor. used to measure the motor windings' temperature. This sensor's primary function is to measure the air's temperature. This is because snow builds up on the rotors and casings in the northeastern nations due to the high moisture content in the air, seriously impeding the rotation mechanism. This will make it simple for you to keep an eye on it and take precautions before it happens. The vibration sensor is a Mercury tilt sensor KY017. The primary factor in wind turbine failure is vibration.

Wind turbine bearings experience severe vibrations at wind speeds more than 80 km/h. This issue is solved with a vibration sensor to detect vibration. This sensor is used to programme, to activate the relay with the LOW. Therefore, when detecting "0" of the vibration sensor, VIBRATION ALARM will be displayed. The wind turbine generator voltage can also be read from the voltage sensor. The values obtained from the sensors are relayed via the Arduino to the Nodemcu where the information is processed and relayed to the Thing Speak Cloud. Where data can be visualized in MATLAB visualization. Also, an e-mail alert is sent to authorized personnel indicating that an error has occurred. Thus, the kit we developed does the fault diagnosis of wind turbine using IOT.

5. SENSORS

To monitor disturbances in wind turbines, we use sensors that can continuously analyse data and take necessary action before disturbances occur. The sensor used is the KY-017 Mercury Tilt Sensor as a vibration sensor that passes adigital output to the Arduino. Thermistor as temperature sensor with analog output. And a voltage sensor to detect the amount of electricity produced by the wind turbine.

6. SOFTWARE USED

Sofware : Embedded C

We here consider Embedded C programming language as it is the low-level programming among all the high-level programming languages. Hence, we adopted it for developing the control among the hardware components.

7. HARDWARE RESULT

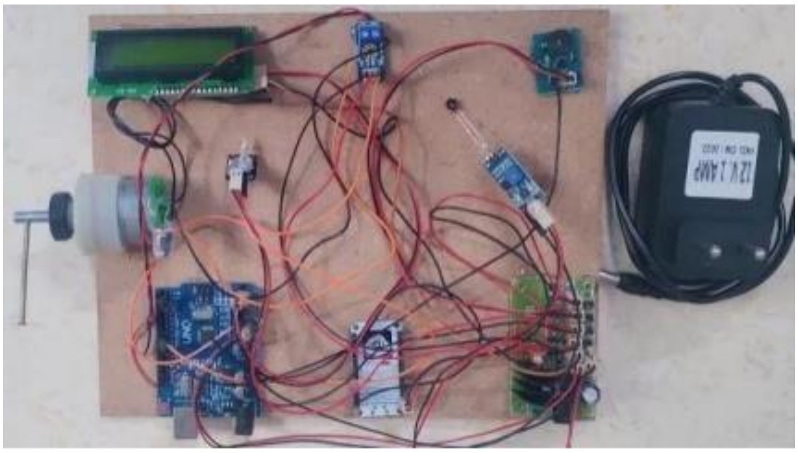


Figure 1: Working and fault display of wind Turbine

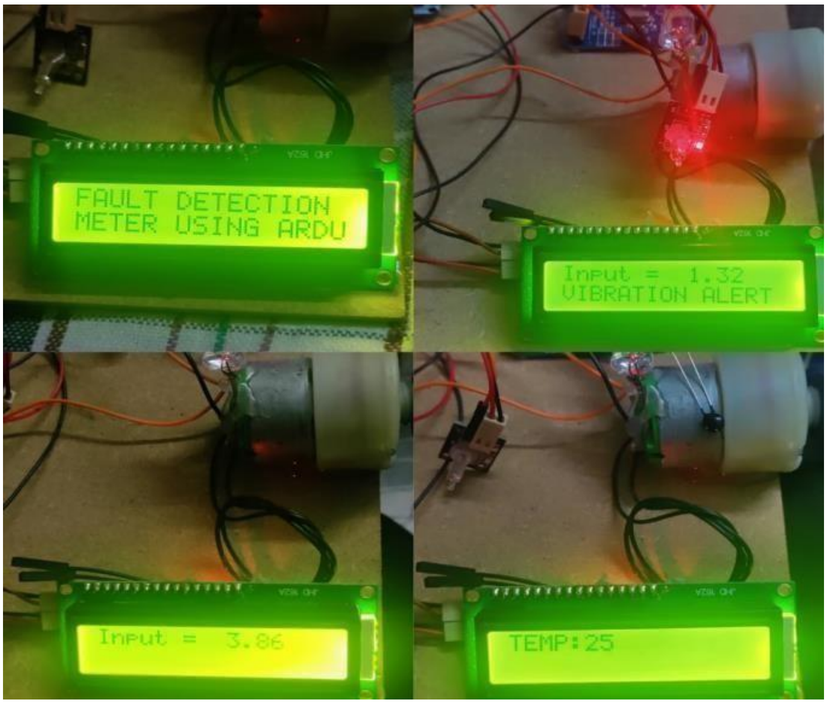
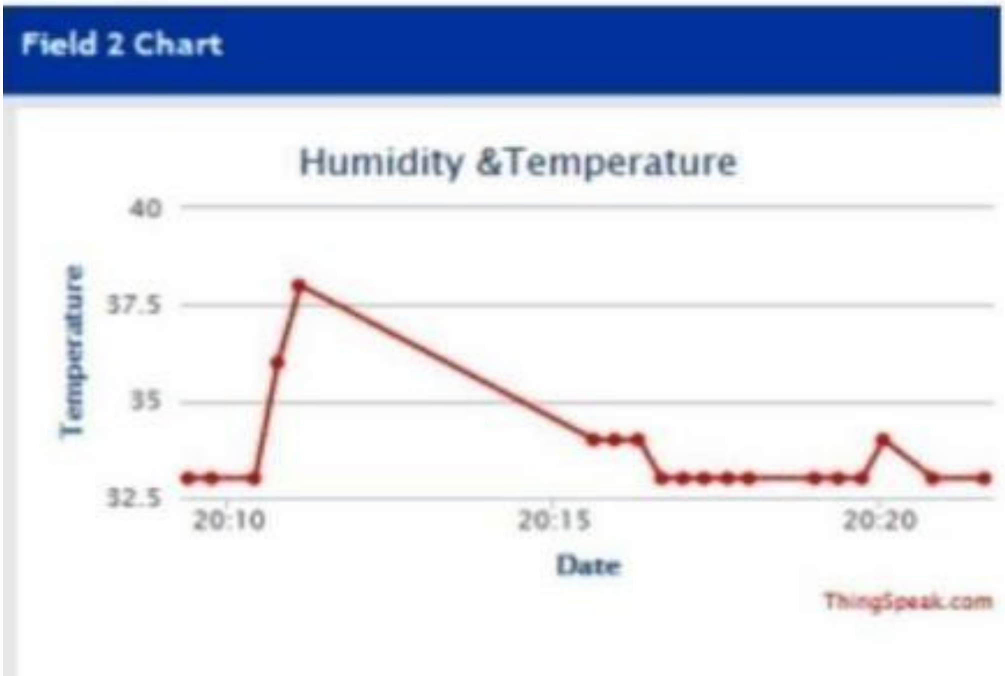


Figure 2: Working and Fault Display of Wind turbine

8. IOT RESULTS



MATLAB Visualizations

8. CONCLUSION

Online condition monitoring enables early detection of mechanical and electrical faults, preventing failure of key components before they reach a critical stage. Proactive response with real-time monitoring and fault diagnosis predicting the eventual shutdown of wind turbines reduces wind turbine maintenance costs and downtime. Improved maintenance extends the life and performance of offshore wind farms. From this we conclude that this project will help monitor wind turbines using his IOT Thingspeak cloud from any location of turbines in rural areas.

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