IOT based Windmill Monitoring System

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***Abstract* - Most of the wind mills are located in remote areas. It may be located in mountains or forests. Continuous monitoring of these wind mills in these remote areas requires a lot of human effort if it is monitored by humans. As humans are prone to making mistakes, electronic devices such as sensors and micro controllers can be entrusted to collect data and help to monitor the equipment from any location and take necessary actions. In the project "IoT based Windmill monitoring system", a temperature and humidity sensor and an ADC are mounted on a windmill. The data from the sensors are given to Raspberry pi (controller). Depending upon the data, the device is turned off or on. Additionally, the live data from the sensors are displayed directly on a dashboard for remote monitoring. This dashboard can be accessed by the authorities in charge and any other actions, if required, can be taken. The data can be shown on hourly, daily, weekly or monthly basis as well. These data can help generate important information like energy generated, power generated , revenue generated.**

Keywords—Internet of things (IOT); Windmill; Sensor; monitoring; cloud;

I. INTRODUCTION

To meet the excess energy requirement, wind energy is used as the alternate source of energy. To be able to use wind energy effectively, proper maintenance of wind mill is required. Whenever fault occurs in wind mills, it becomes a difficult task to reconfigure it. So we require a good technique to do it. . For easy maintenance, certain data are required to govern the maintenance schedule. Earlier it was monitored manually. The process could be made easier if the data required for proper maintenance can be remotely accessed. It also helps when according to the collected data the device can be made to turn off (in adverse condition) or turn on. It saves lot of human workload (manual monitoring). All this can be achieved by the help of Internet of things (IoT). The Internet of Things (IoT) is a system of interrelated computing devices having ability to transfer data over a network without requiring human interaction. IoT data can be analyzed at almost real time speed. In addition of that, certain actions can be taken based on the analyzed data. The objective of the project is to develop a system "IoT based Windmill monitoring system" to collect the data required to monitor a windmill and using that data to determine its maintenance schedule and automate it. The data is used to gather many other useful information.

II. RELATED WORKS

A low-cost and real-time remote monitoring system is proposed in [1] to continuously monitor the output performance and operation status of the distributed wind power plant. This system is based on the LoRa network to monitor those parameters related to the output performance and operation status of the wind turbine.. The monitoring node for wind power generator use the LoRa long-distance transmission protocol to transfer data to realize the regional wind power generator data transmission and monitoring. The functionality and the behavior of this proposed system are validated by a series of tests. In this paper [2], sensors are deployed into a wind turbine farm to monitor the structures to present models of wind turbine behavior and response to loading and controlling the generator parameters by getting even to rewrite the control algorithm from the system.

The monitoring and controlling system uses the RF Mesh network to collect the data from various devices (Turbines) and send them to the back end system via an Access Node. These RF mesh networks are composed of Radio Nodes grouped around Access Nodes [3] which act as gateways over a WAN to a data center that runs a Back end System software for communications, data acquisition, handling of events, storing of data, analyzing, processing, presenting and exporting the data. In this paper [4], author considers the sensor and actuator fault detection issue for large scale wind turbine systems where individual pitch control is used for load reduction. With the aid of a dynamical model of the wind turbine system, a observer in the finite frequency range, is used to generate the residual fault detection. The observer is designed to be sensitive to faults but insensitive to disturbances, such as the wind turbulence. When there is a detectable fault, the observer sends an alarm if the residual evaluation is larger than a predefined threshold. The effectiveness of the proposed approach is demonstrated by simulation results for several fault scenarios.

An interactive embedded system based on WSN [5] is being developed to provide a reliable and efficient link between various sensors in a windmill and it can be monitored in any remote location. The CMS consists of set of sensors that collect operational data of the windmill including blade position, vibration, structural alignment, wind speed, humidity, temperature, vibration, rotor condition, generator condition continuously and then transmit it to an internal controller through wireless network for local supervision. In case of anomalies or errors, the controller reacts quickly to avoid the evolution of any types of defects or fault. The acquired sensor data are monitored through UART for further processing.

III. PROPOSED WORK

Fig. 1 shows the flow graph of the system. It can be broken down in steps as follow:

1) Sensors read the data.
2) The data acquired by the sensors are given to raspberry pi as inputs.
3) From raspberry pi, the data are published on the dashboard so that it can be monitored by the concerned entity.
4) The data in the raspberry pi undergoes the rule set defined and depending upon whether the rules are satisfied or not, the windmill is made to be switched on or off on its own.

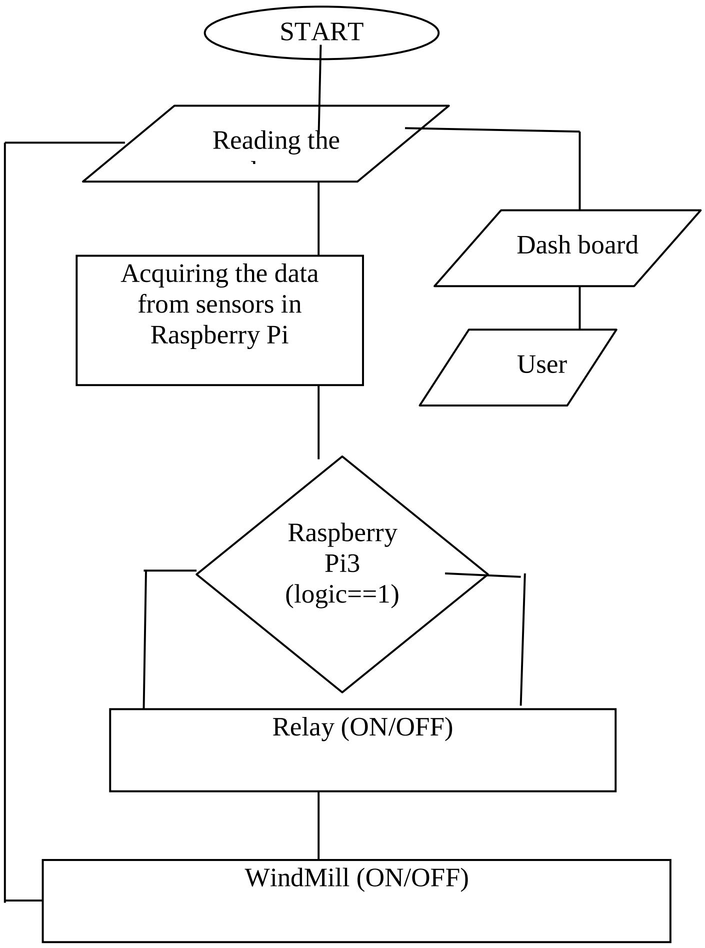

Fig. 1. Flow graph of the Overall System

IV. IMPLEMENTATION

The implementation is carried our in a confined environment . The Fig. 2 shows the schematic diagram of the proposed system. It consists of a Raspberry Pi 3, which acts as the main controller, sensors (DHT11, ultrasonic sensor, ADXL345), a relay.

The functionality of the components used can be broken down as:

Raspberry Pi 3: It is the main controller of the system. It takes the data from the sensors and then determines the state (ON/OFF) of the windmill. It also publishes the data on the dashboard for the purpose of monitoring.

Sensors: It captures the dedicated data from the surrounding or the equipment. These sensors are calibrated and able to capture the data in accurate manner.

DHT11: It captures the temperature and humidity of the vicinity. The variation in temperature is captured for further interpretation

ADXL345: It measures the vibration of the windmill. Which is parameter associated with windmill.

ADC (ADS1115): It is an analog to digital converter which provides 16 bit precision at 860 samples per second over I2C.

Relay: It switches the windmill ON or OFF, depending upon the input it gets from the Raspberry pi.

Dashboard: A data dashboard is an information management tool that visually tracks, analyzes and displays key. It is used for real time measurement of the data on go.

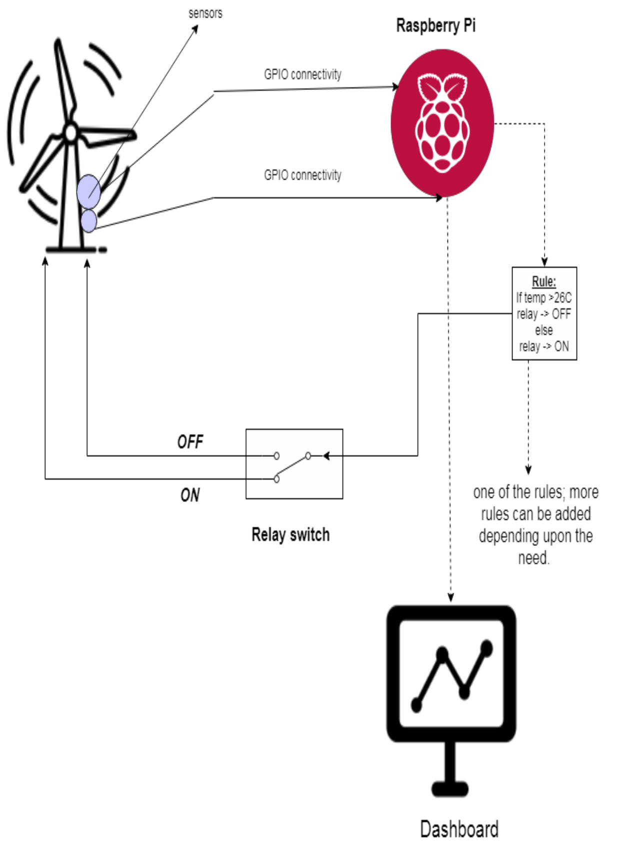

Fig. 2. Schematic diagram of the proposed system

MQTT Protocol:

MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol protocol that provides resource- constrained network clients with a simple way to distribute telemetry information. The protocol, which uses a publish/subscribe communication pattern, is used for machine-to-machine (M2M) communication and plays an important role in the Internet of things (IoT). MQTT enables resource-constrained IoT devices to send, or publish, information about a given topic to a server that functions as an MQTT message broker. The broker then pushes the information out to those clients that have previously subscribed to the client's topic. To a human, a topic looks like a hierarchical file path. Clients can subscribe to a specific level of a topic's hierarchy or use a wild-card character to subscribe to multiple levels.

The detail operation is shown in Fig 2. Different sensors are mounted over wind mills. Further these are sensors are interfaced with raspberry pi through GPIO connectivity. Based on the data collected from sensor, a rule is decided for the proper functioning of wind mill. A relay is connected to wind mill as well as raspberry pi. Whenever the data from sensor changes from the predefined value set in the rule, windmill is turned off by sending command from raspberry pi and with help of relay. Also all the data collected from different sensors are displayed on dashboard in real- time as well as on hourly basis.

V. Result

The experiment is carried out using a small prototype of a windmill and the sensors' data are tabulated in a real –time dashboard as shown in Fig 4 (a) and Fig 4 (b).

Fig 4(a) shows different sensors' data such as temperature, humidity, different axis value. It also displays the current location.

Fig 4 (b) shows the energy generated and wind speed. Also the wind mill is turned off if the sensor's data varies from the threshold value which is set before.

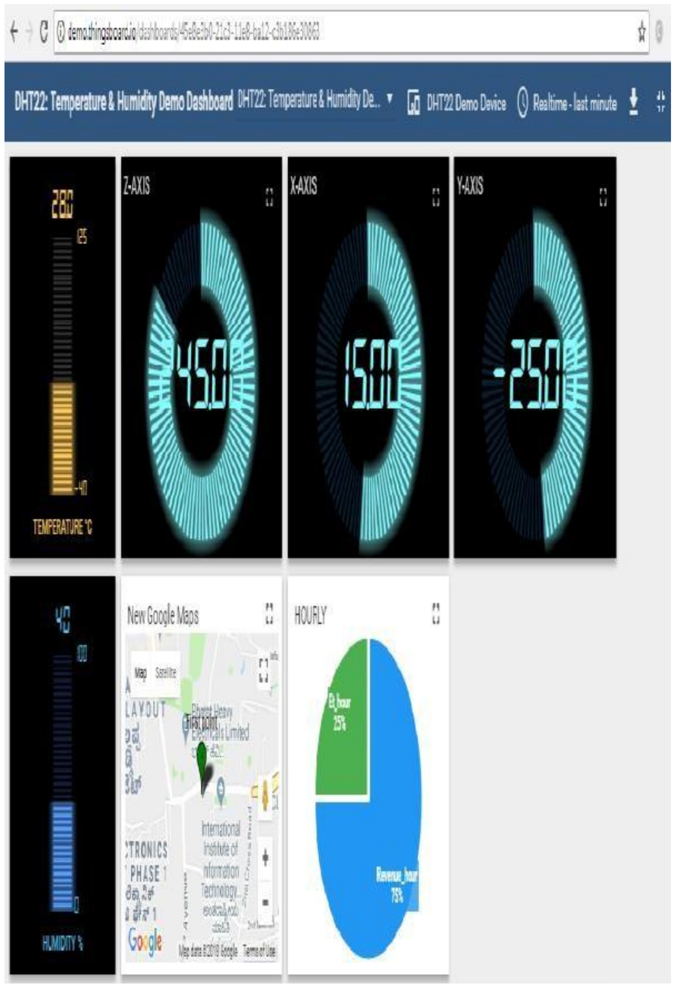

Fig. 4 (a), Sensor's data display

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
NCESC - 2018 Conference Proceedings

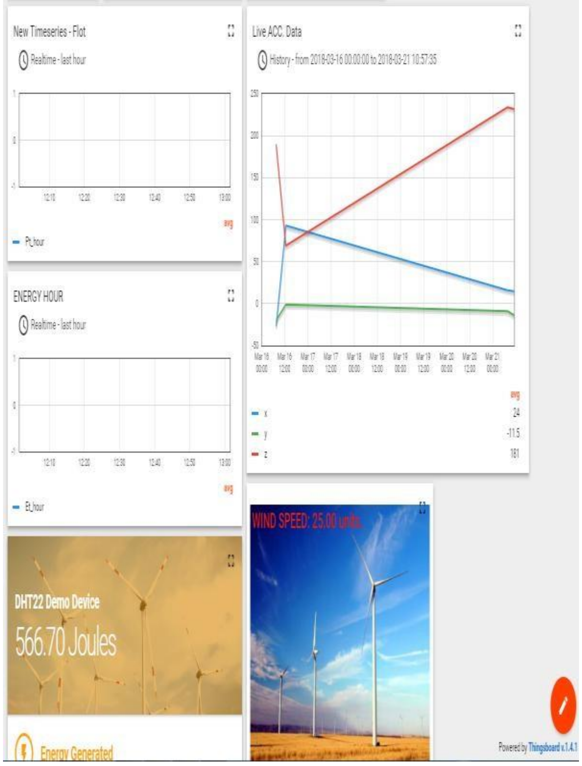

Fig. 4 (a), Energy generated and wind speed

VI. Conclusion

Wind power has a great potential to supply renewable energy without dependence on traditional fuel technologies. Wind mill needs periodical proactive maintenance to increase their electro-mechanical components lifetime. The ”IoT based Windmill monitoring system” has been designed to monitor the various parts of wind turbine using different sensors and control the windmill according to the data received. It also provides a real-time dashboard which can be accessed from anywhere.

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