Prognostic Health Monitoring of wind mill using Long Range Wide Area Network

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ABSTRACT

Renewable energy sector is prospering very rapidly. This indicates that more maintenance work and activities related to it,as well as handling it quicklywould be necessary. IoT, a new and expanding industry, if collaborated with the area of renewable energy sourceswould be beneficial in monitoring the health condition of wind mills. Our primary purpose is to acquire sensor data for the maintenance of windmills, and transmit this data via GSM & LoRa (Long Range Module). LoRa was chosen because of its chirp spread spectrum and its ability to operate in areas with little to no internet coverage. We also aim is to acquire a precise computer vision-based system to identify exterior faults, such as crack identification in windmill blades, etc. The last assignment is to visualize all of the sensor data that was gathered using ThingSpeak 102

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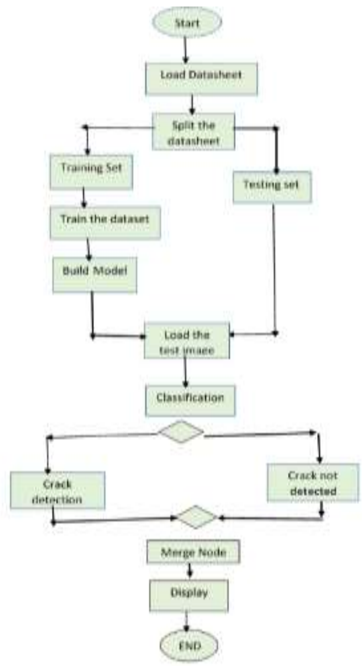
INTRODUCTION

As the race to replace traditional fossil fuels accelerates due to their impending extinction, the field of energy resources, particularly windmills, are seeing an exponential rise in utilization. This claim can be supported by statistical evidence that indicates increase of up to 47.5 billion dollars or 840.9 gigawatts till 2022. [1]. Maintaining the resource is a key task when there has been such rapid growth in a particular industry.



WORKING

The procedure is divided into three stages. These three stages are data transfer from sensors, crack identification using Computer vision, and windmill blade ejection detection. These three systems perform every distinct task required to keep the system operational and in good shape**A.**The Raspberry Pi-4 serves as our microcontroller in this project because it satisfies all system requirements. It has a quad-core CPU, 4 to 8 gigabytes of RAM, 40 GPIO (General Purpose Input/Output) pins, and a quad-core CPU. Each pin serves a distinct purpose, It was picked because of the variety of usage considerations and versatility it offers.

B. Sensors There are many sensors that measure different parameters. In order to better understand the environmental conditions on the area where the windmill is functioning and to get a general idea of corrosion factors, the first device is DHT 22, which measures ambient humidity and temperature. Another sensor on the wind turbine that measures air pressure is the BMP180. Pyrometric temperature is used to gauge the temperature of the turbine; it is a contact less infrared sensor that has been programmed to alert the grid if the turbine is operating at an extremely high temperature. As future overheating can result in serious problems, this aids in better maintenance scheduling. The output of the windmill is measured by voltage and current sensors. This assists in determining whether the wind turbine is producing enough electricity to meet the needs. The role of identifying an anomaly of windmill blade ejection is performed by vibration and ultrasonic sensors. With Thingspeak's assistance, all of this sensor data is sent to the grid. It is an IOT platform that assists in providing sensor data in a graphical way.

C. Modular Transmissions The transmission modules' job is to send sensor data and alert the grid when thresholds are crossed. LoRa and GSM modules are the two that are capable of handling these jobs. The IOT area has recently seen the introduction of LoRa, which operates on the chirp-spread spectrum. LoRa has a transmission rate of 256 Kb/Sec, which may not seem like much, but it can deliver to areas without internet service, making it perfect for places where windmills are located [7]. The Ra-02 module that we are employing has a transmission radius of 10-15 km. By using a

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network gateway as an extension, this can be improved. One additional benefit of both of these modules is that they each offer a year's worth of standby battery power. Both of these modules have the same goal, and Thingspeak receives their output for graphical analysis. For prospective maintenance to stop the system from suffering more harm and past data analysis, Data logging functionality is useful. [5][9][10]

D. A key element of computer vision-based fracture detection is the camera. To do this, we have chosen the Ras-pi Camera 2, a camera that works with our microcontroller and can give 1080p video at a frame rate that is outstanding and adequate for our prototype. Although it also offers 720p at 60FPS, we decided to remain with 1080P because clarity is so important. The camera spots the cracks in windmill's blade and is ideally positioned away from blades.

METHODOLOGY

The process is followed in a specific way, with the tasks being monitoring, data logging, and on-site servicing. A Pyrometric infrared contact -less sensor can be used to monitor the turbine's health as the system's first function. If the sensor detects excessively frequent heating of the turbine, it will set a threshold and dispatch repair crew members to perform on-site maintenance. Through a voltage and current sensor, voltage and current will be measured and tracked live. It will give a broad assessment of the system's effectiveness. The data is transmitted by LoRa and GSM modules to Thingspeak, which does a real-time graphical analysis. For historical analysis and preventive maintenance, the sensor data that was gathered should be stored. Thingspeak may also log data and preserve a record of all the information presented to it. With the aid of RaspiCam V2 integrated with microcontroller, maintenance may be optimized and structural degradation can be detected using improved computer vision-based approaches. To stop further harm to windmills, it can fix this. All the sensors and transmission modules handle the data transmission and automation of the wind farms. These modules can function with little to no internet connectivity and can talk to the control grid. These are some of the highlights of our methodology structure, which has been outlined in the table below[10]

Table1

Sr. no	Problem	Technology	Solution
1	Health Monitoring of Turbine	Pyrometric Temperature Sensor	Can assign repair crew member to resolve the issue
2	Voltage/Current Measurement & Live Tracking	Voltage, Current Sensor, LoRa WAN/GSM	Sensor track Voltage and Current parameters.
3	Data Logging	ThingSpeak	Sensor data acquisition
4	Efficient Use & Maximum Power Generation	ThingSpeak For Graphical Analysis	On Real Time Monitoring
5	Optimize Maintenance	Vibration Sensor, Ultrasonic Sensor	To detect any anomalies like windmill blade ejection
6	Data Transmission	LoRa & GSM modules	In zero internet connectivity it can communicate to controller
7	Physical/ Structural Damage	Rasp Pi CAM V2 integrated with micro controller	Enhance computer vision technique has being use
8	Automating Wind Farms	Pyrometric, Current & Voltage Sensor DHT11, Piezoelectric,	Sensing & Controller

9	Maintenance	Through Thingspeak, Cameras & LoRa/GSM Network Modules	Use historical data, current data and suggest actions

CRITICAL REVIEW

Versions created by several industrial businesses either bank on wired technology or WIART [4], that depend on either Sigfox or supplementary transmission modules that either required internet connectivity or cost a lot more to wire and rewire. We aimed to make use of existing infrastructure and try to make it smart by using up-and-coming IOT technology that was appropriate for everyone the tasks at hand in order to minimize all this unnecessary spending on either wiring or establishing an internet-based ecosystem. Another key benefit when comparing newly developed system models to earlier built system models was the inclusion of structural study and the anomaly of the ejection of windmill blades. As few snags as possible occur while our entire system is operating in tandem.

DISCUSSION

This discussion gives a general overview of the design and operation of the suggested monitoring and maintenance system for wind turbines, as well as some of the minor issues it encounters and solutions to those issues. Weather conditions can also have an impact on the camera that performs the structural analysis, causing it to collect a variety of erroneous or useless data that can be upsetting for the entire system. A wiping mechanism should be supplied to wipe the lens at regular intervals since the lens needs to be cleaned on a regular basis. This will guarantee that the camera takes accurate, high-resolution pictures. Both LoRa and Thingspeak IOT are currently under development and will only become better with time. Once they receive enough attention to shine, these resources would prove useful. Utilizing these resources gave us vision into how to improve the system even more so that it can reach its full potential. This system's basic idea of being able to keep an eye on windmills with the aid of sensor data collecting & data logging for preventive maintenance is pretty logically straightforward & simple to understand. Additionally giving Thingspeak a grid with a thorough analysis of the sensor data that is sent through GSM & LoRa. Enhanced computer vision, among other things, provides precise structural analysis.

RESULT

Through the sensor data collecting process, which was carried out by combining sensors with our raspberry pi-4 microcontroller, a number of characteristics will be monitored. It was also possible to broadcast this data via transmission modules in locations without access to the internet. The API keys issued to each sensor are then used to provide this data to the Thingspeak interface, enabling data logging and precise graphical analysis. While delivering what has been promised, the YOLO V3 model training system combines accurate structural analysis with an improved computer vision technology. The integration of ultrasonic and vibration sensors to address the blade ejection anomaly works flawlessly. Readings of temperature, humidity and pressure acquired through the system are shown here.

CONCLUSION

The system's final assessment is that it can accurately acquire data based on all the results that have been acquired thus far. Delivering data to transmission modules as error-free as feasible and transmitting it to the grid as effectively as possible. The YOLO V3 model with trained and tested data set, which is used in the system, produces significant results. Overall, the entire system is operating as smoothly as an efficient machine.

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