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Controller Area Network based wind Turbine Safety Management system for Disaster Prediction and Maintenance

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Abstract. Wind generators are a significant component of renewable. Turbine servicing is time-consuming and costly. This study describes a CAN-based framework for turbine surveillance and problem diagnostics. CAN is a message-based system created for automotive, subsequently aircraft, factory equipment, and diagnostic implants. The CAN communication module is used to send monitoring information between the wind generator and the control centre. Disturbance happens during data transfer through one terminal towards another. To prevent these disruptions, we suggest the CAN interface. Throughout this research, we created a system that uses the ARM and CAN protocols to detect and diagnose faults in a turbine operation. The project is concerned with the transmission of data between 2 components in real time with no interruptions. The CAN protocol lengthens data transfer time. ARM core1 is the turbine component to which detectors are linked, and ARM core2 is the fault diagnosis and monitoring part.

Keywords: safety management system, disaster, controller area network, wind turbine, prediction

INTRODUCTION

Wind power is one of the most promising sources of clean energy. India has an abundance of wind power, which could be a key part of the solution to the country's energy needs. But the country has lagged far behind other countries in its development of wind power. India has the potential to be a leader in wind energy, but only if it can get past the barriers holding it back [1]. India is a land of diverse landscapes and cultures, with a varied climate and geography. It is also home to an ever-expanding renewable energy sector, which is playing a vital role in the country's quest for sustainable development and energy security. Wind power is one of the fastest-growing segments of India's energy landscape, with a wind power capacity of more than 40 gigawatts, or about 4% of the country's total installed power capacity. This represents a significant opportunity for business, with the Indian wind sector set to expand further to meet the country's growing energy demands and climate goals [2]. Windmill energy is found as the most affordable renewable energy source. However, one of the system's components, the wind turbine, is not. The wind farm is an essential part of the system. Wind turbines utilize the energy of the wind to create energy. A wind turbines fan and blades may appear identical, yet their functions are diametrically opposed.

A fan generates wind with energy, whereas a turbine generates electricity with wind [3]. Today, most of the world's electricity is produced by coal, gas, and oil power stations. But we have also come up with better ways to generate electricity than turning coal and gas into heat. We can harness the power of the wind by using wind turbines to generate electricity. The blades of a turbine capture the wind, which turns a shaft and makes a generator rotate [4].

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Wind turbines have become one of the most cost-effective ways to generate electricity. They harness the power of the wind, generating clean energy without generating any emissions [5]. Wind power is also a great way to reduce our reliance on fossil fuels and build a more sustainable future. But like all machines, wind turbines require maintenance to keep them running smoothly [6]. We employ a microcontroller as a data collecting device to minimize economic concerns and to give more convenience to consumers. The tracking and management procedure is carried out as normal [7]. The application component contains a web server for actual system monitoring when comparison to other programs, the coding component is significantly simpler. The devices are used to gather different types of data and communicate it to a microcontroller.

A fault diagnostic system framework is built, and data on wind turbine vibration status is gathered, analyzed, and used for problem diagnosis [8]. To begin with, wavelet coefficients are calculated using vibration acceleration data gathered from wind turbines using a discrete wavelet transform (DWT) [9]. In addition, the current study creates a unique framework for inspection and maintenance planning that maximizes the advantages of completing inspections on a multi-unit system. Finally, the established framework is applied to a sixty-installation offshore wind farm, and a thorough description of the planned inspections is presented [10]. This chapter [11] discusses some fundamental aspects of wind energy conversion. The emphasis is on wind modeling, the aerodynamic process, concept options for power management and safety, yearly energy yield optimization, and certain blade dynamics features. Wind turbines are usually placed in the windiest locations, but as they get larger, they begin to impact the surrounding area. The sound of a wind turbine, especially a large industrial wind turbine, can be a nuisance.

In the past, wind farm operators had to rely on visual indicators such as the size of the turbines and the direction of the wind to determine the health of the wind turbines [12]. This article [13] discusses wind turbine monitoring and problem diagnostic system that makes use of a CAN interface. The monitoring settings and CAN interface are thoroughly discussed. In the past, wind turbines were used to generate electricity. However, in the future, wind turbines will not only generate electricity, but they will also produce many other byproducts that can be used for a variety of purposes [14]. The most common use of these uses is the generation of electricity in a wind turbine energy production system. Wind turbine energy production systems use many wind turbines to produce a large amount of energy [15].

PROPOSED METHODOLOGY

The CAN communication module is used to transmit monitoring data between the wind turbine and the control centre. Disturbance occurs during data transmission from one terminal to another [16]. To avoid these disturbances, we recommend using the CAN interface. Throughout this research, we develop a system that detects and diagnoses defects in a turbine operation using the ARM and CAN protocols.

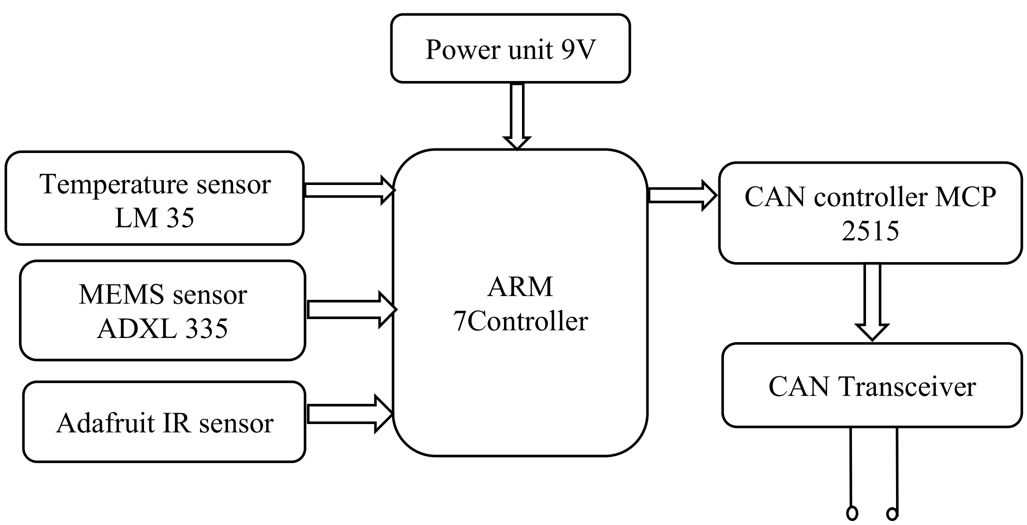

FIGURE 1. Transmitter block diagram

The proposed model is divided into two components: the transmitter and receiver system. Here the transmitter system consists of an ARM controller which controls the whole system. The system uses a temperature sensor, MEMS sensor and IR sensor to monitor the turbine system in a continuous real time monitoring concept [17]. The temperature of the air surrounding a wind turbine can have a significant impact on the amount of electricity that it generates. Extreme heat or cold can cause turbines to shut down or reduce the amount of power that they produce. Temperature sensors in wind turbines can help operators to respond to changes in the weather, ensuring that their wind farms are always producing as much electricity as possible [18].

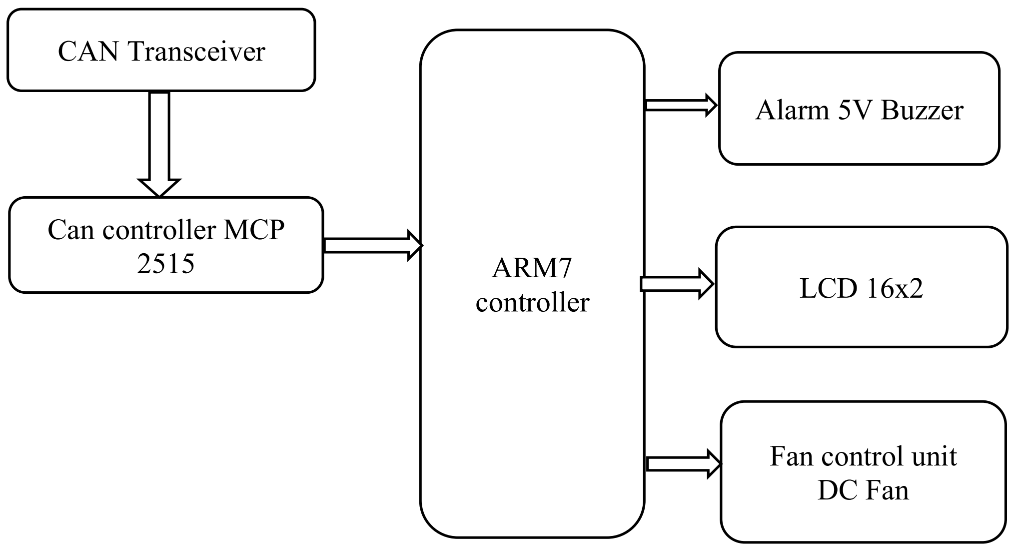

FIGURE 2. Receiver block diagram

The receiver module consists of an alerting system about the present condition in the wind turbines. Here we used a buzzer to create an alarm about the problem for safety purposes in the system. A controller area network (CAN) is a vehicle data bus used for communication between the various components of a vehicle. CAN was originally designed as an automobile network, but it's since been adapted for use in other vehicles and machines, such as aircraft, spacecraft, and submarines. CAN is a unidirectional network, meaning that it only allows signals to move in one direction. This means that multiple CAN transmitters can be used to broadcast signals to a single CAN receiver. Here we used the CAN module as a communication system for alert the wind turbine monitoring system [19-20].

RESULTS AND DISCUSSIONS

The generator must be turned down to avoid safety issues or main system outages. They are frequently restarted due to incorrect failure detection, which might be caused by noise inside the system, and so these failures are not regarded as critical concerns. If the failure is severe, a visual check must be performed, which can be done by the operators or authorized professionals. Finally, anytime a big failure occurs, a report is generated. The most prevalent failures in wind turbines are high and low speed shaft problems. Generally, problems in wind turbines may be discovered via current measurement.

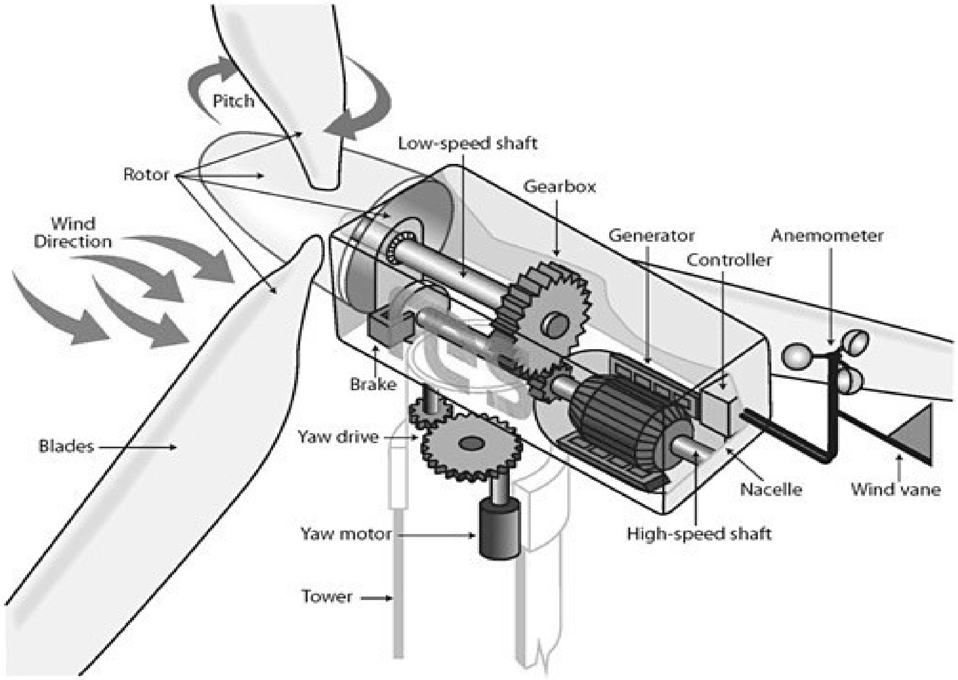

FIGURE 3. Wind turbine

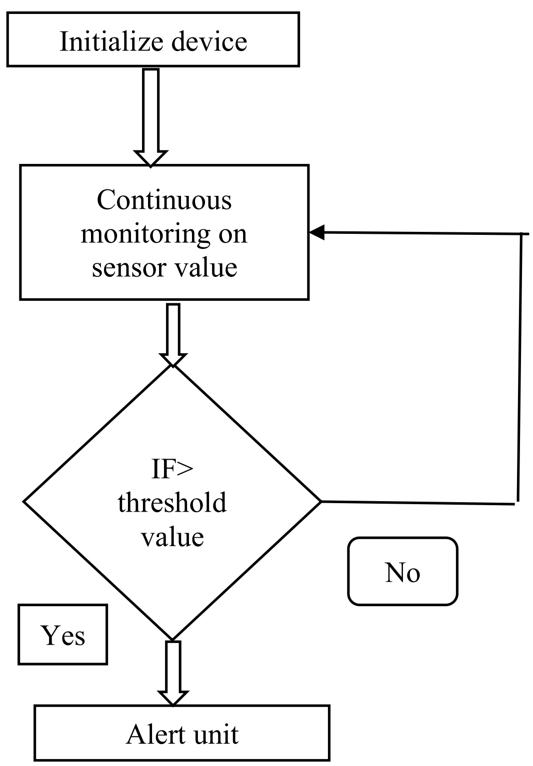

FIGURE 4. Flowchart of the system

You can't see them, but wind turbines have a security system to protect them from intruders. The system uses sensors to detect movement, and if someone gets too close, it triggers an alarm. The system is designed to protect the expensive equipment inside the turbine, as well as the wiring, which carries the electricity produced by the turbine to the national grid. This means that if someone breaks into a turbine, they will be detected, and the system will shut down.

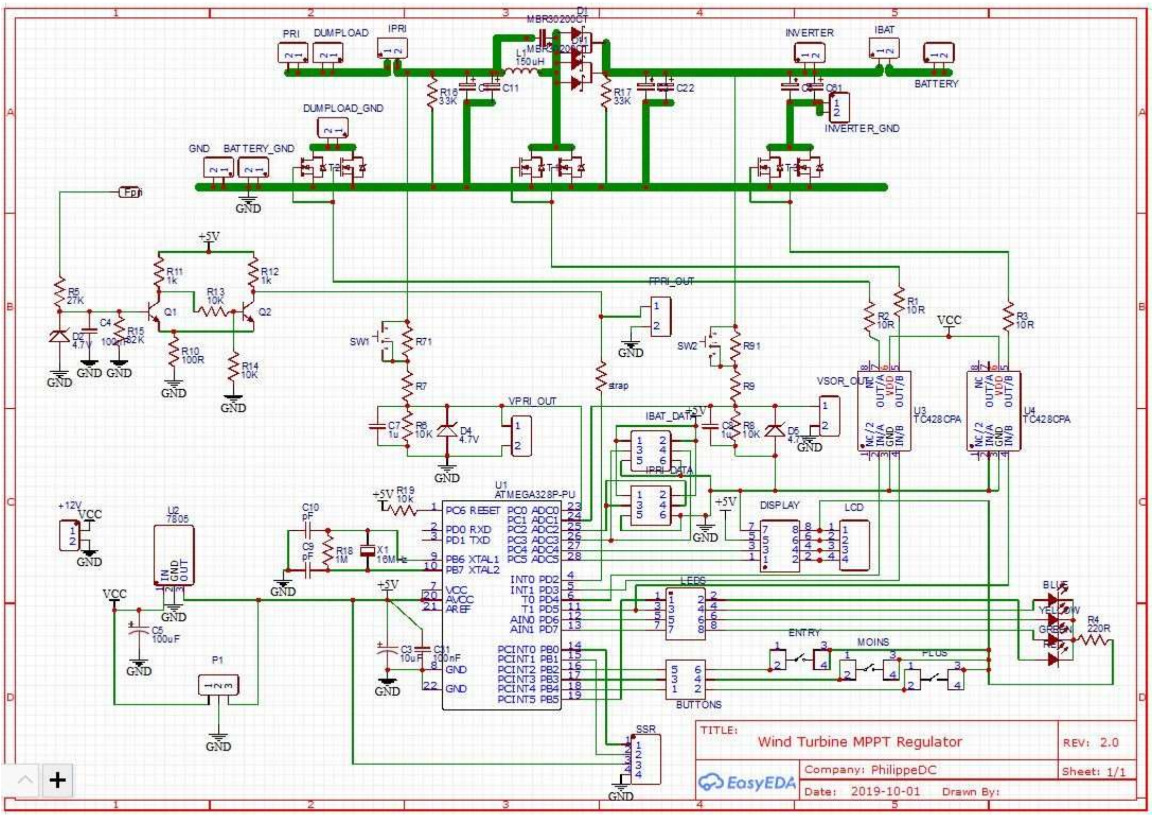

FIGURE 5. Circuit diagram

The sensors are designed to always monitor the area around the turbine. If someone approaches the turbine, the sensors will trigger the alarm. The sensors are designed to detect movement of people or animals, so the alarm won't be triggered by a bird flying by. The sensors are also designed to detect objects that are moving towards the turbine, such as a car or person.

TABLE 1. Sensor values

Sensors	Threshold value	Alert
Temperature	>Thres	Alarm on
MEMS	>Thres	Alarm on
IR	=1	Alarm on

Here the above Table 1 shows the results of our proposed system. Here, we programmed the device in some threshold value for all sensors; if the wind system gives the production value means it will create an alarm to the authority to prevent the damage.

CONCLUSIONS

Energy monitoring is in high demand in today's environment of changing technologies and increasing energy use. As a result, the requirement for monitoring the growth of technologies such as IoT has aided us in reaching this aim. If embedded framework for renewable power system model is dependent on the internet network things, its efficiency increases. The world is becoming increasingly dependent on renewable energy. One of the most promising sources of renewable energy is wind energy. In the past decade, wind energy has become one of the most promising sources of renewable energy in the world. Today, wind turbines generate more electricity than any other source of energy in the world. In the future, create and extend the suggested system to monitor the complete turbines in a wind farm, so that it may be used for smart grid applications. In addition, we may add more things in the future. As an example, numerous types of sensors might be used to monitor various parameters.

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