ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 6, March 2017

IoT BASED WIND TURBINE MONITORING, FAULT DIAGNOSIS AND CONTROL USING UART

Fran lizza.M[1], Anitha.S[2], R.Raj Mohan[3]

UG scholar[1, 2], Associate Professor[3]

Department of ECE, Gojan School of Business and Technology, Chennai, India.

***Abstract*— Wind energy is used as an alternate form of energy to meet the increasing energy crisis. Wind farms are set up in highly exposed sites. Wind is fluctuating in nature and hence a continuous monitoring system is needed. The wind turbine is used for converting wind energy into a useful form of energy. In this project the various parameters of wind are measured and monitored by setting up an instrumentation system. Due to environmental conditions, the remote location of wind farms, and the vertical height of the nacelle, it is expensive to physically visit wind turbines for maintenance and repair. So, we proposed the system to monitor the status of wind turbine from anywhere in the world using Internet of Things (IoT) technology. In our present work, it is declared that the system with IoT and Universal Asynchronous Receiver/Transmitter (UART) to monitor and diagnose the problem in the wind turbine application. The work deals with the data transmission between two units in the exact time without any disturbance.**

***Index Terms*— ARM Processor, IoT, Wind turbine,UART.**

I. INTRODUCTION

In front of the huge increase demand in energy over the world, and in order to search a substitutional kind of energy against the prices rise of the energy fossil fuel resources and then its exhaustion reverse in the long term [1]. The development of this alternative is encouraged because it offers natural, economic, clean and safe resource. Monitoring and diagnosis become essential to reduce maintenance costs and ensure continuity of production,because stopped a wind installation for unexpected failures could lead to expensive repair and to lost production[2-3]. This operating system stopped becomes critical and causes very significant loses , for this reason there is an increase need to implement a lot efficient maintains, This online surveillance allows an regular early detection mechanical and electrical faults; it must able to prevent major component failures the wind turbine becomes an important topic in scientific research and industries[4-5]. The main objective of this project is to study the design of a real time monitoring and controlling system for state supervision of wind generator machine.

II. EXISTING SYSTEM

"Energy can neither be created nor be destroyed"

Today because of an increase in human resources the need for energy resources is also increasing. The surplus amount of resources has been decreasing. Hence there is an urge to find any alternate resources .Energy can be renewable and nonrenewable[6]. The use of nonrenewable energy resources reached a particular extent. It is better to use any renewable form of energy resources. Among the renewable energy resources wind energy is widely used. It has its own advantages such as availability, non-polluting ,no greenhouse gas emission etc[7]. Wind energy can be converted to a useful form of electrical energy using wind turbines. For any process to get the perfect results the process should be controlled and monitored at regular interval of times[8]. The importance of instrumentation system lies here. The various parameters like wind speed, temperature, direction are measured periodically and monitored to check if any deviations occur.

III. PROPOSED SYSTEM

To avoid economic problems and to provide more convenience to the users we are using a microcontroller as a data acquisition system. As usual the control and monitoring process is carried out. The software part includes web server for real time monitoring of any system. The programming part is much simpler when compared to other tools. The sensors are used for collecting various information and sending them to a controller. The sensor used to measure temperature is LM35 temperature sensor, current sensor, voltage sensor, vibration sensor and humidity sensor. By using Universal asynchronous receiver/transmitter interfacing connecting both PIC Microcontroller and Internet of things. IoT consists of the one microcontroller which is used to control the relay.

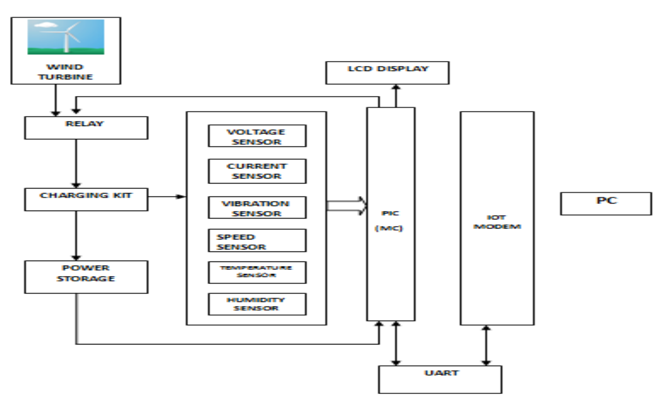

Fig. 1: Block Diagram

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 6, March 2017

IV. SENSORS

A. CURRENT SENSOR

- ☐ Current sensor is a device that detects electrical current in a wire and generates a signal proportional to it.
- ☐ Measures current from 1 to 10Amp.

B. VOLTAGE SENSOR

- ☐ Voltage sensor is a device that converts voltage measured between two points of an electrical circuit into a physical signal proportional to the voltage
- ☐ Monitor input voltage ranging from 3to 500v DC

C. TEMPERATURE SENSOR

- ☐ Temperature sensor is a device that generates electrical voltage which is directly proportional to changes in temperature for temperature measurement.
- ☐ LM35 is a precision IC temperature sensor with its output proportional to the temperature.
- ☐ Temperature sensor is frequently provided in IC to detect when the operating temperature limits have been exceeded.
- ☐ Temperature can be measured more accurately than with a thermostat.

D. HUMIDITY SENSOR

- ☐ Humidity sensor is a device in which its impendence can be changed with the related humidity.
- ☐ Polymer humidity sensor is made of a thermosetting resin based on AL203 ceramic.

E. VIBRATION SENSOR

- ☐ A piezoelectric sensor is a device that uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to an electrical signal.
- ☐ Vibration sensor can also be used to harvest wasted energy from mechanical vibration.

F. SPEED FORMULATION

The speed/RPM sensors are built, based on various determining principles Hall Effect, magneto resistive, inductive to detect without getting a hold of the rotary movement of phonic or toothed wheels and usually of any rotative device fabricated in a ferrous material and provided with slots or obtrusive parts. They provide a frequency output signal which is digital in nature for the Hall effect or magneto resistive versions or a sinusoidal signal for the inductive versions that pursue exactly the alternating sequence of presence and absence of ferrous material presented by the rotative device[9].

$$\text{Speed}=\frac{RPM}{V} \quad \text{----------------} \quad (1)$$

Where,

V - Voltage, RPM- Revolutions per Minute

V. WORKING OF WIND TURBINE

A. TURBINE

The mechanical device which converts rotational energy into electrical energy by help of generator. Turbine has blade or rotor, which converts the energy in the wind to rotational shaft energy. Drive train, usually including a gearbox and a generator. A tower that supports the rotor and drive train and other equipment including controls, electrical cables, ground support equipment, and interconnection equipment.

B. THE BLADES

Designed like airplane wings, modern wind turbine blades use lift to capture the wind's energy. Because of the blade's special shape, the wind creates a pocket of pressure as it passes behind the blade. This pressure pulls the blade, causing the turbine to rotate. The blades spin at a slow rate of about 20 revolutions per minute (RPM), although the speed at the blade tip can be over 150 miles per hour.

C. THE NACELLE

The nacelle houses a generator and gearbox. The spinning blades are attached to the generator through a series of gears. The gears increase the rotational speed of the blades to the generator speed of over 1,500 RPM. As the generator spins, electricity is produced. Generators can be either variable or fixed speed. Variable speed generators produce electricity at a varying frequency, which must be corrected to 60 cycles per second before it is fed onto the grid. The gear also helps in avoidance of reversal movement of blades.

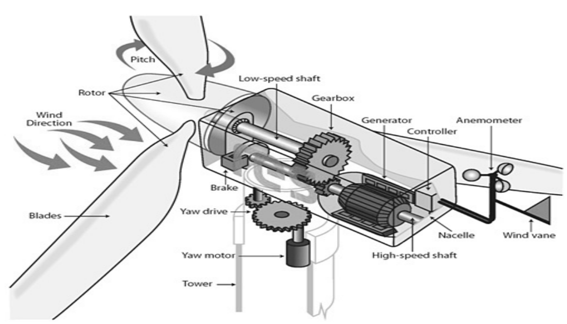

Fig. 2: Wind Turbine

VI. PIC MICROCONTROLLER

PIC 16F877A is one of the most advanced microcontroller from Microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability. It is ideal for applications such as machine

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 6, March 2017

control applications, measurement devices, study purpose, and so on. The PIC 16F877A of all the components which modern microcontrollers normally have.

A. FEATURES

- High performance RISC CPU.
- Maximum operating frequency is 20mHz.
- Data memory (bytes) is 368.
- It consists of 5 inputs and outputs.
- Self programmable under software control.
- Single 5V, DC supply for circuit serial programming.

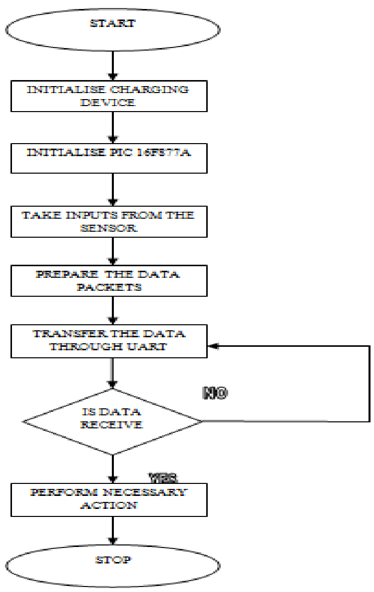

Fig. 3: Flow chart of the system

VII. BATTERY

Electrical energy is normally converted from mechanical energy, solar energy, and chemical energy etc. A battery is a device that converts chemical energy to electrical energy. The battery has been the most popular source of electricity in many daily life applications. In our daily life, we generally use two types of battery; one of them is which can be used once before it gets totally discharged. Another type of battery is rechargeable which means it can be used multiple times by recharging it externally. The former is called primary battery and the later is called secondary battery. Batteries can be found in different sizes. A battery may be as small as a shirt button or may be so big in size that a whole room will be required to install a battery bank. With this variation of sizes, the battery used anywhere from small wrist watches to a large ship. This is the most popularly used symbol for battery. The bigger lines represent positive terminal of the cells and smaller lines represent negative terminal of the cells connected in the battery.

VIII. RELAY

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). Relay is a switch it on with a tiny current and it switches on another appliance using a much bigger current.

IX. UART

A UART is a type of "asynchronous receiver/transmitter", a piece of computer hardware that translates data between parallel and serial forms. UARTs are commonly used in conjunction with other communication standards such as EIA RS-232.

A UART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. UARTs are now commonly included in microcontrollers. A dual UART or DUART combines two UARTs into a single chip. Many modern ICs now come with a UART that can also communicate synchronously; these devices are called USARTs.

The Universal Asynchronous Receiver/Transmitter controller is the key component of the serial communications subsystem of a computer. The UART takes bytes of data and transmits the individual bits in a sequential fashion. At the destination, a second UART re-assembles the bits into complete bytes. Serial transmission of digital information (bits) through a single wire or other medium is much more cost effective than parallel transmission through multiple wires. A UART is used to convert the transmitted information between its sequential and parallel form at each end of the link. Each UART contains a shift register which is the fundamental method of conversion between serial and parallel forms.

X. IOT (INTERNET OF THINGS)

A. Introduction to IoT

The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate exchange and consume data with minimal human intervention. There is, however, no single universal definition. Devices have existed for decades. The recent confluence of several technology market trends, however, is bringing the Internet of Things closer to widespread reality. These include *Ubiquitous Connectivity, Widespread Adoption of IP-based Networking, Computing Economics, Miniaturization, Advances in Data Analytics, and the Rise of Cloud Computing.*

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE
International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 6, March 2017

B. Connectivity Models

An implementations use different technical communications models, each with its own characteristics. Four common communications models described by the Internet Architecture Board include: Device-to-Device, Device-to-Cloud, Device-to-Gateway, and Back-End Data-Sharing. These models highlight the flexibility in the ways that IoT devices can connect and provide value to the user.

C. Transformational Potential

If the projections and trends towards Internet of Things become reality, it may force a shift in thinking about the implications and issues in a world where the most common interaction with the Internet comes from passive engagement with connected objects rather than active engagement with content. The potential realization of this outcome – a "hyper connected world" -- is testament to the general-purpose nature of the Internet architecture itself, which does not place inherent limitations on the applications or services that can make use of the technology.

In security attributes of many Internet of Things (IoT) implementations present new and unique security challenges. Addressing these challenges and ensuring security in Internet of Thing products and services must be a fundamental priority. Users need to trust that Internet of Thing devices and related data services are secure from vulnerabilities, especially as this technology become more pervasive and integrated into our daily lives.

In privacy in their full potential of the Internet of Things depends on strategies that respect individual privacy choices across a broad spectrum of expectations. The data streams and user specificity afforded by Internet of Thing devices can unlock incredible and unique value to Internet of Things users, but concerns about privacy and potential harms might hold back full adoption of the Internet of Things. This means that privacy rights and respect for user privacy expectations are integral to ensuring user trust and confidence in the Internet, connected devices, and related services.

D. Emerging Economy and Development Issues

The Internet of Things holds significant promise for delivering social and economic benefits to emerging and developing economies. This includes areas such as sustainable agriculture, water quality and use, healthcare, industrialization, and environmental management, among others. As such, IoT holds promise as a tool in achieving the United Nations Sustainable Development Goals.

The broad scope of IoT challenges will not be unique to industrialized countries. Developing regions also will need to respond to realize the potential benefits of IoT. In addition, the unique needs and challenges of implementation in less-developed regions will need to be addressed, including infrastructure readiness, market and investment incentives, technical skill requirements, and policy resources.

The Internet of Things is happening now. It promises to offer a revolutionary, fully connected "smart" world as the relationships between objects, their environment, and people become more tightly interwined. Yet the issues and challenges associated with IoT need to be considered and addressed in order for the potential benefits for individuals, society, and the economy to be realized.

Ultimately, solutions for maximizing the benefits of the Internet of Things while minimizing the risks will not be found by engaging in a polarized debate that pits the promises of IoT against its possible perils. Rather, it will take informed engagement, dialogue, and collaboration across a range of stakeholders to plot the most effective ways forward.

E. Interoperability / Standards

A fragmented environment of proprietary Internet of Things technical implementations will inhibit value for users and industry. While full interoperability across products and services is not always feasible or necessary, purchasers may be hesitant to buy Internet of Things products and services if there is integration inflexibility, high ownership complexity, and concern over vendor lock-in.

In addition, poorly designed and configured Internet of Things devices may have negative consequences for the networking resources and the broader Internet. Appropriate standards, reference models, and best practices also will help curb the proliferation of devices that may act in disrupted ways to the Internet. The use of generic, open, and widely available standards as technical building blocks for Internet of Things devices and services (such as the Internet Protocol) will support greater user benefits, innovation, and economic opportunity.

F. Legal, Regulatory and Rights

The use of Internet of Things devices raises many new regulatory and legal questions as well as amplifies existing legal issues around the Internet. The questions are wide in scope, and the rapid rate of change in Internet of Things technology frequently outspaces the ability of the associated policy, legal, and regulatory structures to adapt.

One set of issues surrounds cross border data flows, which occur when Internet of Things devices collect data about people in one jurisdiction and transmit it to another jurisdiction with different data protection laws for processing.

While the legal and regulatory challenges are broad and complex in scope, adopting the guiding Internet Society principles of promoting a user's ability to connect, speak, innovate, share, choose, and trust are core considerations for evolving Internet of Things laws and regulations that enable user rights.

XI. FAULT DETECTION

The fault is defined as the termination of the capability of an object to complete a function. When a failure occurs inside the wind turbine, e.g., abnormal status in speed,

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 3, Special Issue 6, March 2017

temperature, voltage, current and vibration. It registers the consequence of the fault, and responds referring to the type of the malfunction. In order to avoid safety hazards or main system breakdowns, the turbine has to be shut down. Often they are restarted because of wrong failure detection, which could be caused by noise within the system, and therefore these faults are not considered as crucial problems.

If the failure is serious, a visual inspection has to be made which can be carried out by the operators or by authorized personnel. Finally, whenever a major failure has happened ,a report is documented. High speed and low speed shafts faults are the most common failures in wind turbine. Mostly, the faults in wind turbine can be detected by current measurement.

XII. Conclusion

The fault identification is done and the parameters are measured and the monitored data is analyzed and send to PC through UART. The location and the type of faults are transmitted from wind turbine to control through IoT.

The effect of harsh condition and the nature of large electromechanical system are the causes of fault to be occurring in the wind turbine. It is very important to perform the monitoring and fault diagnosis of wind turbine parameters. The UART which is used for serial communication which provides high data transmission rate and reliability.Thus, the design of a remote monitoring and fault diagnosis system based on the UART. Finally,the system performs efficiently.

Our future work in this project is to intimate the abnormal status to the user by automatic voice call.

References

[1] Huynh, Duy C., and Loc D. Ho. "Improved PSO Algorithm based Optimal Operation in Power Systems Integrating Solar and Wind Energy Sources." *International Journal of Energy, Information and Communications*, *vol 7, issue 2,***(2016),**pp.9-20.

[2] Jlassi, Imed, Jorge O. Estima, Sejir Khojet El Khil, Najiba Mrabet Bellaaj, and Antonio J. Marques Cardoso. "Multiple Open-Circuit Faults Diagnosis in Back-to-Back Converters of PMSG Drives for Wind Turbine Systems." *IEEE Transactions on Power Electronics*, *vol 30, issue 5,* **(2015),** pp.2689-2702.

[3] Bennouna, Ouadie, Nicolas Heraud, and Zbigniew Leonowicz. "Condition monitoring & fault diagnosis system for offshore Wind Turbines." *11th International Conference on Environment and Electrical Engineering* **(2012).**

[4] Mojumdar, Md. R., Mohammad S. Himel, Md. S. Rahman, and Sheikh J. Hossain. "Electric Machines & Their Comparative Study for Wind Energy Conversion Systems (WECSs*)." Journal of Clean Energy Technologies*, *vol 4, issue* 4, **(2015)** 290-294.

[5] Khayyamim, Tara, Khosrow Hajsadeghi, and Abolghasem Zabihollah. "A Novel Optimization Algorithm for Reliable Energy Generation based on Wind, Solar and Fuel Cell." *Journal of Clean Energy Technologies*, *vol 4, issue* 6, **(2016),** pp. 444-447.

[6] Saad Chakkor, Mostafa Baghouri and Hajraoui Abderrahmane. "Real Time and Wireless Smart Faults Detection Device for Wind Turbines." *International Journal of Computer Science and Telecommunications* (IJCST), *vol 5,issue10,* **(2014)** 1-8.

[7] Mohanraj, M., R. Thottungal, and K. Jaikumar. "A CAN bus based system for monitoring and fault diagnosis in wind turbine" *International Conference on Emerging Trends in VLSI, Embedded System, Nano Electronics and Telecommunication System (ICEVENT)* **(2013).**

[8] Puja kumari, Kalpesh Naik, Kanishk Sen, and Parul Gulati. "A CAN bus based fault monitoring and diagnosis system." *International Journal of Electrical, Electronics and Data Communication , vol 2, issue 3* **(2014).**

[9] S. Ding,"Model-based Fault Diagnosis Techniques: Design Schemes, Algorithms, and Tools", *Springer Verlag,* **(2008)**

