ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Direction Control of Wind Turbines Using MEMS Sensor and Damage Detection

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Abstract:
Maintenance and repair of wind turbine structure have become more challenging and at the same time essential as they evolve into larger dimensions or located in places with limited access. Even small structural damages may invoke catastrophic detriment to the integrity of the system. So, cost-effective, predictive, and reliable structural health monitoring (SHM) system has been always desirable for wind turbines. A real-time nondestructive SHM technique based on multisensory data fusion is proposed in this paper. The objective is to critically analyze and evaluate the feasibility of the proposed technique to identify and localize damages in wind turbine blades. The structural properties of the turbine blade before and after damage are investigated through different sets of finite element method simulations. Based on the obtained results, it is shown that information from smart sensors, measuring strains, and vibrations data, distributed over the turbine blades can be used to assist in more accurate damage detection and overall understanding of the health condition of blades. Data fusion technique is proposed to combine these two diagnostic tools to improve the detection system that provides a more robust reading with reduced false alarms.

Keywords:
Raspberry Pi processor, ADC, MEMS sensor, vibration sensor, DC motor.

I.INTRODUCTION:

Wind energy is a fast-growing sustainable energy technology and wind turbines continue to be deployed in several parts of the world. Driven by the need for more efficient energy harvesting, the size of the wind turbines has increased over the years (several MW of rated power and over 100m in rotor diameter) for both off-shore and land-based installations. Therefore, structural health monitoring (SHM) and maintenance of such turbine structures have become critical and challenging [1]. In order to keep the number of physical inspections to minimum without increasing the risk of structural failure, a precise and reliable remote monitoring system for damage identification is necessary. Condition based maintenance (CBM) [2] is increasingly being used recently since it is cost-efficient and significantly improves safety compared to periodic non-destructive evaluations and visual observations [3]. CBM is performed when one or more indicators show that the structure needs maintenance.

This type of maintenance necessitates a means to determine the condition of machines while in operation and involves the observation of the system by sampling dynamic response measurements from a group of sensors and the analysis of the data to determine the current state of system health. This goal is being pursued through the development of reliable sensors, and intelligent algorithms. Although any part of the wind turbine is prone to failure [4], considerable attention is often given to the turbine blades as they are the main elements of the system. The blades could cost up to 20% of the total cost and theirs are the most expensive type of damage to repair [5]. Numerous wind turbine blade damage detection and health monitoring techniques exist, each with its own advantages and drawbacks:

Acoustic emission sensors [6], ultrasonic testing [7], thermal imaging method [8], x-ray radioscopy [9], Eddy current method [10], fiber optic (FO) sensors [11], PZT patches [12], smart materials and strain memory alloy method [13], wavelet transforms [14], and microwave techniques [15] are the key examples. The majority of these methods have limitations with regard to large-scale sensing, difficult signal interpretation, or have safety issues. FO strain sensors and particularly fibre Bragg gratings (FBGs) [16] are currently the most widely used in wind turbine structural monitoring.

II. RELATED WORK:

2.1 TRANSMITTER:

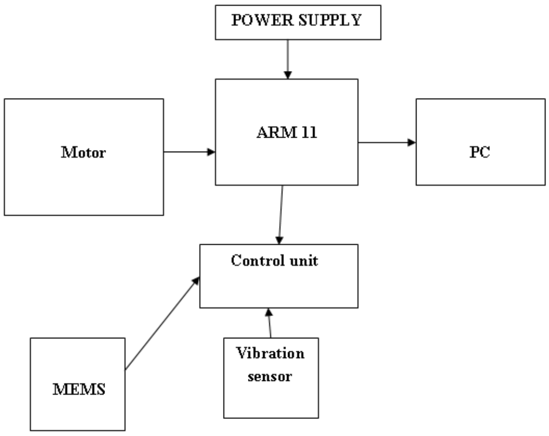

Figure-1: Block diagram of transmitter

2.3 EXISTING METHOD:

Maintenance and repair of wind turbine structure have become more challenging and at the same time essential as they evolve into larger dimensions or located in places with limited access. Even small structural damages may invoke catastrophic detriment to the integrity of the system.

2.4 PROPOSED METHOD:

In proposed system there is a problem to check large turbines so, to overcome all these problems we come to proposed method if we want to change the direction of turbines through the mems sensor we will change the angle from one to another.

At the same time there is a use of vibration sensor in this project the use of this sensor is if any problem occurs at that moment the information is displayed in monitor.

III. HARDWARE COMPONENTS:

3.1 RASPBERRY PI PROCESSOR:

Figure-2: Raspberry Pi diagram

The Raspberry Pi board involves a processor and snap shots chip, Random Access Memory (RAM) and more than a few interfaces and connectors for external devices. Some of these instruments are main others are optional. It operates in the identical method as a ordinary pc, requiring a keyboard for command entry, a show unit and a vigor give. considering that raspberry Pi board operates like pc it requires 'mass-storage', but a tough disk pressure of the variety observed in a ordinary pc is not relatively in maintaining with the miniature dimension of Raspberry Pi.

3.2. MEMS SENSOR:

Micro electromechanical systems (MEMS) is a process technology used to create tiny integrated devices or systems that combine mechanical and electrical components. They are fabricated using integrated circuit (IC) batch processing techniques and can range in size from a few micrometers to milli metres. These devices (or systems) have the ability to sense, control and actuate on the micro scale, and generate effects on the macro scale.

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In the most general form, MEMS consist of mechanical microstructures, micro sensors, micro actuators and microelectronics, all integrated onto the same silicon chip. Micro sensors detect changes in the system's environment by measuring mechanical, thermal, magnetic, chemical or electromagnetic information or phenomena. Microelectronics process information and signal the micro actuators to react and create some form of changes to the environment.

Figure-3: MEMS sensor

3.4. DC MOTOR:

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

IV.RESULTS:

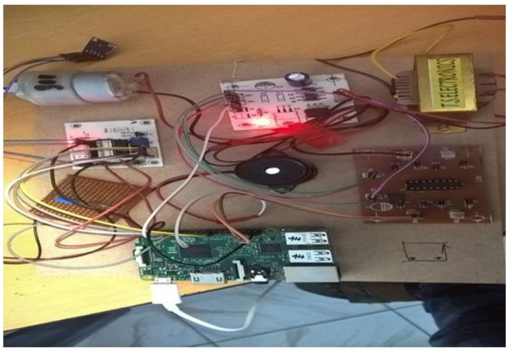

Figure-4: Hardware of the project

V. CONCLUSION:

The project "DIRECTION CONTROL OF WIND TURBINES USING MEMS SENSOR AND DAMAGE DETECTION" has been successfully designed and tested. It has been developed by integrating features of all the hardware components and software used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced ARM11 board and with the help of growing technology the project has been successfully implemented.

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