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IOT Based Condition Monitoring of Electric Machinery

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***Abstract*—** This paper presents the scheme of a remote monitoring system for electric machines based on Internet of Things (IoT) technology for safe and economic data communication in industry. To make the system fast and user friendly, authors have developed dedicated software in JAVA platform by which the authorized person can monitor the condition of all remotely located machines from an industry via a common server. A module of sensors monitor the parameters like voltage, current, speed, temperature etc. and the server records run time data of all machines and observes the performance of every machine. The authorized person can check the database when required on that day from the server. For any unwanted situation, the software module send a SOS message along respective fault information to that authorized person's mobile whether he/ she will be present or not present in control room.

***Keywords*—** Arduino UNO, Condition Monitoring, Electric Machines, Machine Parameters, Internet of Things**,** Sensors

I. INTRODUCTION

In any small, medium and large scale industries, a set of electric machines work in tandem for smooth running of industry. To maintain smooth operation of those machines, continuous monitoring of its parameter is essential to avoid unwanted fault condition [1]. The performance of any electric machines mainly depends on different electrical, mechanical and environmental parameters like voltage, current, speed, vibration, temperature, external moisture etc. If any one of parameter crosses its margin level, the quality of product also changes. Hence controlling of electric machines during production becomes a serious issue [2]. But it is quite difficult for an individual to check all the machine parameters separately on a regular basis. This is not only time consuming but also very much risky to check daily on spot. So, a more accurate, easy and reliable system is required to monitor all the machine condition continuously.

The main disadvantage of condition monitoring system is that sufficient manpower required and it is also time consuming to analyze data from all machines in the industry. Recent advancements in communication technology, availability of fast processing and up gradation of automation technology, electric machines are no longer manually monitored or controlled [3]. The condition monitoring methods become automatic by computer controlled or remote controlled devices. In modern smart technology, wireless communication, Internet of Things (IoT) provides lots of benefit for industrial automation through remote access [4, 5]. The concept of the IoT (Internet of Things) was 1st invented by Peter T. Lewis in September 1985. The IoT allows objects to be controlled remotely across existing network infrastructure, provide opportunities for more direct incorporation with physical world into computer based system and resulting in economic benefit, accuracy and improved efficiency with reduced human intervention. Basically, IoT is expected to offer advanced connectivity of devices that go beyond machine to machine communications and covers a variety of domains, protocol and applications. In IoT technology, each device in a system are able to communicate with other devices, which leads to exchange of relevant data, statistics, logs and various other parameters information various devices to improve their performance. This will help industries to get better productivity, management and increased throughput [6, 7]. The basic advantages of remote monitoring are it saves time and money. IoT based solution for continuous condition monitoring and predictive maintenance of machines set by establishing a communication between electronic hardware with cloud computing. So, condition monitoring becomes online and real time.

In this paper, IoT based remotely condition monitoring of electric machines through common software portal with minimal manpower has proposed. The authors have developed an embedded system where hardware motor module and software based server will work synchronously to monitor machine parameters on real time and it will allow authorized person to keep an eye to all machines in a plant

from a single platform. The standard values of different machine parameters are set and marked as a reference value for protection purpose. Control unit controls overall protection system. Control unit takes input from different sensors and upload the data on cloud via wifi network. All data are saved in server for processing as well as for future use. By which the authorized person can compare the performance of all machines on real time and decides whether any machine needs maintenance in near future.

In the rest of the paper, related work on this topic is explained in Section II, methodology and block diagram of the whole work is explained in Section III and Section IV describes hardware and dedicated software for this work. Finally, section V explains conclusion and future scope of this work.

II. RELATED WORK

As mentioned earlier, in current scenario of automation technology, IoT is the focus of light and it can break through original frame of traditional condition monitoring system. The combination of IoT and condition monitoring can make full use of technological supports and share more information to carry out flexible remote fault prediction which improves working efficiency and intelligent level of fault prediction. Many researchers have done their valuable researches on IoT based condition monitoring. Some of these given below:

In reference [8], IoT based intelligent fault prediction system is proposed. Here initially the system characteristics are analyzed and then four-layer functional architecture of that system is designed to realize comprehensive condition monitoring and computer intelligent information processing for fault prediction. In reference [9], authors developed a wireless IoT based system for condition monitoring of traction motor system in electric vehicles. Reference [1] explains about condition monitoring of induction motor with wireless TCP/ IP Protocol by detecting the deviation of operating parameters from normal values before the occurrence of faults. Reference [4] proposed about diagnosis of vibration fault of single phase induction motor using IoT technology. This system diagnoses the variations in vibration and current and then the data is stored on cloud. The main advantages of this system are its ability to provide a real time alerts. The paper in Reference [10] presents IoT based safe and economic data communication for industrial three phase induction motor drives. Sensors and transducers monitor different motor parameters and send data to processing unit. Processing unit communicates with Gateway module to send information to cloud database for remote monitoring. Reference [3] describes fault diagnosis of an elevator using IoT technology. The elevator monitoring system fully uses advanced sensing technology and combined with modern communication technology for transfer the information from many elevators in a certain area to the main computer.

III. METHODOLOGY

The detailed block diagram of proposed scheme is given in Figure 1.

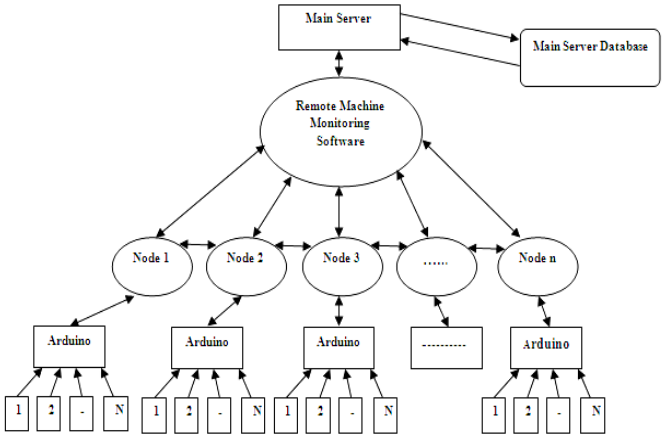

Figure 1. Block diagram of proposed condition monitoring system

IOT based remote condition monitoring system initially works with dedicated embedded system for monitoring of different machine parameters already mentioned from every machine in a plant. Here, 1, 2, 3, ----N indicate different machine parameters like Voltage, current, speed, temperature etc. Different sensor measures its corresponding parameter value in real time and sends to ARDUINO UNO module from which machine data are stored in main server remotely via Bluetooth module. In server every machines indicated as a node. If any parameter value increases from its reference value, that will be sensed by Java program in server and immediately send a SOS message to the authorized person's mobile. So, it is not required for the authorized person to always sit in front of server. Detailed explanation about hardware and software module is explained in next part of the paper.

IV. DEDICATED HARDWARE AND SOFTWARE MODULE

The hardware part is mainly based on different sensors and Arduino UNO Microcontroller. In this work, to sense different electrical parameters Potential transformer, Hall sensor, Proximity sensor, temperature sensor is used. All this sensors are connected via Arduino UNO GSM module.

Arduino UNO is an open source microcontroller board based on AT-MEGA 328P. It is a high performance Microchip 8 – bit AVR RISC based microcontroller with 32KB ISP Flash Memory, 1 KB EEPROM, 2 KB SRAM, 23 general purpose

I/O lines and 32 general purpose working registers. The board has 14 digital pins and 6 analog pins programmable with Arduino IDE (Integrated Development Environment) via a type B USB cable or by an external 9 V power source. Arduino Uno has a number of advantages for communicating with a computer or other microcontrollers, as it provides UART (Universal asynchronous receiver transmitter) module, TTL (Transistor transistor logic) for serial communication.

After interfacing of Arduino with different sensors, programming has to be written of AT MEGA328 controller via USB to serial programmer. The AT MEGA 328 on Arduino UNO is pre burned with boot loader which allows downloading a new code to it without using of any external hardware programmer. Arduino software uses a serial monitor which allows monitoring of simple textual data to be sent to and from the Arduino board. A program is written for fetching the sensor data and transferring it to PC or Laptop via Bluetooth module. The snapshot of the dedicated hardware during speed measurement of an Induction machine is given in Figure 2.

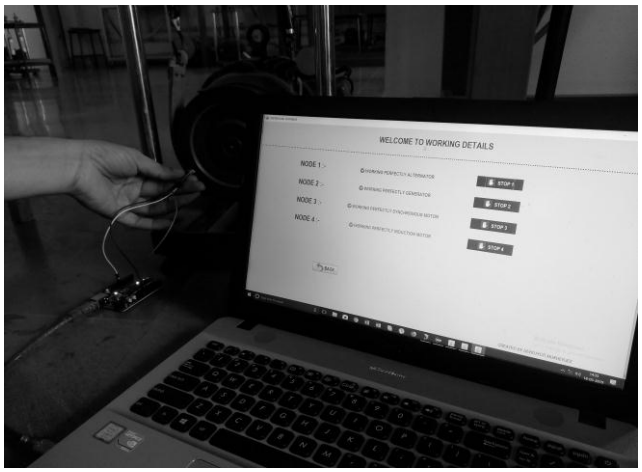

Figure 2. Hardware interfacing system with Arduino UNO

In server , a new software has been developed in JAVA platform with the backend support of MYSQL server. Every machine is connected remotely with this server via ddicated ARDUINO UNO based hardware. The software is able to take and display the run time data of every machine parameters. The software is also able to analyze the performance of every machine based on its parameter value and emergency case able to inform to the authorized person about the fault occurrence.

The software is totally sequired with login id and password, which will be only known by authorized person. So, Server will be protected from any mal operation . In Figure 3, the Log in portal of MYSQL server is shown.

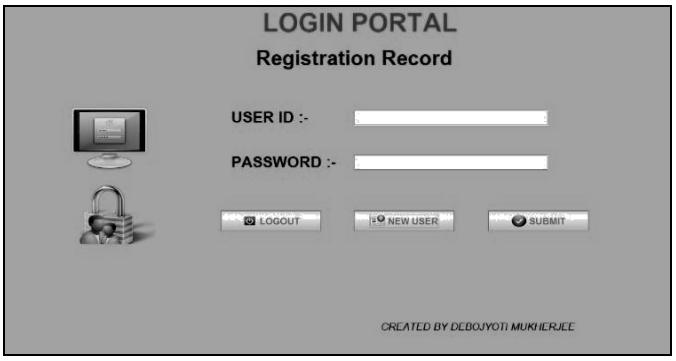

Figure 3. Log in page of dedicated software

After Login properly, the authorized person can check the working status of every machine of this plant with its parameter values as shown in Figure 4.

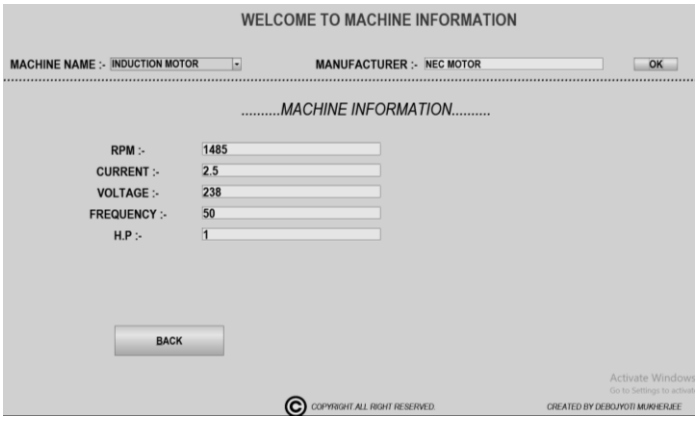

Figure 4. Parameter values of a particular machine

When fault occurs, parameter value changes from estimated value. This is sensed by Arduino program and sends a quick SMS to the mobile of authorized person via Java application. For example, when device detects high voltage or low voltage, it will send a message to the installed number that "Machine No. ….High/ Low Voltage occur. The message display is given in Figure 5.

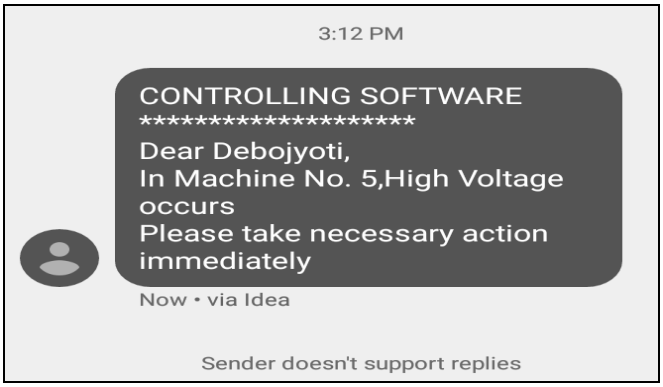

Figure 5. SOS message alerts when fault occurs in a particular machine

As the software is made with the backend support of MYSQL server so every data is stored in the server from which dedicated person can easily monitor the health of every machine and also can predict about the future fault.

V. CONCLUSION AND FUTURE SCOPE

The main purpose of this work is to monitor parameters, gather information about all machines running simultaneously in a plant remotely via a common server and analyze the data to get idea about the health of any machines. Here, the software designed and developed by the authors to process and analyzes the data acquired through Arduino UNO Microcontroller and if fault occurs, then send graphical display along with SOS message to the authorized user's mobile. The concept of IoT is presented here for remote condition monitoring of electric machines. The proposed system can easily be upgraded by adding other sensors on sensing node to measure other different parameters of machine if required. The system has a high autonomy, easy installation and low maintenance costs and minimal man power required. So, it is expected that, the proposed system will be beneficial for industrial automation.

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