

IOT BASED 3 PHASE INDUCTION MOTOR PARAMETER MONITORING AND CONTROLLING

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ABSTRACT— Now days, the induction motor has remained the most popular type of motor for industrial applications. Monitoring and controlling of induction motor parameter is very essential in many application and also for the reliable operation there are several techniques available for the same. This paper deals with the monitoring of various parameters & control of three phase induction motor and various electrical appliances remotely based on Internet Of Things [IOT]. A module of sensor and transducers monitors the parameters likes speed, temperature, current and voltage of induction motor and send to the processing unit which will display parameter on server. The aim is to design and implementation of IoT technology to monitor and diagnose the condition of Induction motors by recording key operation indicators. The proposed method comprises of an IoT based platform to collect and process the induction motor parameters. The system also presents the automatic and manual control methods to stop or start the induction motor to avoid any system failures through server gateway. The Implementation of this scheme will increase the working efficiency of machine by continuously monitor to avoid breakdowns and also to determine the preventive maintenance.

Keywords—*Internet Of Things, Parameter Monitoring, Induction Motor, Parameter Controlling.*

I. INTRODUCION

In today's manufacturing industries, mechanical and electromechanical systems are mostly driven by electric motors. Before the invention of AC induction motors dc motors were widely used for industrial requirements. With the invention of AC induction motors due to their higher performance attributes over DC motor, industrial automation is being frequently done with it. The primary advantages of the induction motor are its straightforward rotor construction leading to low cost, ruggedness, and low-maintenance requirements. From the study of construction and operation of an induction motor, it reveals that main Faults in induction motors can be categorized as follows:

1.1 Electrical faults: Faults occurred due to the unbalance supply voltage or current, single phasing, under or over voltage of current, overload and etc.

1.2 Mechanical faults: Faults due to broken rotor bar, mass unbalance, air gap eccentricity, bearing damage, rotor winding failure, and stator winding failure.

1.3 Environmental faults: Faults under this classification are occurred due to ambient temperature as well as external moisture and Vibrations of machine.

The performance of the AC Induction motor depends on above mentioned electrical, mechanical and environmental parameters of the motor, so that the controlling methods for AC induction motor are very sensitive to motor parameters. Therefore there is need of monitoring induction motor parameter for uninterrupted operation and to estimate the pre fault state to avoid any breakdown condition.

As an emerging technology brought about rapid advances in modern wireless telecommunication, **Internet of Things** (IOT) has attracted a lot of attention and is expected to bring benefits to numerous applications [3]. The newly introduced concept of IoT is providing a helping hand to achieve the Industrial automation through remote access terminals. In IOT each device or devices constituting a system can be able to communicate with the other devices or systems over a common platform [1],[8]. Thus an enhanced communication is achieved by a "System of systems". Hence this leads to exchange of relevant data, statistics, logs and

various other parameters information among devices to improve their performance, which will help industries to gain better productivity, management and increased throughput [9].

2. LITERATURE SURVEY

Significant efforts have been dedicated to induction machine monitoring during the last two decades and many techniques have been proposed. Thus, a brief description of the main techniques presented in the literature, as well as their advantages and disadvantages are presented in this section.

2.1) A non-intrusive and in-service motor efficiency estimation method was proposed in 2008, where the efficiency estimation was done using Air Gap torque method [4]. Only motor terminal quantities and nameplate details, with special considerations of motor condition monitoring requirements are required. Pre installed potential transformers and current transformers for protection purpose. But there is requirement of continuous monitoring of motor parameter on site.

2.2) A low cost wire less sensor network for in-field operation monitoring of induction motor was proposed for high range motors [5]. Where a smart switch system was proposed. Smart switch has a data logger that is used to monitor operation condition and automatically manages the motor winding connection mode. But this system is limited to small area, long range communication is not possible.

2.3) SCADA programs are utilized for developing user interfaces. However, SCADA programs do not provide adaptability to users because of their expensive libraries.

2.4) RF, ZigBee and Bluetooth technologies are widely preferred in easy-to-use applications due to the short range between the sender and the receiver, and the small volumes of data transferred [5], [6]. The ZigBee, RF and Bluetooth wireless communication techniques are generally restricted to simple applications because of their slow communication speeds, distances and data security.

2.5) There are some successful examples such as PLC SCADA based fault detection and protection system is implemented which provides the web based user interface for remote control and monitoring was developed and presented online to users but the main disadvantage is cost this system are more costlier

2.6) Bacterial foraging algorithm along with a non-intrusive method is used for the efficiency estimation in [7]. But the system becomes lengthier in calculations.

3. SYSTEM ANALYSIS

These all above mentioned examples for monitoring and control of various industrial applications has some limitations in form of long distance communication, data acquisition, fidelity and cost. Thus, there is a stringent requirement of a system that can monitor as well as control the industrial applications using a reliable protocol that enables a wireless communication over long distances. This present paper is focused on providing a reliable solution to overcome the limitations of existing techniques, this paper designs and realizes the effective monitoring and controlling of Induction motor using the newly introduced concept of Internet of Things. The design presents many advantages as described below. First of all the different sensors employed in motor helps to detect the physical conditions and environmental abnormalities of required industrial applications to be accessed. Secondly the WiFi based communication between a user and Industrial application to be monitor and control is possible without any restriction of distances. There is also an arrangement of accessing the sensed data by the sensor remotely to any location, thus portability of the Industrial environment is also achieved. Also the control aspect of these industrial applications can be achieved by means of Wi-Fi enabled modem.

4. BLOCK DIAGRAM AND SYSTEM DESCRIPTION

The proposed system is having two parts. *First* is monitoring of Industrial applications and *second* includes controlling them. The first part of monitoring is focused on Industrial applications that will be continuously monitored through a set of sensors as shown in architecture. A set of sensors is place at industry that collects the relevant data from various industrial applications to determine

whether they are working well under certain threshold conditions. The sensed data from these sensors is fed to the controlling device basically an microcontroller. Now Wi-Fi module ESP8266 is connected to Internet via Microcontroller. A sophisticated Program have been running in the Microcontroller ATmega328 and in Wi-Fi Module which help this device connected to the **ThingSpeak** and **BLYNK APP** Servers via Internet.

The Program in the Microcontroller will first On the Wi-Fi Module and help him to connect to internet. Then it will “ON” the 3 Phase Induction Motor via Contactor and Relay through BLYNK APP Sever by this the Motor get ON. Now microcontroller is ready to sense the data and also to send it to ThingSpeak server. Thus it will sense the data first through the sensors one by one and send it to Server. At the ThingSpeak server, data will be shown in Graphical manner where we can visualize all the parameter of IM motor in remote device.

4.1) System block diagram of iot based data monitoring system

In Figure 1 describes about block diagram of proposed system. It consists of PT and CT on induction motor to measure voltage and current respectively to find input power, also it measures a temperature by using temperature sensor lm35 and for speed measurement infrared sensor all this measured value send to microcontroller. Where it process and encrypted packet are formed. This packet are transfer to server via wifi module ESP8266 which is attach to the main controller. The data available at server can access by remote device through encrypted connection so that data security is maintain.

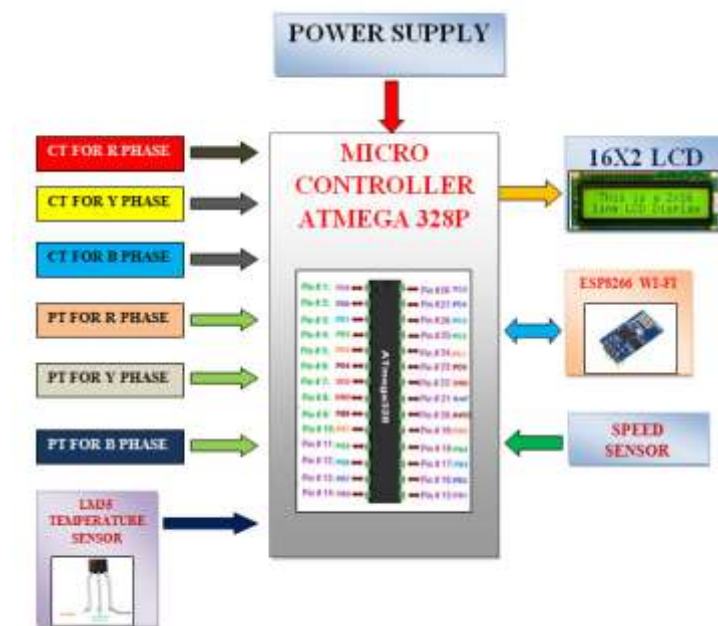


Figure1:- System Block Diagram Of IOT Based Data Monitoring System

4.2) System block diagram of iot based controlling system

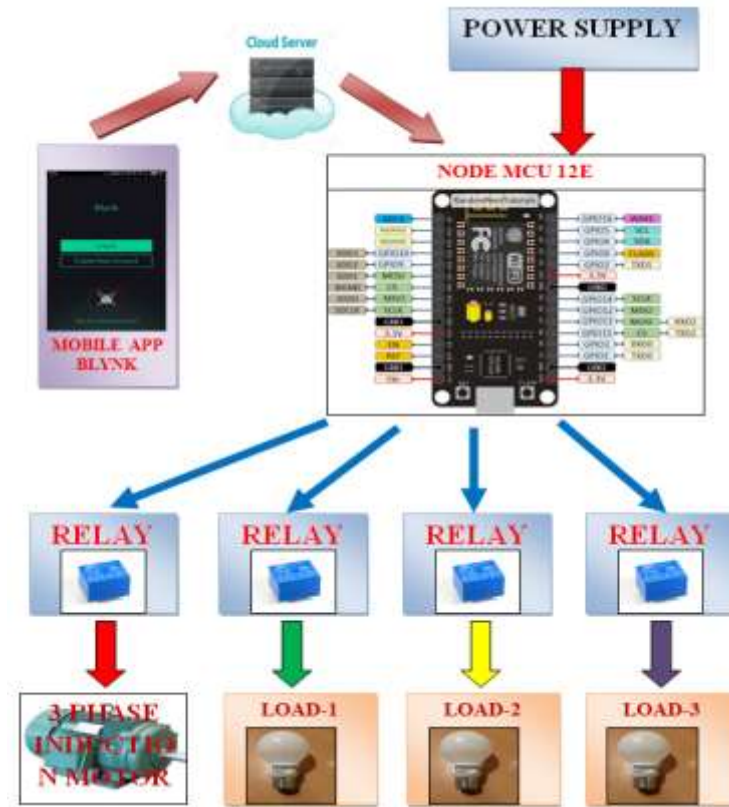


Figure2:- System Block Diagram Of Iot Based Controlling System

IN figure 2 shows system block diagram of IOT based machine controlling system , it consists NODE MCU Controller , SPDT Relay and Power Supply ,with the help of NODE MCU system develop connection with internet . According to BLYNK app signal NODE MCU give control signal for relay to control induction motor and other load.

5. SOFTWARE DESCRIPTION

5.1. Thingspeak

Thing speak is a web based open API IoT source information platform [04] [05] [06] that comprehensive in storing the sensor data of varied „IoT applications“ and conspire the sensed data output in graphical form at the web level. Thing speak communicate with the help of internet connection which acts as a „data packet “carrier between the connected „things“ and the Thing speak cloud retrieve, save/store, analyze, observe and work on the sensed data from the connected sensor to the host microcontroller such as „Arduino, Raspberry-pi etc [2].

The primary element of Thing Speak activity is the channel, which contains data fields, location fields, and a status field. After you create a Thing Speak channel, you can write data to the channel, process and view the data with MATLAB code, and react to the data with tweets and other alerts. The reference output graph is shown in the fig1. The typical Thing Speak workflow lets you:

1. Create a Channel and collect data
2. Analyze and Visualize the data
3. Act on the data using any of several Apps

The Thing Speak API is available on GitHub and includes the complete Thing Speak API for processing HTTP requests, storing numeric and alphanumeric data, numeric data processing, location tracking, and status updates [7].



Figure 3 :- Reference Thing Speak Graph of current vs Time

5.2.Blynk App

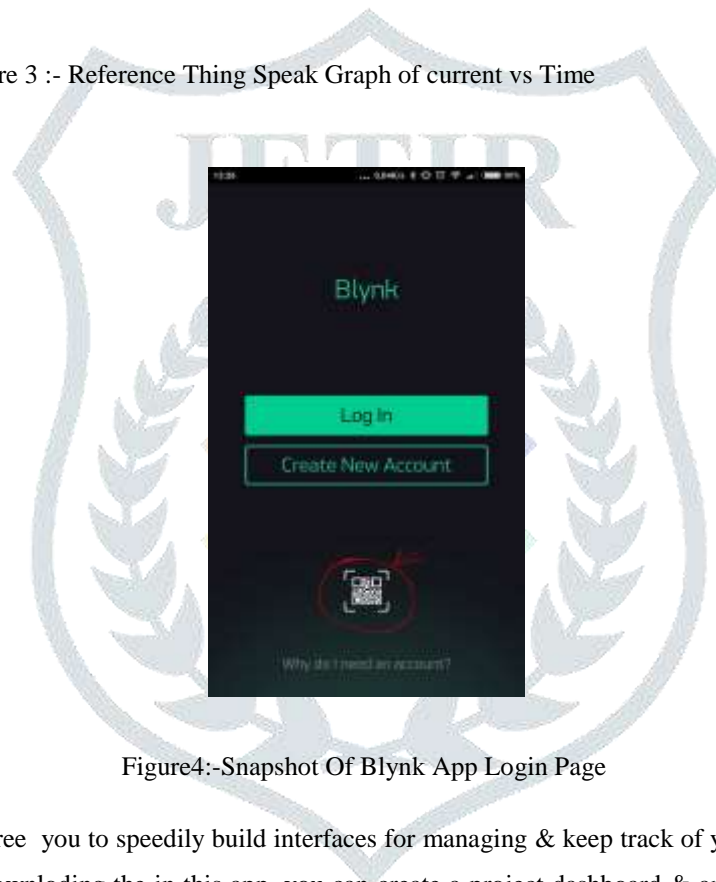


Figure4:-Snapshot Of Blynk App Login Page

Blynk is a new platform that agree you to speedily build interfaces for managing & keep track of your hardware projects from your ios & Android device. After downloading the in this app, you can create a project dashboard & arrange buttons, sliders, graphs, & other appliance into the screen.This app design for the internet of thing . It can work on hardware remotely, can deliver sensory data, can store data, imagine it and do many things.The three main components of this platform are:

- **The Blynk App** : allows to you create wonderful interfaces for your projects using various widgets we provide.
- **The Blynk Server** : responsible for all the interfacing between the smartphone and hardware. You can utilize Blynk Cloud or utilize your privatized Blynk server topically. Blynk server is open source which can easily operate lots of devices and can be start by the Raspberry Pi.
- **TheBlynk Libraries** - This is used for all compatible hardware platform authorize server communication and process all incoming and outgoing instructs

6. HARDWARE DESCRIPTION

The system hardware consists of a set of sensors that monitors the industrial applications and a microcontroller interfaced with the Wi-fi module as shown in Figure 1. Description and function of each is described below.

6.1 Sensors

Sensors refer to a particular category of devices that can sense or measure defined physical, chemical or biological quantities and generates associated quantitative data. A set of sensors is place at motor to collects the relevant data from motor

6.1.1 Voltage Sensor

The voltage sensor being used here is implemented using 3 transformers. Since we have to monitor the 3 phase supply (R, Y, B) provided to various industrial applications in industry so we are connecting these 3 transformers which are 230V-12V step-down voltage transformers to corresponding 3 phases of supply. Each transformer having a 230V at its primary winding and delivers a step-down voltage of 12V at its secondary winding. The voltage at secondary winding of each transformer is then rectified to a dc voltage of 5V using 3 Fullwave bridge rectifiers and current limiting resistors and fed to the 3 I/O pins of microcontroller

6.1.2 Temperature Sensor:-

Temperature sensor is used to measure the temperature with an electrical output proportional to the temperature. The LM35 device does the function of measuring the surrounding temperature. LM35 is shown below in Fig5.

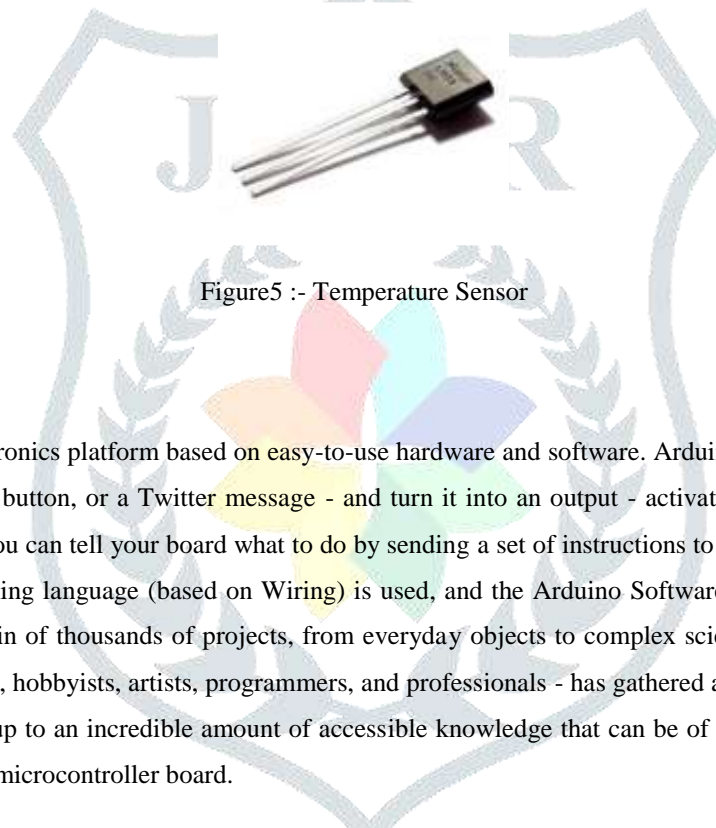


Figure5 :- Temperature Sensor

6.2 Microcontroller

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino Board are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. For that the Arduino Programming language (based on Wiring) is used, and the Arduino Software, based on Processing. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike[10]. Fig6 Shows Arduino microcontroller board.



Figure 6:- Arduino Controller Board

6.3 ESP8266 Wi-Fi module

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers (and that's just out of the

box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts. There is an almost limitless fountain of information available for the ESP8266, all of which has been provided by amazing community support. In the Documents section below you will find many resources to aid you in using the ESP8266, even instructions on how to transforming this module into an IoT (Internet of Things) solution[11]. ESP8266 Wi-Fi module is shown in the Fig7.



Fig 7:- ESP8266 Wi-Fi Module

6.4 Contactor

A contactor is an electrically-controlled switch used for switching an electrical power circuit. A contactor is typically controlled by a circuit, which has a much lower power level than the switched circuit, such as a 24-volt coil electromagnet controlling a 230-volt motor switch.[12]. A basic Contactor s shown in Figure8.



Figure 8:- Contactor

6.5 Liquid Crystal Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs s. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Figure9 shows 16x2 LCD.



figure9:-16x2 lcd display

6.6 Current Transformer:

A current transformer is an instrument transformer where the secondary current is considerably proportionate to primary current and differs in phase from it by ideally zero degree. *Current transformers* reduce high voltage currents to a much lower value and supply an correct path of safely sensing the real electrical current flowing in an AC transmission line utilizing a standard current measure by an device. The predominant of functioning of a basic current transformer is slightly different from that of an ordinary voltage transformer.



Figure 10:-Current Transformer

7. RESULT

In this work , each sensors are tested individually and implemented .The WI-FI module and LCD display are correctly interfaced. In the running condition of the motors ,the sensed value are displayed continuously in serial monitor and also in think speak website graphically. The motor is tested for abnormal condition. The sensor information displayed in serial monitor, LCD display and Think speak website are given below,



Figure11:- Phase Voltage Display On Lcd



Figure12:- Phase Current Display On Lcd



Figure13:- Temperature And Speed Display On Lcd



Figure14:- Data Update Shown On Lcd

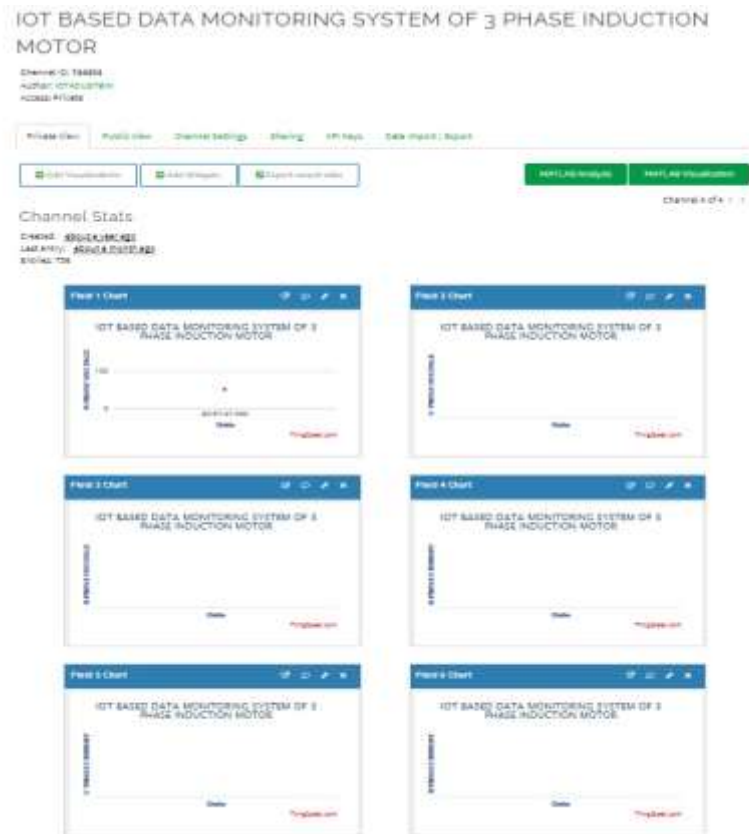


Figure15:- Parameter On Think Speak Server

8. CONCLUSION:

This paper presents the concept of Internet of Things for early detection and monitoring of motor system failures remotely. The system has been designed to combine various parameter measurements in real-time, improving the detectability of different faults. The monitoring of the motor system presents the measurement of different parameters namely speed, temperature, voltage and current consumption. Thus, compared to conventional methods that relies solely on v temperature, this design has more information sources which can enable an alarm. The concept of IoT is presented here for remote monitoring and controlling the motor. The data received by the coordinator node is stored and graphically presented in real-time by means of a application developed in remote device. With the help of this device, it is very easy to have the real time parameters of the Induction motor which will helps us in various aspects leading to the growth of the industry and increase working efficiency of motor.

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