Scientific Journal of Impact Factor (SJIF): 4.14
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 3, Issue 7, July -2016

Development of Online Condition Monitoring System for Hydraulics Machine

Arunkumar[1], Dr. R. Suresh[2], Dr. C. Mallikarjuna[3]

[1]PG Student, Industrial Automation Engineering Department, VTU PG Studies, Mysuru,Karnataka, India,
[2]Professor, Industrial Automation Engineering Department, VTU PG Studies,Mysuru, Karnataka, India
[3]Associate Professor, Industrial Automation Engineering Department, VTU PG Studies,Mysuru, Karnataka, India

ABSTRACT: *In the areas of applications like hydraulic machines some important concerns are safety, machine's performance, efficiency. This paper discusses about the prototype model developed for hydraulics machine to monitor its condition and the collected data of machine can be used for analysis purpose. The condition monitoring online system is the resoluteness of the status of machine or device condition and its variation to judge its state at any time specified and the parameters like temperature, current/voltage or varied potentiometer etc. resolute machine state. These different parameters value furnishes a sign of changing machine state. Around the clock monitoring system for hydraulics machine was developed for achieving its good condition or performance and measured data can be obtained through online with low cost.*

Keywords:*Arduino UNO Microcontroller Board, LabVIEW Software, Zig-Bee, Temperature Sensor, Potentiometer.*

I. INTRODUCTION

In any fields of developing a product or a system or machines, online monitoring of that particular system or machine is very important thing in deciding its conditioning status. Whether the system or machine performing better in future or not can be known before it fails. The manufacturers who make machines suitable for different applications are more focused in designing on condition monitoring system which can be built-in with that particular machine.By developing condition monitoring system for any machines may leads to reduce costs which are invested by the company for maintenance for a long period. Reliability of the machine will be higher and skilled manpower may be reduced when the machines operate at different conditions at any time.

The condition monitoring online system is the resoluteness of the status of machine or device condition and its variation to judge its state at any time specified and the parameters like temperature or current/voltage or vibration or pressure or varied potentiometer etc. can resolute machine state. The different value of these parameters furnishes a sign of changing machine state. In general, the needs of Development of Online Condition Monitoring System (DOCMS) are as follows:

- If there is a line shutdown in a production or in the generating section then to avoid machine failure DOCMS is needed.
- If the loss in the production and in the finance income occurs then to minimize the costs of maintenance and prevent downtimes which are unscheduled, DOCMS is required.
- The DOCMS is needed to know condition and overall machine health due to the changes in the value of parameters.

Around the clock monitoring system for hydraulics machine was developed for achieving its good condition or performance and measured data can be obtained through online. The temperature of hydraulic fluid or machine, oil level of hydraulic tank can be measured by the incorporating suitable sensors and the current and voltage values from hydraulic machine can be measured online at given interval of time or continuously. An Arduino-microcontroller was used to get the measured values from the hydraulic machine and is transmitted by Zig-bee to the Zig-bee receiver where the receiver is connected to the laptop or personal computer. A Lab-View software is used to monitor these measured values displaying in the front panel and stored into a computer in an excel sheet automatically. This displayed data on the front panel can be accessed through a web server by entering a website address created and the measured values of hydraulic machine is available online continuously for monitoring at any location.

II. BLOCK DIAGRAM OF DOCMS for Hydraulics Machine

The figure 1 displays the block diagram of DOCMS for hydraulics machine. It is a prototype model developed for hydraulics machine. The online condition monitoring system which is developed is a system consisting of a microcontroller, Zig-Bee, LabVIEW software as main components.The input parameters to the microcontroller are voltage/current signals of hydraulic machine, temperature sensor and potentiometer.

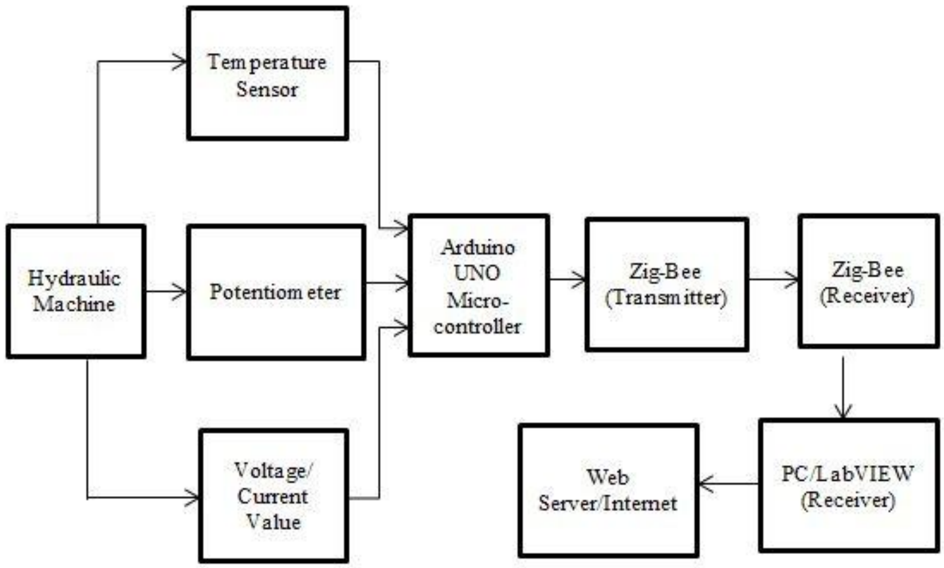

Figure 1.Block diagram of DOCMS for hydraulics machine

The output data of microcontroller are sent to LabVIEW via wireless network of Zig-Bee transmitter and Zig-Bee receiver.The LabVIEW software provides the measured data and these measured data with respect to time are plotted in the graphical representation which are displayed in the front panel window of the LabVIEW.Also these data can accessed from the web server by connecting a modem to PC and the temperature sensor data, potentiometer and the current and voltage values with respective to time are stored in the excel sheet of the Microsoft with an extension file ".xls" and this data is used to monitor the machine for the healthy working condition by predicting the faults at the earliest.In the LabVIEW, the web based process involves steps like enabling web server, accessing the web server, choosing the VI file, fixing the page titles, configuring the HTML page and grabbing the URL so that displayed data can be accessed on the internet for monitoring and analyzing purpose. The figure 2 and figure 3 shows developed prototype model of DOCMS.

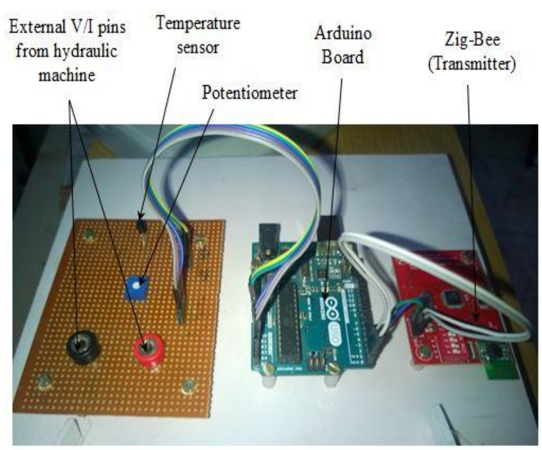

Figure 2. Developed prototype model of DOCMS (Zig-Bee Transmitter connected to Arduino board)

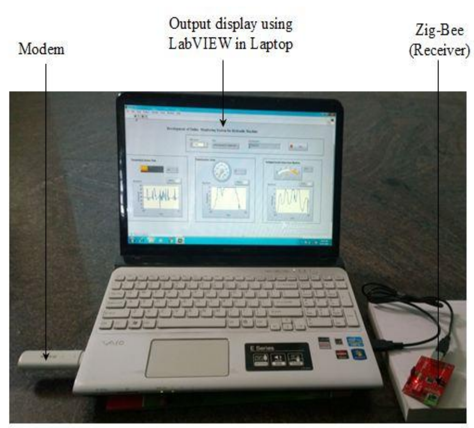

Figure 3.Developed prototype model of DOCMS (Zig-bee Receiver connected to Laptop)

IV. FLOWCHART OF DOCMS

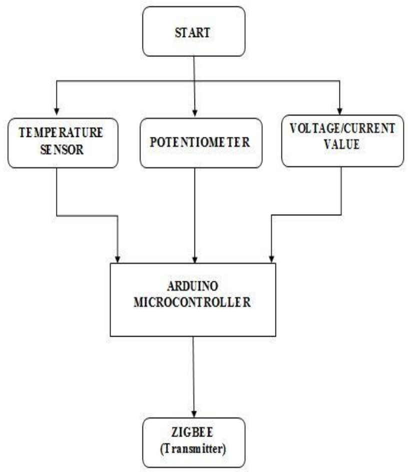

Figure 4. Flow chart of hardware section:Transmitter unit of DOCMS

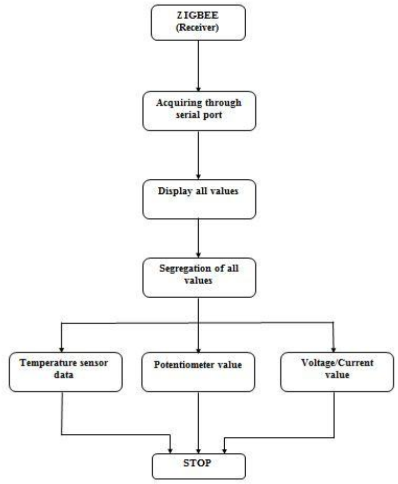

Figure 5. Flow chart of Software section: Receiver unit of DOCMS

V. SYSTEM COMPONENTS

5.1 Microcontroller

The microcontroller Arduino Uno board shown in figure 6 incorporates ATmega328, which has fourteen pins namely digital input pins and output pins. Generally six pins can be made useful for PWM outputs. Analog inputs are six. A crystal oscillator with sixteen megahertz, one power jack, one connection for USB, header ICSP one and one button for resetting are available inside the board. To start the microcontroller, an adapter with AC to DC is required or else it can start with a battery.
The arduino is a single board microcontroller which is powerful and very easy. The board is priced cheaper and software is an open source which is available freely.To perform the functions, few commands or programs are enough.With less effort, circuits interfacing to read sensors, switches, lights and motor control can be created and programs can be written.

Figure 6.Arduino Uno Board

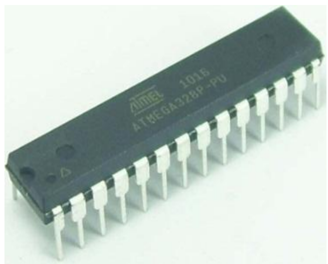

Figure 7. ATMEGA328-PU (IC)

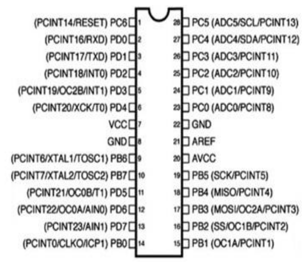

Figure 8. ATMEGA328-PU (IC) Pin Diagram

The language used is arduino programming language. The arduino's important feature is that, a control program can be created on the computer host and is downloaded onto the board of arduino and the program runs automatically. Even when a reset button is pressed, the control program will run each time from the starting of program. Another feature is that when a battery is removed and board is closet for some months, the previous program which is stored will execute after reconnecting the battery. Requirements of the working system are arduino board, programming USB cable, battery of 9V or power supply external and computer host running development environment of arduino like window, Linux. The figure 7 and 8 shows ATMEGA328-PU IC and Pin Diagram respectively.

5.2 Temperature Sensor

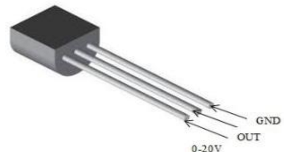

Figure 9.LM35 Temperature sensor

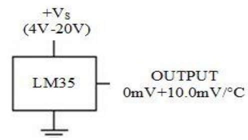

Figure 10.Symbolic Diagram of LM35

. LM35 series temperature sensors are precision integrated circuit type of devices and the output voltage is linearly proportional to the centigrade temperature. The figure 9 and figure 8 shows LM35 temperature sensor and symbolic diagram respectively. The device LM35 is over linear that calibers in Kelvin and to obtain centigrade scaling conveniently, the constant voltage which is large is not required to subtract from output. The device LM35 at room temperature, accuracy is ± ¼ °C and at over full -55 °C to +150 °C range of temperature, accuracy is ¾ °C can be provided without any external calibration or trimming. At wafer level trimming and calibration, the lower cost is assured. It is easy to readout or circuitry control when interfacing the device LM35 of inherent precise calibration, linear output and output impedance which is low. The power supply that is used for the device is single drawing 60µA only with self-heating very low i.e. in still air, it is lesser than 0.1°C.The device LM35 accuracy specifications w.r.t linear transfer function is given below:
The output voltage, Vout =10mV/° F * T

Where Vout is output voltage of LM35 device, F is Fahrenheit and T is temperature. The device functional mode is the analog output of the LM35 device is directly proportional to temperature.The device is suitable for general applications of temperature sensing. There is a limited ability by the device LM35 to drive capacitive loads that are heavy and without precautions the device alone drives 50pF.

5.3 Potentiometer

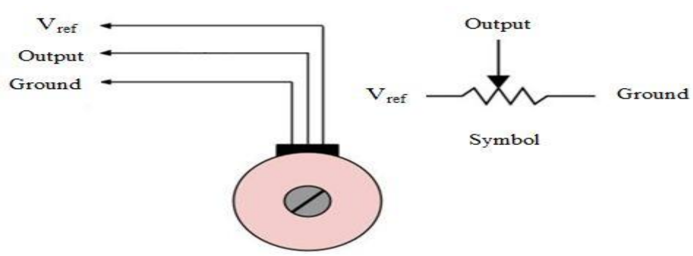

Figure 11.Potentiometer

The potentiometer has the features like bushing mount, metal or plastic shaft and bushings, AR pin optional feature, wire wound, sealable, PC pins or solders lugs; it is designed for HMI applications and RoHS compliant. The potentiometer is shown in figure 11. The potentiometers have electrical characteristics and are as follows:1.The range of standard resistance is about 200 to 100 KΩ.2.Linearity independent ± 0.25%. 3.The power rating is two watt at +40°C and zero watts at +125°C. 4.The total resistance of tolerance is ±5%.5. The absolute minimum resistance is 1Ω or 0.1%6.The noise is about 100Ω.

5.4 Zig-Bee

The Zig-Bee RFM75 USB device shown in figure 12 is a transceiver which has a frequency band ISM operating at 2400 to 2483.5 megahertz available in the world wide. The RFM75 is used in the applications where the consumption of the power is low. It transmits in burst mode and the air data rate is up to 2Mbps. RFM75 USB Zig-Bee operates as a transmitter or operates as a receiver when it is in TDD mode. The serial data to transmit and to receive with baud rate adjustable at RS232 level is of 9600/4800/38400/19200 bps for interfacing directly to computer port USB or similar devices. RFM75 can work with other model like sensor embedded type with 2.4GHz, and it can work at a range of 30meter. This can be used where there is two way transmission of the data is to be wireless. The transmission distance is farer and it has high rated data. It has a transparent user interfacing and the protocol to communicate is self-controlled. To the present design, the module is embedded to communicate wireless and is easy to setup. If the transmitter and receiver is to communicate with each other, it has to be programmed with the RF channel frequency with same value.For the 16 MHz crystals tolerate is ±60ppm.

Figure 12.Zig-Bee USB RFM75/CC2500/NRF75-BOARD

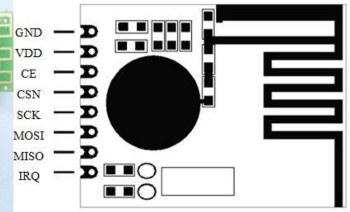

Figure 13.Zig-Bee RFM75 Pin Assignment

The figure 13 shows Zig-Bee RFM75 Pin assignment. The pin GND functions as Ground which is of zero volts. The pin VDD functions as power of supply 1.9 volts to 3.6 volts. The Chip Enable CE pin activates RX or TX mode. The pins CSN, SCK and MOSI functions as digital inputs and the pins MISQ and IRQ functions as digital outputs.Packet processing is automatic. The payload length which is variable is from 1 to 32 bytes. The SPI 4 pin interfaces clock rate with maximum 8 MHzand has QFN package with 20pin 4*4mm.

5.5 LabView

LabVIEW means Laboratory Virtual Instrumentation Engineering Workbench, a platform developed by National Instruments. It uses visual programming language and in 1986 it is released originally for Apple Machintosh which is used for acquisition of data, controlling instrument and industrial automation on the different platforms. Inherently parallel execution is capable for simultaneously multiple nodes. The variables type definition in the LabVIEW is not needed, by the node in which data is supplying, the wire type is defined.

5.5.1 Graphical Programming

The front panel user interfaces are created from LabVIEW in the development cycle. The subroutines or the programs of LabVIEW are the Virtual instruments abbreviated as VI's, each VI has front panel component, block diagram and connector panel components saved as ".vi" file extension. Interfacing of the program is served by front panel which implies each VI is simply tested earlier in embedding it as a subroutine into a long program. Building a program is simple even nonprogrammers can drag easily and drop the lab equipment virtual representations through a graphical approach.

5.5.2 Dataflow programming

In this language, the function nodes which are different and are connected by drawing wires which propagates variables, the nodes are executed from graphical structure of block diagram when input data becomes available. The hardware with multi-threading and processing is exploited automatically by a scheduler built in multiplexes the threads of multiple operating systems over the nodes which are available for execution.The LabVIEW accesses the hardware instrumentation by providing support extensively. The instruments of different types and buses are incorporated with the abstraction layers and drivers which presents themselves as graphical nodes. The hardware devices communicate and are interfaced through standard software allowed by abstraction layers. An interfaced driver reduces development time of the program. A driver topology DAQmxBase is new hardware consisting components of G-code having less register calls via DDK i.e. Driver Development Kit of NI hardware measurement which functions access to acquisition of numerous data and instrumentation devices on hardware independent platform and also on windows OS or Linux or Unix platforms.

5.5.3 The LabVIEW Environment

The programs of LabVIEW are known as Virtual instruments with extension file ".vi" due to the operation and appearance which imitate the physical instruments like multimeters and oscilloscopes. This environment includes wide set of tools for data acquiring, displaying, storing and analyzing and also the tools for code troubleshoot. When the LabVIEW application is opened, a window naming "Getting Started" is displayed. If a new VI is to be created, "Blank Vi" is selected and if a new LabVIEW project is to be created, "Empty project" is selected. The front panel window untitled appears when a blank VI is opened. This is one of the two windows of LabVIEW and the second window is block diagram. These windows are appeared when a VI is to be created new one or an existing is selected. Here user interface or control-indicators of front panel are built for the interactive VI input and VI output terminals. Controls include push buttons, dials, knobs and other devices of the input and the Indicators include LEDs, graphs and displays. The output devices of the instrument are simulated by controls and display the block diagram acquired data.

In the LabVIEWblock diagram shown in figure 14, the objects of the front panel is appeared as terminals and also objects of block diagram includes sub VIs, wires, structures, constants and functions by transferring the data between other objects. Once the user interface is created, using the VI's, the code is added, structured to control built objects of front panel which uses graphical representation of functions.

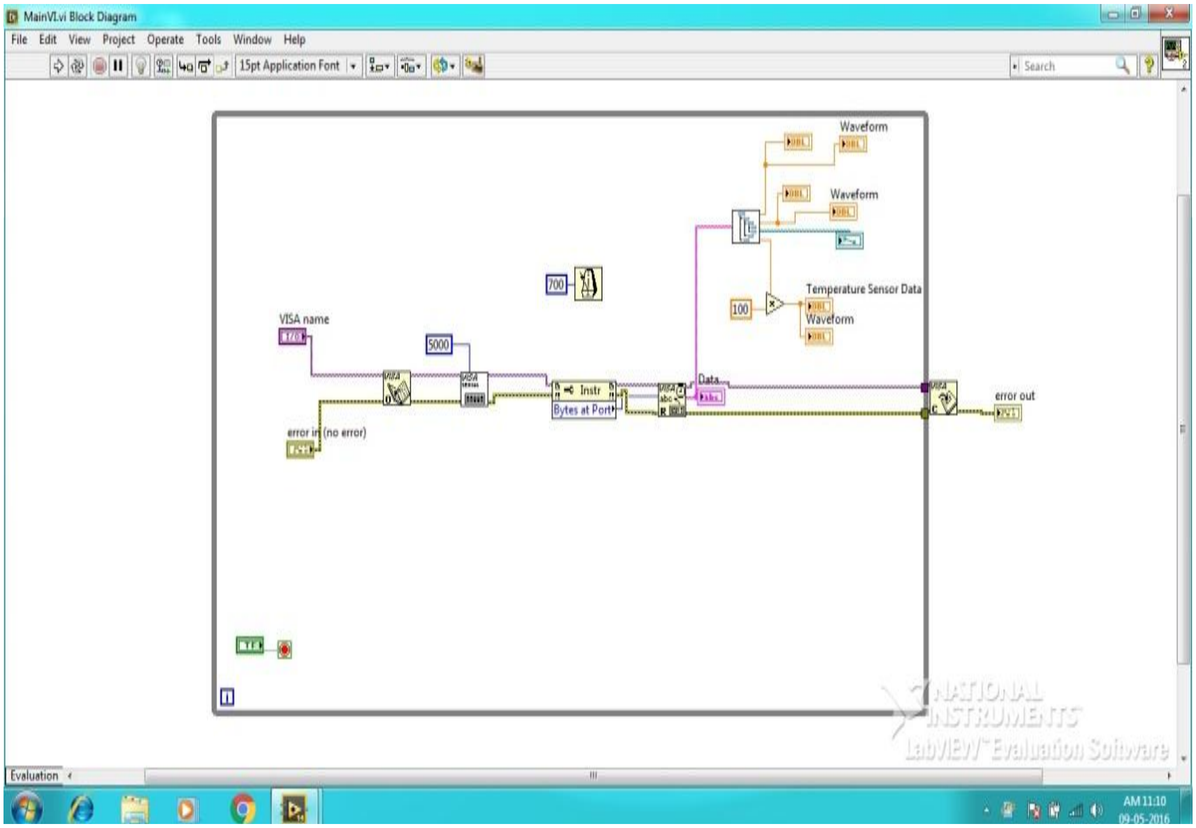

Figure 14.LabVIEW Block Diagram

To setup a build and deploying the source code into an application executable, the project explorer is essential. The files are checked easily in and out of the system source code by integrating through a tool source control and the application is deployed or distributed when it is finished and it is shared.The user-friendly graphical user interfaces in LabVIEW are created which involves sub panel, splitter, decorations and tab control etc. The system palette is used to control to create GUI but not created from classic or modern palettes and the controls appearance is MS Windows standard. It has look, feel, user friendly and changes due to the operating system appearance changes.Plotting the data has the functionality more powerful which is offered by LabVIEW. There is a graph palette which has more controls useful for visualization and plotting of the data in the waveform graph, waveform chart and XY graph. The LabVIEW customizes components of different chart. The colors are set and different line styles are created by clicking "Plot Legend."

VI. RESULTS AND DISCUSSIONS

The monitoring system developed was tested using LabVIEW and found satisfactory with the results which are tabulated in the below tables. In the Table no. 1, it shows the readings of Date and Time, Temperature sensor data, Potentiometer data and External voltage values which were displayed on the front panel of LabVIEW.Graphically, the temperature sensor data, potentiometer data and voltage and current data against time were plotted in the figure 15, figure 16, and figure 17 respectively taken from the sheet data of MS excel.

Table No. 1: Displayed data of time, temperature, potentiometer and external voltage at DATE: 17/05/2015 and TIME: 00:09:00 am to 00:28:00am.

Time in minutes	Temperature in ° C	Potentiometer in volts	External voltage (V)
00:09:00 am	29	5	2.24
00:10:00 am	28	5	1.91
00:11:00 am	26	5	4.87
00:12:00 am	22	5	5.00
00:13:00 am	34	5	3.67
00:14:00 am	28	5	2.80
00:15:00 am	26	5	4.75
00:16:00 am	21	5	5.00
00:17:00 am	26	5	1.93
00:18:00 am	36	5	2.63
00:19:00 am	25	5	3.21
00:20:00 am	21	5	5.00
00:21:00 am	27	5	2.84
00:22:00 am	22	5	5.00
00:23:00 am	25	5	2.84
00:24:00 am	22	5	5.00
00:25:00 am	26	5	2.29
00:26:00 am	22	5	2.54
00:27:00 am	29	5	1.93
00:28:00 am	27	5	1.91

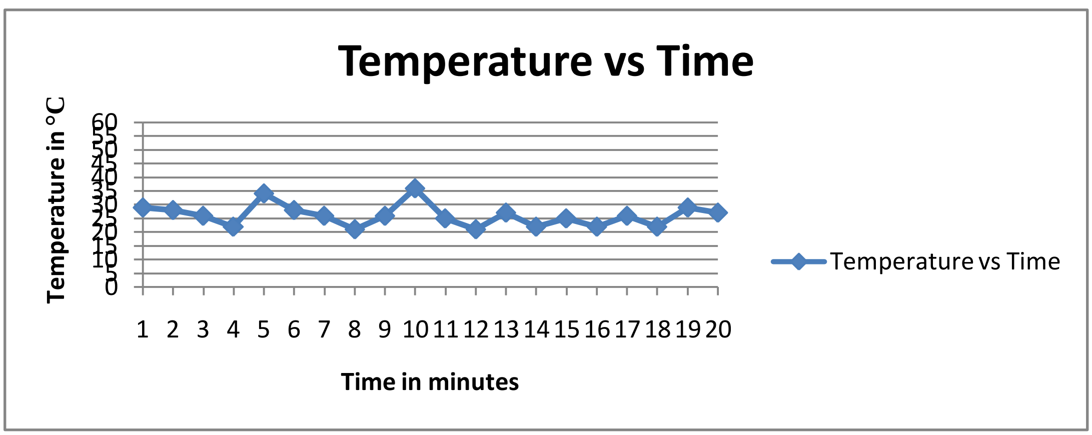

Figure 15.Temperatrure versus Time graph on 17/05/2016 at Time 00:09:00 am to 00:28:00 am

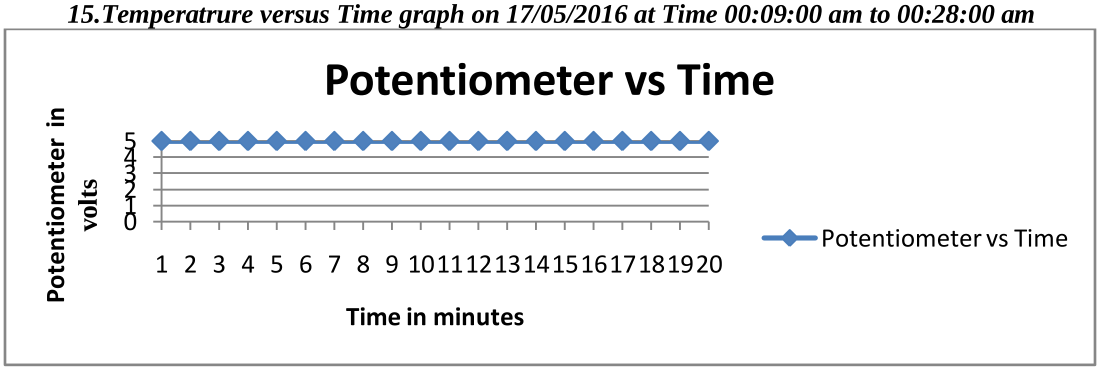

Figure 16.Potentiometer versus Time graph on 17/05/2016 at Time 00:09:00 am to 00:28:00 am

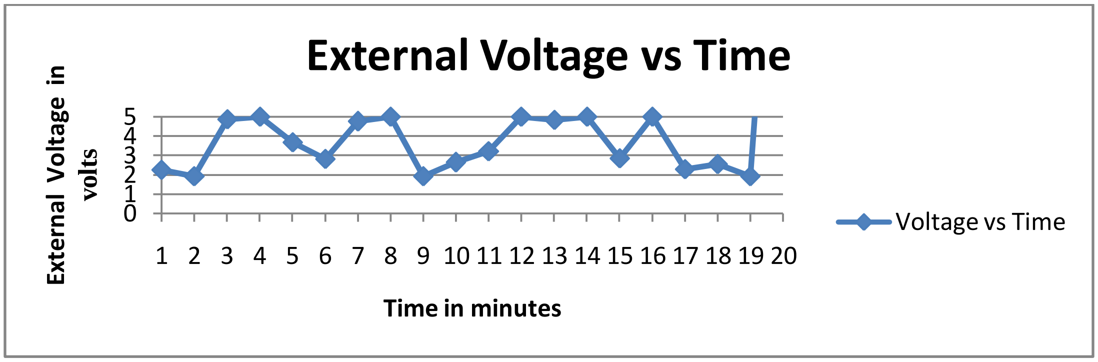

Figure 17.External Voltage versus Time graph on 17/05/2016 at Time 00:09:00 am to 00:28:00 am

The figure 21 shows the front panel of LabVIEW screenshot displaying the parameters data with waveform was taken under testing time after clicking the RUN command of the LabVIEW.

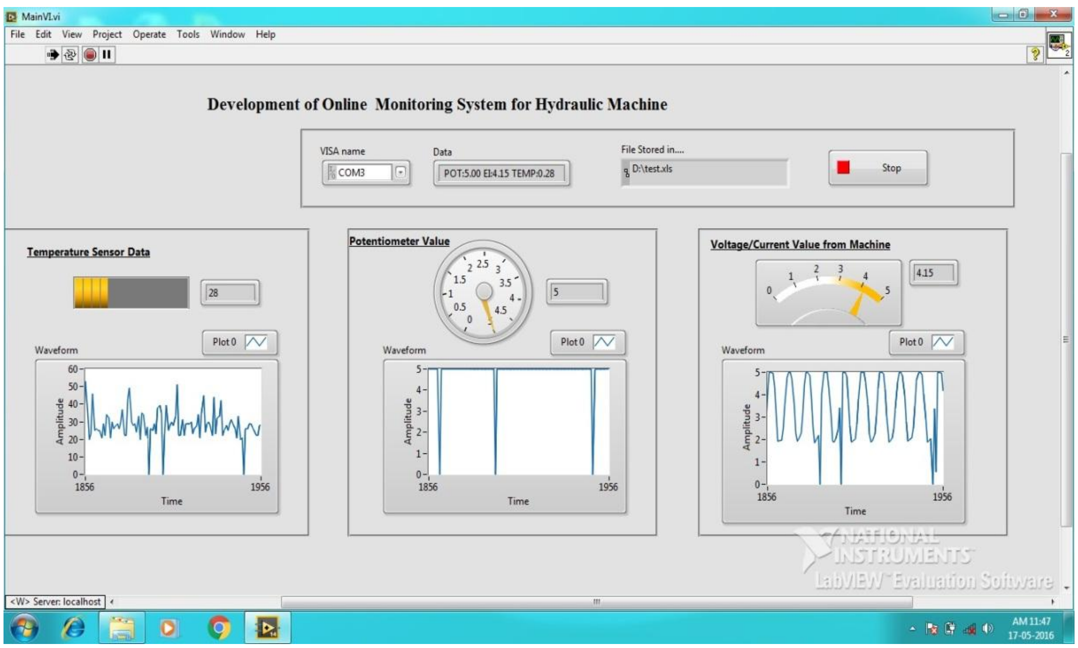

Figure 21: shows the front panel of LabVIEW screenshot

The data were saved continuously in ".xls" sheet of Microsoft which can be used for the analysis purpose so that the machine can be monitored continuously and prevented at the earliest without any faults occurring to it. The front panel displayed data on the LabVIEW was found to be available on the web server using the modem device connected to the computer or Laptop by entering the web address at any location and at any time.

VII. CONCLUSION

This paper concludes that development of online condition monitoring system (DOCMS) for hydraulic machine was made to know the health status of the machine at any time round the clock and the measured parameter data like temperature data, potentiometer data, and current or voltage values can be obtained through online.The DOCMS using LabVIEW was tested for online measurements at any given interval of time successfully.The graphical waveforms of temperature data, potentiometer data and the current or voltage values with respect to time which are displayed on the front panel of LabVIEW can used for analysis purposes of the machine.In this prototype model, the data displayed in the front panel data of LabVIEW with graphical representation on the computer can be accessed anywhere for monitoring purpose.The DOCMS using LabVIEW displays all the input parameters on the front panel window /simultaneously with its data and graph for the analysis work.The temperature data, potentiometer data and the current/ voltage values are continuously stored and saved in the excel sheet of the Microsoft every second with date and time which can be used for monitoring the condition of the machine.The DOCMS using LabVIEW provides high performance with low cost, helps to reduce down times, reduce maintenance costs, improve reliability, provides safety and reduce skilled manpower.The DOCMS future scope is that the system can be flexible for more than one hydraulic machine and their parameters data can be displayed at a time which can be used for analysis purpose.The DOCMS future scope is that the system can be flexible for more than one hydraulic machine and can be used for analysis purposes.The developed system can be applied to monitor different hydraulics laboratory experiments or projects.The DOCMS is suitable for different applications like solar monitor, wind monitor, oil and gas industry etc. for analysis purpose by continuously monitoring the system.

REFERENCES

[1] DarkoLovrec, Vito Tic, On-line Condition Monitoring Systems for Hydraulic Machines, UDC 621.22, FACTA UNIVERSITATIS, series: Mechanical Engineering Vol.10, N0 1, pp. 81-89, 2012

[2] Dr. George P Succi and Dr. Harrison Chin, Helicopter Hydraulic Pump Condition Monitoring using Neural Net Analysis of the Vibration signature, SAE Aerospace Atlantic Conference, May 1996, Dayton, OH, Paper No.961307.

[3] Chokribelhaj Ahmed*, Mahmoud Kassas, Syed Essamuddin Ahmed, PV-standalone monitoring system performance using LabVIEW, International Journal of Smart Grid and Clean Energy, vol. 3, no.1, January 2014.

[4] DiptiAgarwal, Mr.NareshYAdav, Mr.SureshSaini, Condition Monitoring of Slip-ring Induction Motor, International Journal of Innovative Research in Advanced Engineering (IJIRAE) Issue 3, Volume 2 (March 2015).

[5] SaadChakkor, MostafaBaghouri, AbderrahmaneHajraoui, Wind Turbine Fault Detection System in Real Time Remote Monitoring, International Journal of Electrical and Computer Engineering (IJECE), Vol. 4, No.6, December 2014, pp.882~892, ISSN:2088-8708.

[6] Victoria J. Hodge, Simon O'Keefe, Michael Weeks, and Anthony Moulds, Wireless Sensor Networks for Condition Monitoring in the Railway Industry: A Survey, IEEE Transactions on Intelligent Transportation Systems, Vol. 16, No.3, June 2015.

[7] Samuel Telford, Muhammad IlyasMazhar and Ian Howard, Condition Based Maintenance (CBM) in the oil and Gas Industry: An overview of Methods and Techniques, Proceedings of the 2011 International Conference on Industrial Engineering and Operations Management Kuala Lumpur, Malaysia, January 22-24, 2011.

[8] E.Ariza, A. Correcher, C. Vargas and F. Morant, Supervsion, Condition Monitoring and Fault Diagnosis System in a Hybrid Renewable Energy Systems (HRES) Laboratory, International Conference on Renewable Energies and Power Quality (ICREPQ'15), Renewable Energy and Power Quality Journal, ISSN 2172-038 X, No.13, April 2015.