Retraction

Retraction: Solar Powered Real Time Transformer Health Monitoring System Using Internet of Things (IoT) (J. Phys.: Conf. Ser. 1916 012155)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Solar Powered Real Time Transformer Health Monitoring System Using Internet of Things (IoT)

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Abstract. Distribution transformer are primary and most important segment in a distribution system. As there is no efficient protocols to monitor the vital parameters of the transformer, the transformers health declines rapidly, thereby resulting in complete failure or partial malfunction in the distribution transformer. So we give a system to detect the health of the transformer. Using the help of the sensors we can sense that variations in current, voltage, temperature in the transformer. Before this changes cause any damage in transformer we will cut off the supply. Also it will store in cloud for the future analysis. The system will also detect the abnormalities in the measured parameters and then sends an alert message to the authorized personnel about the situation. Then the personnel can assess the situation by viewing the real time data that is made available in the IoT platform and can download for any report.

Keywords: Transformer, Cloud, Monitoring system, IoT

1. INTRODUCTION

The Distribution transformer are one of the main component present in the distribution side, it acts as the final step in the connection between the generating station and the consumers. When the distribution transformers are not monitored properly it can result in the malfunction of the transformer [1]. The malfunctions can be overcurrent, over voltage, increase in the transformers core and increase or decrease in the oil level. To protect the transformer normal function from these common system malfunctions, we propose the transformer monitoring system. As the transformer can be subjected to voltage fluctuation we have given an external supply to the microcontroller and the connectivity modules from a solar panel [2]. The micro controller and network connectivity module are programmed specifically to do the required operation and are fully programmable for future updating and changes. The monitoring system is controlled by a microcontroller which collects the transformer vital parameters and the analyzes it with the basic rating of those transformer parameters, As the existing system that is proposed to monitor the transformer lacks a consistent power supply to the microcontroller and the connectivity module ,it lacks in that part as the parameter monitoring will be severely affected once the existing power supply to the system fails [3].

So the newly proposed is provided with such backup and direct supply from a solar photo voltaic system. The system thereby collects the vital parameters and then stores it in an IOT platform so that it can viewed for future optimizations [4]. The system can also alert the authorities of the
happening malfunctions in the transformer the real time monitoring makes the electrical distribution network more efficient and error free. The system so that give us a complete set of monitored values and with that we can even calculate the distribution losses and monitor of electrical theft. The proposed system can eventually send an alert message to the authorized personnel via an GSM module, about the abnormal situation in whatever parameter that is not in its normal or beyond the rating of the transformer [5].

The proposed system can reduce the human work in monitoring the distribution transformers which are placed in remote areas. The automation in the monitoring can greatly reduce the work of labours and provide us the key for further optimization of the transformers and implementing load sharing in the transformers which are in such remote areas.

2. FAULTS IN TRANSFORMERS
The main faults that occur in a distribution transformer are due to current, voltage, temperature and oil related. So by effectively monitoring these values we can easily find out the malfunctions in them and maintain their health normally, So it don’t get into complete failure.

2.1 Current monitoring: The main and the foremost malfunction in the distribution transformer is that they are susceptible to overcurrent or overload situations. As the load increases thereby increases the current drawn by them, if it goes beyond the rated value it can damage the transformers core.

2.2 Voltage monitoring: The voltage values increases when the line to ground connections are not proper, it means that the earthing is not proper in th system. It can lead to fault current and voltage values which will degrade the systems health. So monitoring the voltage value is miscellaneous

2.3 Temperature: The most ignored parameter in monitoring of the transformer is the temperature values. The temperature of the core increases when the Coolant level decreases or when the fault current increases in the system, So by monitoring the temperature values we can easily reduce the damage to the core during malfunction.

2.4 Oil level: The oil in transformer acts as a coolant as well as an insulator. It is commonly monitored and controlled by the buchholz relay, but further monitoring is needed to avoid error as oil is an important part in the transformers system. So we have added an part to monitor the level of the oil in this proposed system.

3. PROPOSED SYSTEM
The proposed system is a distribution transformer health monitoring system using internet of things(Iot), it consists of units which will monitor and record the parameters in the transformer. The parameters to be monitored are secondary voltage, load current, temperature and transformer oil parameters. The voltage value on the secondary is measured and recorded by connecting a potential transformer in parallel with the load section, thereby it can give us a reduced voltage value which will be converted to a digital value by using a voltage sensor(it converts the analog voltage value to a digital output). Then the current value is measured by connecting a current transformer in series with the load to acquire the load current values, it also reduce the current value upto a certain ratio and then sends it to the current sensor which will change the analog current value to digital value and then it is sent to microcontroller which then multiplies or divides the reduced current value to produce the actual value [6].

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The temperature value in the transformer core is recorded by a temperature sensor and the oil level in the tank is measured by using a oil level sensor. Then the gathered values which are in the microcontroller are converted into string functions and then fed to the network connectivity module so that it can read and upload the information to the Iot platform [7].

The shared information in the Iot platform are then converted into graphical model and can viewed by the authenticated user. The system not only shows the values in graphical format but also gives overall values acquired in the required set of format for report making and data collection.

Then by making use of the proposed system we can be provided with the complete set of data and timings of malfunctions and failures of the transformer. In any abnormal situation that is when the parameters vary beyond its normal ratings, the system will send an alert message to the authorized personnel via an GSM module and the authorized can get into the cloud platform to obtain the real time values of the abnormality in the transformers parameters as shown in Figure 1.

**Figure 1. Block diagram of proposed system**

### 3.1 BLOCK DIAGRAM DESCRIPTION

The block diagram represents the system which can be used to monitor the distribution transformer. The voltage and current transformers are used to obtain the voltage and current values, the temperature sensor LM-35 is used to measure the temperature and the oil level sensor is used to obtain oil level measurements. The values are gathered by a microcontroller and then transferred to the IoT platform by using a wifi module(Node MCU). The microcontroller and the node MCU are both powered by using a solar panel which ensures the continuous operation of the system by making use of a backup power source from a battery. The GSM module is set to alert the authorized personnel about the happening abnormality in the transformers basic parameters values [8].

### 3.2 PV SYSTEM

A photovoltaic system is a system used to convert the solar energy into electrical energy. The system uses a photo voltaic cell which emits anions when its surface is exposed to sunlight [9]. The positive terminal of the cell is connected to the negative terminal of the battery and vice versa. In general cases
the photo voltaic cell is directly connected to the load, but in our case the cell is connected to a regulator module and a battery so that the Arduino gets constant uninterrupted supply as shown in Figure 2.

![Figure 2. General structure of pv cell](image)

The ideal circuit of a photovoltaic cell is connected with a current source in parallel with a diode but in practical cases the cell is not ideal, so a shunt and a series resistance is added to the circuit. The shunt resistance has a high value of resistance compared to the series resistance, so that to create a low resistance path [10].

Applying Kirchhoff’s current law to the node where $I_{ph}$ enters the node and, diode, $R_p$ and $R_s$ meet, we get Equations (1-3)

$$I_{ph} = ID + IR_p + I$$  \hspace{1cm} (1)

We get this equation for the photovoltaic current:

$$I = I_{ph} - IR_p - ID$$  \hspace{1cm} (2)

$$I = I_{ph} - I_B \left[ \exp \left( \frac{\gamma H_1 R_s}{V_t} \right) - 1 \right] \left[ \frac{(1+R_p)}{R_p} \right]$$  \hspace{1cm} (3)

The proposed system contains a solar cell which provides energy to the microcontroller as well as to the network connectivity module. The previous system are not provided with a stable power source, which result in loss in data transmission during a power failure. so we have proposed the updated system with a power source from a renewable energy source from a solar panel, which will charge a battery source for backup and mainly powers the microcontroller which is Arduino.

### 3.3. CURRENT TRANSFORMER

Current Transformer is a protective device that protects the assigned circuit from high current values. So as the circuit operates completely without any failure. The current transformers primary is connected to a high current rated circuit and secondary to the circuit that needs protection. The current value applied to the primary is reduced to a small value. The current value on the secondary is proportional to the rating of the current transformer. The current transformer that we used in the system has maximum rating of 20A and reduces the applied high current value to an average of 8mA as shown in Figure 3.
3.4. POTENTIAL TRANSFORMERS

The potential transformer otherwise known as voltage transformer is a protective device that protects the particular circuit from high voltage values. These transformers are mainly used to protect the underlying low voltage circuit that requires comparatively very low voltage values for its operation. The voltage transformers are connected in parallel to the underlying circuit as shown in Figure 4.

The potential transformers found their major application in electric metering and electrical protection circuits. The primary winding of the potential transformer is connected to the high voltage circuit or supply.

The secondary of the transformer is connected to the low voltage circuit. The potential transformer is basically a step down transformer, it reduces the primary voltage that is fed to the secondary and steps down it to a certain voltage based on the rating of the transformer.

The stepped down voltage is now reduced as aptly to the circuit, so it operates fine without any malfunctions or failures. The potential transformer we used here reduces the applied 50V to 5V. The reduced voltage values is then fed to the voltage sensor which converts the stepped down analog voltage value to digital values. Then the digital value is fed to the Arduino micro controller and the micro controller converts the numerical values to string so that the network connectivity module grasp the data and updates it to the IOT platform.

3.5. TEMPERATURE SENSOR

Temperature Sensor - The LM35
The LM 35 temperature sensor is used in the proposed system to monitor the abnormality in the distribution transformers temperature. The temperature sensor measures the temperature values by detecting the change in electrical resistance or current values. The detected temperature is then acquired by the microcontroller which then transmits it to IOT platform for us to monitor and analyze.

3.6. ARDUINO

The Arduino UNO is a microcontroller which can be programmed in possible ways for the customized use of the user. The Arduino UNO micro controller has 32K bytes of flash memory and 2k bytes of SRAM which is higher than most low end pc’s. The Arduino micro controller in the proposed system is used to acquire the digital data in the system and then convert it into a string, so that the network connectivity module can read and transmit those data. The micro controller has a reset pin which will format the entire micro controller, so that we can update it if required. The sensor values are acquired by programming the microcontroller based on the pins used by the user. The programs are then uploaded to the micro controller by using a USB cable which will be connected to the serial port in the arduino which will even power the Arduino. Figures 5 and 6 shows the graph.

3.7. LEVEL SENSOR

Level sensor is a device that senses the change in level of the liquid by using a floating dock or sensitivity sensor. The sensor measures the change in level by using a proximity technique, which will detect the liquid level when it touches the sensors surface. It then converts it into an electrical signal and the micro controller reads the values and transmit it to the IOT platform. Figures 7 and 8 shows the current and temperature gauge.
3.8. NODE MCU
The Node MCU gathers the data collected by the microcontroller and then shares it to the IoT platform. It uses an API key from the IoT platform to share the data, thus we should program the Node MCU by giving it the destination server address and API key through which it connects with the server. The network connection is given by a WIFI network, which is also programmed in the Node by giving the networks name and password through which it automatically connects to the network when its turned on.

3.9. GSM MODULE
The GSM module is connected to the Arduino to do an essential and a most important function. As the abnormal condition is detected in the transformer basic parameters, micro controller analyses whether the rapidly changing parameters are under the normal ratings of the transformer. If the observed readings are not under the rated values, the microcontroller activates an alert message based on the acquired values with the parameters name and the transformers current status. The message will be sent to the authorized personnel and the personnel can access the cloud page and analyze the parameters to work on its recovery and normal operation. Figures 9 and 10 shows the result. Table 1 shows the specification.

4. RESULT AND DISCUSSION
4.1. Hardware output specifications

| Parameter | specification | input | output |
|-----------|---------------|-------|--------|
| Retracted | Retracted     |       | Retracted |
Voltage sensor | Step down | (0-230)V AC | (0-5)v DC
---|---|---|---
Current sensor | Step down | (0-5)amp | (0-1)amp
Microcontroller | Control & monitoring | (0-5)V | (0-5)V
IoT | monitoring | monitoring | monitoring

### 4.2. Software output

![Current Graph](image1)

![Voltage Graph](image2)

**Figure 9. Current Graph**

**Figure 10. Voltage graph**

The proposed system as expected monitored the transformer effectively and we obtained a set of readings based on the normal and abnormal conditions. It is observed that the system when under abnormal condition has sent alert signals to the authorities via the GSM model and the cloud system provided the correct records of the measured readings, in both normal and abnormal condition.

#### 4.3. Advantages

- The main advantage of implementing the system is that time can be saved in finding the malfunction in transformer placed in remote area.
- The acquired information about the transformers loading and unloading can be used in future when load sharing techniques have to be implemented.
- The real time data acquiring techniques helps in solving the problems faster and in efficient manner.

#### 4.4. Application

- The proposed system can be used in a distribution transformer which is located in a remote location.
- The technique can even be implemented in a standalone transformer.
- The proposed method can be adopted by the electrical boards for creating a transformer monitoring network.

### 5. CONCLUSION

From this project we have formed a system that can monitor the Distribution transformers health, the system thereby monitors the health by carefully calculating and analyzing its essential parameters such as load current, secondary voltage, Transformer core Temperature and Oil level in the transformers coolant tank. The mentioned essential parameters are obtained by using the microcontroller and wifi module through a number of sensors and they and transmitted to a far location where the main
monitoring station is located. Upon gathering the data we can easily determine whether the transformer is under normal operating condition or not, if the transformers parameters vary indefinitely based on time as we have obtained those readings in an abnormal over load condition, the current value increased beyond the rated current that the transformers secondary side or load side can withstand. As the system is monitoring the current value, it automatically sends an Alert signal to the authorized personnel via the GSM module. Thus the abnormal current parameters are indicated the personnel can view the whole set of reading before and after the over load condition. The readings set comprises of the date and time of those readings which are obtained under over load condition can clearly show the abnormality in the voltage, current, oil level and temperature of the core. Those readings can be compared with the readings under normal condition, to prevent future over load related malfunctions. The result of the project we done shows that the smart monitoring of the distribution transformer is effective in its operation and can be implemented into the systems for efficient transmission and distribution. The notification of the abnormal condition has also been sent at the right time to the authorized personnel and so the transformer will be repaired or shut down for safety of the transformer as well as the networks connected to it. The showcased user interface in the IoT platform has been recognized as one of the effective and efficient methods to centralize all he transformers into a single control and monitoring unit. So the manual work can be done in time and system failure can be reduced.

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