Distribution Transformer Monitoring using IoT

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Abstract

- We have created a system for remote monitoring and data analytics of vital parameters of a distribution transformer in real time. According to our system model, all the distribution transformers in a particular area would be equipped with a microcontroller unit and various sensors.
- To measure various important transformer parameters. We have divided the monitoring task into 3 subtasks:
  i) General Parameters Monitoring
  Ii) Oil and Gas Monitoring
  iii) Breather Moisture Monitoring
- All the above parameters are transmitted via the internet to a website accessible by the power company's engineers.

General Parameter Monitoring

- Winding Temperature: Measured by a thermistor, it tells the operator whether the winding is overloaded, and can help predict short circuit faults.
- Conservator Temperature: This parameter is measured by a BMP sensor, and provides the temperature level of the conservator.
- Conservator Air Pressure: This parameter is measured in parallel with the conservator temperature. Prevents transformer explosions due to build-up of gases.
- Conservator Oil Level: Shows how much oil remains in the conservator's reserve. Measured by using a ultrasound sensor.
- Hum and Vibration Analysis: Using Z-score anomaly detection, we can detect faults. Transformer vibrations are acquired using a microphone.

Gas and Oil Parameters, BREATHER MOISTURE

- Quantity of CH3, CO, and H2 gas dissolved: An array of gas sensors, namely MQ4, MQ7, and MQ8 are used to measure the amount of dissolved gases in the oil. Since the amount of dissolved gases in oil and gas in the air surrounding is in equilibrium, we can accurately detect the levels of gases in ppm that is contained within the oil. Gas levels can be used to predict faults such as low and high energy partial discharge, overheating, etc.
- Spectral analysis of transformer oil: Using IR sensors, we detect the opacity and characteristic color of degrading oil to predict the health of the oil and when it needs replacement
- **BREATHER MOISTURE ANALYSIS**
- Humidity and Temperature Measurement: Using a calibrated DHT-11 sensor, the amount of moisture and the temperature in the breather can be measured and is relayed to the website.
- Silica Gel Replacement Detection: Using a color sensor, the quality of the silica gel present in the breather can be determined. Silica gel turns to pink from blue when it is saturated with moisture. This principle is used to obtain data on the due date of silica gel, and hence will reduce unwanted maintenance visits by engineers.

OUR PLAN

- Installation of all sensors in the distribution transformers. That would need an additional installation cost of Rs. 500.
- Running requires just a wi-fi connection and some power consumption by our Microcontroller unit. (NodeMCU consumes about 1W, additional sensors: 2-3W, AC to DC loss = 5-20%, max power consumption = 5W, energy consumption of 0.005 KwH)
- A website has been created to view and export the sensor data. The website can potentially handle a large number of distribution transformers, each of which has its own parameters tracked.
- All the sensors on the distribution transformer is connected to a NodeMCU.
- The NodeMCU relays all the data acquired through an IoT service called UbiDots. The data is then transmitted onto the website where it is displayed graphically for better insight into the data.

Cost of the system

- NodeMCU x 2: Rs. 640
- MQ4 gas sensor: Rs.150
- MQ7 gas sensor: Rs.140
- MQ8 gas sensor: Rs.160
- Ultrasonic sensor: Rs. 120

- NOTE: This is the cost of sensors which were used for model building. In actual industrial implementation, sensor cost will be more. Approx. total cost: Rs. 15000 per transformer

- Color sensor: Rs. 320
- DHT-11 humidity and temperature sensor: Rs. 60
- BMP-180 pressure sensor: Rs. 180
- IR LEDs and Photodiodes x 2: Rs. 20
- Thermistors: Rs. 15
- Initial installation cost: Rs 500

Total: Rs. 2,305

Approximate timeline for completion:

6 months

Why this monitoring system?

-Very handy for chief engineers to monitor the health of each and every distribution transformer in their division and get alerts if some anomaly happens

-Customer base is huge- all the electricity boards

-Very few competitors in India

-Will enable full condition monitoring and real time analysis and fault prediction and prevention

-Decreases hassles of making physical visits to transformers to check their health

-Saves time and human effort