REAL-TIME MONITORING AND PROTECTION TO THE TRANSFORMER

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Abstract:-

A transformer is a critical component of the transmission & distribution system. The aim of developing, transformer protection system is to manage in such a way, that we are using microcontroller and IoT to give automatic protection and real-time monitoring to the transformer. There are many faults occurring on a transformer such as over-voltage, under-voltage, intense temperature, etc. The kit is planned in such a manner that it will be compatible with all types of distribution and power transformer of any evaluation. These kit introduced sensor, microcontroller, IoT module. To protect the transformer from any catastrophic failure. Moreover, the system displays real-time data on the PC at the operator station. This system can use for detecting problems before they occur due to this we can prevent faults that are costly to repair and result in a loss of service. We provide an innovative design to develop a system for monitoring the voltage, current, temperature, oil parameters of the transformer in a substation or in the field. The proposed design is developed for the user to easily recognize the transformer if it is suffered by any problems and what are the current online parameters. This system will help the transformers to operate smoothly and identify problems before any catastrophic failure.

Keywords:- Transformer, Faults, Protection, Inrush Current, Relay, IOT module, Monitoring, controlling & protection, microcontroller.

I. INTRODUCTION

As we know, the transformer is the heart of a whole electrical power system (EPS). It is very essential to protect them from various faults that occur in the system due to some natural or unnatural faults. Protection against fault in the electrical power system (EPS) is very essential and vital for reliable performance. A power system is said to be faulty when an undesirable condition occurs in that power system, where the undesirable condition might be short circuits, overcurrent, overvoltage, etc. This system with a unique concept to date is being designed specifically to have complete extreme secure protection for transformers ranging from KVAs to MVAs.

Its main objectives are as follows: -

- To detect & prevent faults that are costly to repair and result in a loss of service.
- The system will be designed for monitoring voltage, current, phase angle, temperature& oil parameters of the transformer at a substation or in the field.
- It will be equipped with the IoT module for the machine to machine wireless communication
- The system parameters will be displayed on the PC or on any internet operated device.
- The system will have a TFT display, which will display online status in graphical and tabular data.
- The system will have all required main protection assembly to protect the transformer, with the backup power supply.

Recent huge interest in Machine to Machine communication is known as the Internet of Things (IoT). They have to look at it continuously by using this project. It can minimize working efforts and improve accuracy, stability, efficiency in this project. Sensors are used to sense the main parameters of equipment such as voltage (over-voltage, under-voltage), over current, high temperature, oil level this sensed data is sent to the microcontroller. This controller checks analyze data provided by sensors and give instructions to protection devices as per requirement and this data further send to the IoT module of these data make sure the right information is at hand for the operator and the operator can make useful decisions before any catastrophic failure on the basis of that data of parameters. So that we need a real-time monitoring system to detect all operating parameter operations, and send it to the monitoring center in time. It leads to Online monitoring of key operational parameters of transformers can provide useful information about the health of transformers which will help the utilities to optimally use their transformers and keep the asset in operation for a longer period.

II. EXPERIMENTAL

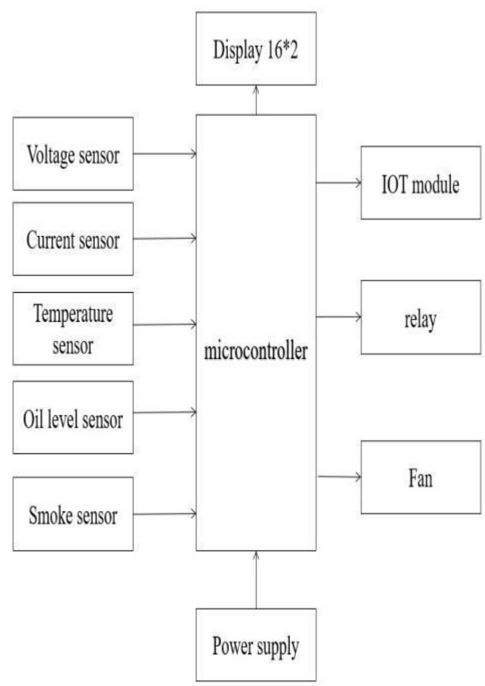

Fig. 1. Watermark Extraction algorithm, Block Diagram

We are using the latest technology to build up this project, it's a prototype model because this project or this system can be used in a high rating transformer which is unaffordable to us and due to sum safety conditions we are showing all the mention system on a prototype model.

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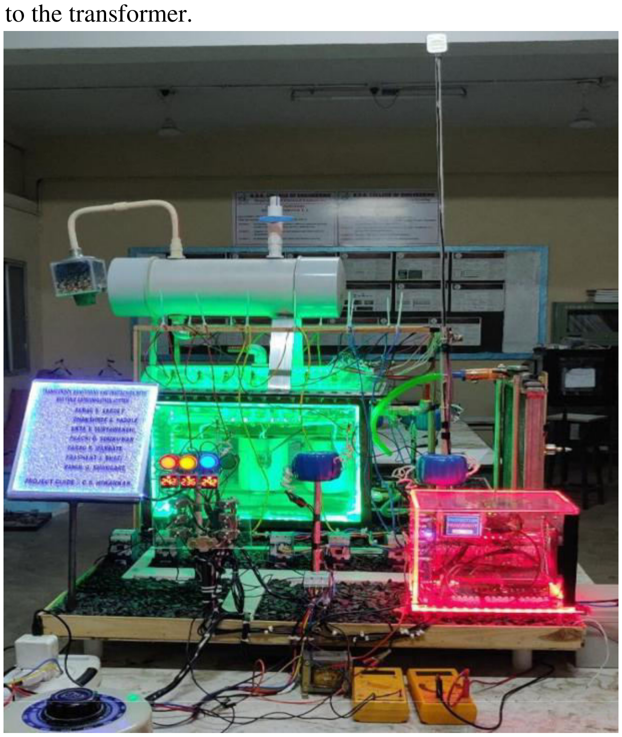
In this system, we are introducing various sensors to sense various parameters of the transformer in various weather conditions. This data can use for the protection of the system and use to reduce disaster occurs due to a fault condition. We are also connecting this data to the " IOT module " for real-time monitoring and if any fault occurs in the system, then the operator can easily identify fault location and fault type so it can help to reduce recovery time and increase efficiency. A component used in the system is as follows:-

1. Voltage sensor (to measure over voltage and under voltage of the transformer)
2. Current sensor (to measure overcurrent of the transformer)
3. Temperature sensor (to measure winding and oil temperature of the transformer)
4. Oil level sensor (to measure oil level in transformer)
5. Smoke detector (to detect fire fault in the system)
6. Microcontroller unit (to control and commanding to the whole system)
7. Fan's (for cooling purpose)
8. IoT module (for real-time monitoring)

All the experimental setup has been fabricated on 5.3x3 feet to have a resemblance of it with real-life power substation. It includes a 3KVA transformer specifically designed with open terminals on both sides of the transformer and no internal vector configuration by default. CTs installed are nearly identical to the practical CTs used in substations. The main configuration of vector groups done automatically uses contactors connected to the transformer.

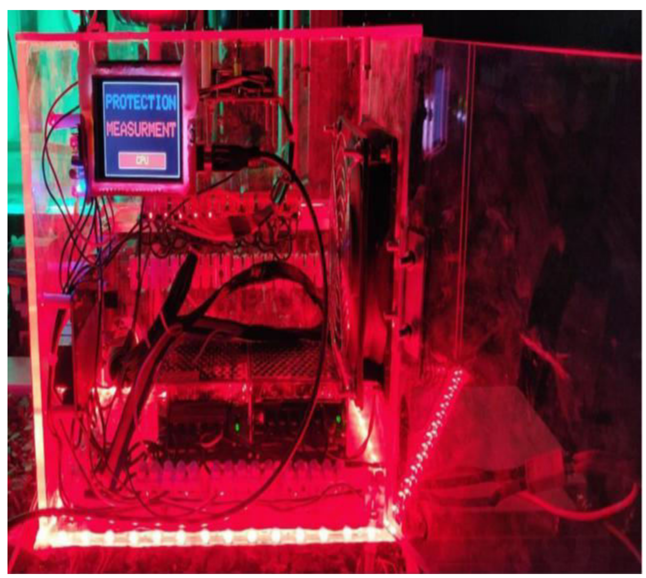


All the wiring connections from each equipment are brought forward up to the main supply point via fiber casing. As the main intentions were to have an oil-filled transformer for which the radiator with cooling fan setup is installed. The bottom surfacing is covered with gravels similar to the layout of a real substation. The setup also includes the main monitoring and protection kit and control panel for automatic vector group switching and connections. 3KVA Transformer: Fabricated with all outcoming secondary and primary terminals open and unconnected, the transformer occupies a total area of approximately 1.5 x2.5". It is covered with acrylic housing supported by a metal frame with wheels to make it mobile. Channel is fixed at the bottom for its mobility and positioning in a similar manner as in the main real-life substations are used. The outcoming terminal is brought down to the contactors (in total six on each side) as the main switching of vector groups will be done by contactors.

Inside the housing of the transformer, the windings are installed with seismic sensors which will be providing a signal to the protection kit in case of vibrations in the windings in fault situations. To have status about all-time transformer temperature, LM35(temperature sensors) are installed from the inner side. These will give ongoing temperature details directly to the display.

Contactors:- contactors are also used for switching purpose and it generally uses power for making and breaking of power supply in electrical products. Mainly for switching and protection purposes, we have used contractors here. To have a different configuration of vector groups as per requirement we need to switch the phase points accurately at start or end terminals of R, Y and B phase on each side, which is done with the help of these contractors.

Radiator for cooling purpose:- Transformer installed in outdoor premises rating in MVAs are oil filled and need



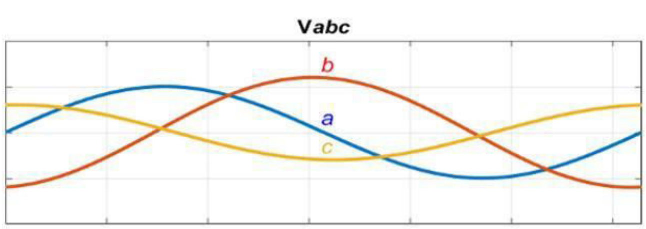
strong cooling systems to keep them working in healthy condition. To have a similar kind of setup for our transformer in this experimental setup radiator for cooling purposes is used. It is provided with a cooling fan and a jaguar pumping motor. This setup is coupled with a temperature sensor and is operated via signals from the monitoring kit when the temperature starts increasing above its normal setup.

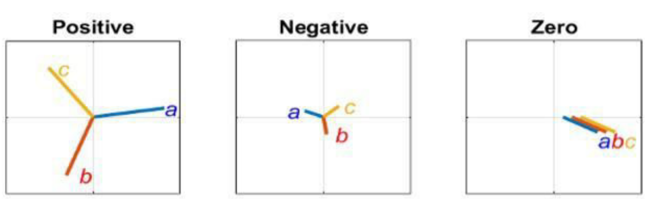
The sensor provides data of current temperature to the kit where it is processed and matched with the normal value, any detection in increased value will pass out a signal to the pumping motor. This will start circulating the transformer oil into the radiator for cooling purposes. If the temperature keeps on increasing then signals for switching on the fan will be given out. Further increase in the temperature will receive a signal for an increase in the fan speed, thus in this way cooling setup is done which will operate automatically when the normal limit is crossed.

Control panel: Automatic switching of vector groups is done with the help of the control panel it consists of phase and supply indicators, digital voltmeters and SPDT switches. Nine SPDT switches are used in total, three for primary side and three. Separate connections amongst the switches for star and delta on each side are done (for having starred at star/endpoint for star connections and start-end/end-star for delta connections). This connection design and logic have completely terminated human errors while doing the connections manually.

Protection kit:- Main part of the whole system mainly working as the CPU the protection kit senses every minute movement happening inside and out of the transformer. It is completely made of microcontrollers (Arduino based) and sensors plus modules which will be receiving input from the various CTs, PTs, sensors process the data and then give the input to the relays and modules to work and give output as per the programming is done in the Arduinos for a proper action to be taken.

Powered by two SMPS units the kit has its own specialty that it can be mounted on any kind of transformers ranging from KVAs to MVAs. As all the ongoing data will be made visible on a TFT display we can have a graphical analysis of the current and voltages inside the transformers. Multiple communication systems are adopted over here by using various modules and systems.

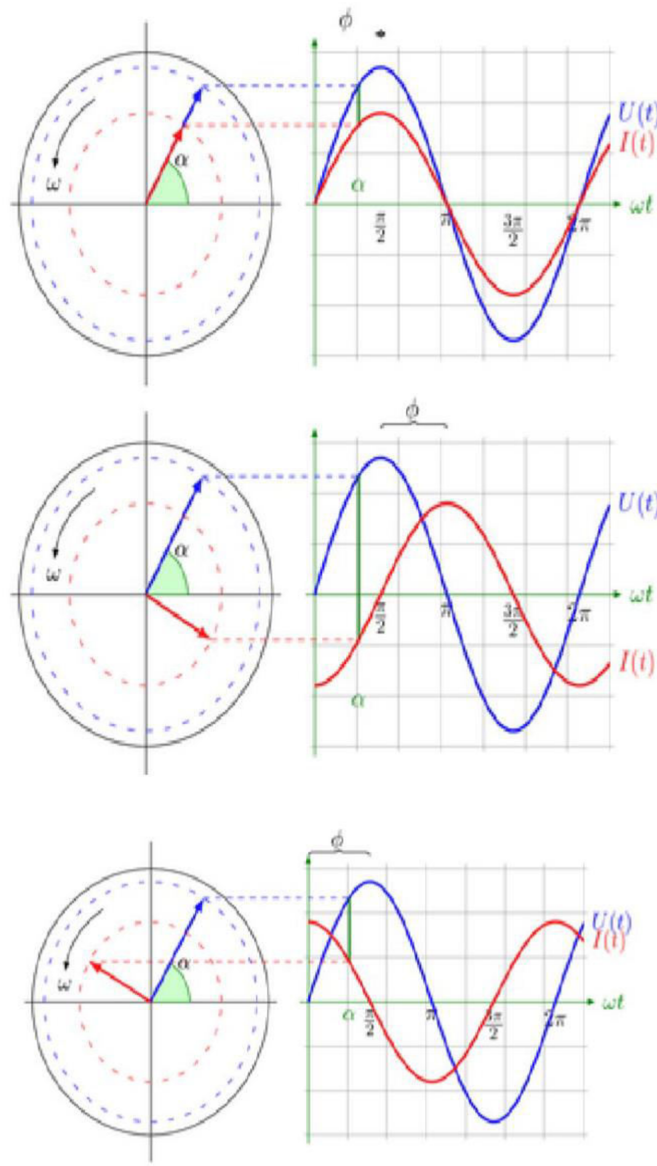




III. FURTHER SUGGESTED WORK

MOBILE APP & MATLAB:- The data of kit would be seen on mobile through a specially designed app in the android studio it will be able to show fault data as well as the online parameters in graphical and tabular forms. With this it will also be able to show the current position of the transformer and also tracking of the transformer can be requested to see the position of the transformer with a time lag of 10 seconds.
The future designed app will be completely compatible with android 4.0 KitKat and above versions of android.

MATLAB Graphical Designing-MATLAB software will be used to processes the data to gate waveforms and vector representation of the current and voltage vectors in a 3d space with proper angular displacement of them. The data to MATLAB system would be received through USB, Lan Wi-Fi etc. The MATLAB software will process the data using a program written in MATLAB script and will show output in the desired form.



IV. CONCLUSION

The problem of high-cost maintenance because of the deformation of transformer winding due to the destructive forces generated in the transformer core and winding assembly under fault condition due to fault current or any other parametric change could be rectified by the developed protection system. The designed kit is capable of providing all the existing primary protection to the transformer which includes differential protection, restricted earth fault protection, overcurrent protection, overvoltage protection with temperature monitoring and controlling via cooling system as well as it also provides over-temperature protection. The advanced feature includes a communication system for data exchange via the IoT module. This specified system makes the kit capable of exchanging data with the desired system placed at any place with high efficiency and reliability with good compatibility and connectivity. The onboard display mounted on the kit is capable of providing the data in proper graphical and tabular form which is easy to read and understand also provides a lot of informative data. The advanced IoT module technique helps in better ways of communications which enhance the improvement in the real-time monitoring process. When the set parameter increases more than the pre-set value, then the circuit will trip & the protection devices are ON. This system most advanced techniques and protection equipment to give 100% efficiency.

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