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Smart substation Monitoring and Controlling by using IOT and GSM

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ABSTRACT: India is stepping into smart world, with digital technology and smart cities. This needs our power system to be smart and responsive. To achieve it we have to upgrade our substations. In our project we are building a replica of a substation and implementing automated monitoring and control mechanisms to ensure that there is 24/7 monitoring of the essential parameters electrical power: voltage and current. These data are uploaded on the cloud server through IOT and also the entire substation can be controlled through an app. With the help of timer mechanism load shedding can be completely automated.

Today's electrical distribution network has grown into a complex network creating challenges for monitoring and controlling. Therefore automation of substation is the way forward for every utility company to increase its efficiency, reliability and power quality. In the heart of this project VCPID controller is used which continuously takes the inputs of voltage and current of the bus and then operates the auto connectors which can be closed and opened depending upon the line parameter values. In case of under voltage, over voltage and over current the auto connector is opened thereby protecting the system. This data is continuously monitored with the help of microcontroller and also uploaded on the cloud with the help of IOT. The substation operation is controlled with the help of GSM remotely by using android app. Load shedding is preset by using timer which can control the peak demand.

KEYWORDS: controller circuit,Timer IOT, Relay, Monitoring.

I. INTRODUCTION

The monitoring of substation is an important task for supplying healthy power to consumer in the automated area. Due to old technology of substation and its having difficulties in manual checking which is more time consuming for utility. The solution to all problem is automation of substation and the parameters are monitored and in future it can be controlled. The microcontroller programming is done in such a way that exceeded value of parameters are inform to web server through IOT by using GSM modem. Therefore it necessary a monitoring system that is able to automatically detect, monitor, and classify the existing constraints on electrical lines. Mainly focusing on monitoring and controlling of power in the range of limit of the meter. The IOT has recently become universal to highlight the vision of a global structure of interconnected physical objects. as more number of electricity- consuming products coming into daily lives, such as electrical vehicles (EVs) and advanced heating, ventilation, and air conditioning systems, load demand increases dramatically and power required at high amount. Improve the quality of power with a different solution, it is necessary to be familiar with what sort of constraint has occurred. Additionally, if there is any inadequacy in the protection, monitoring, and control of a power system. The system might become unstable. Therefore it necessary a monitoring system that can automatically detect, monitor, and classify the existing constraints on electrical lines. Today power still experiences control blackouts and power outages because of the absence of mechanized examination and poor deceivability of the utility over the grid.WiFi will give the service to provide the needed view by collecting information from different sub-systems of the grid. A sensor node will decide information or to slightly delay this notification whether to notify the sink about this information immediately.

A GSM module is used for transmitting the values that are obtained. In general, the proposed design is developed for the user to easily recognize the distribution transformer that is suffered by any open or short circuit and rise in temperatures. The ultimate objective is to monitor the electrical parameters continuously and hence to guard the burning of distribution transformer or power transformer due to the constraints such as overload and input high voltage. Monitoring of substations are essential task for supplying healthy power to the consumers in this automated era.

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II. PROPOSED METHOD

The purpose behind this undertaking is to secure the unknown electrical parameters like Voltage, Current and its associated parameter. And send these ongoing qualities by using IOT and GSM for checking and controlling at the power station.. When fault is occur then this change value sense VC PID controller and gives signal to the GSM as well as IOT.gsm send sms to the operator ,IOT upload data to the web server through cloud. Here two relay is used. One for load shading and another one for VC-PID controller. After occurring fault relay trip the circuit.

The working of this project can be explained with the help of the block diagram shown in the fig.1.The VCPID controller is connected in between primary distribution transformer and secondary distribution transformer. VCPID controller consists of three sections in that first two sections are display units and third is micro controller unit.In display unit there is three knobs are present that are used for delay,under voltage and,over voltage.and four LED'S are associated with it.one LED is used for indication of normal operating condition and others are showing under voltage, over voltage and delay conditions.230v Ac supply is given to the controller kit on which the relay is mounted this will operate when the supply voltage level is exceeded beyond the certain limits.In this

project for creating fault like over voltage by using dimmer stat is done.and under voltage fault condition is created by using under voltage knob.

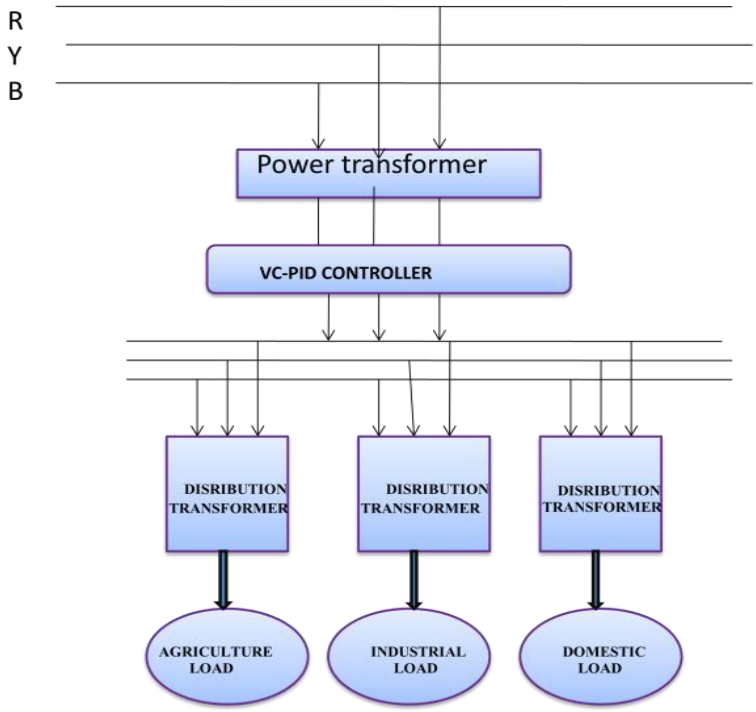

Fig.1: Block Diagram of Proposed Method

In third microcontroller unit, 8051 microcontroller is programmed in such way that it will operate the VCPID controller.

There is two relay contactors in which one is connected to the Timer and another one is connected to the VCPID controller, this two relay contactors are controlled by Timer and VCPID controller respectively.

The VCPID controller is connected to smart substation system (distribution system).In which three distribution transformers are connected to three lamps indicating industrial, commercial and agriculture sectors. in normal condition all three lamps will glow, whenever fault occurs in system like overvoltage ,undervoltage , overcurrent, undercurrent. Then this changed value sensed by VCPID controller and gives trip signal to relay contactor.In which Ardunio UNO interfaced with VCPID controller for sensing voltage and currentvalues.

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Then VCPID controller which is also connected to GSM and IOT (internet of things) WiFi module in which IOT collects and integrates the data and gives all information of parameters to web server through cloud.And GSM gives message to operator.

Relay-

A relay is an electrically operated .switches Many relays use an electromagnet to manage a switch mechanically, yet other working standards are likewise utilized, for example, strong state transfers. Transfers are used where it is important to access a circuit by a different low-control flag, or where one signal must control several circuits. The principal transfers were utilized as a part of long separation broadcast circuits as enhancers: they rehashed the flag rolling in from one circuit and re-transmitted it on another circuit. Transfers were utilized widely in phone trades and early PCs to perform intelligent tasks. A kind of transfer that can deal with the high power required to control an electric motor or other loads directly is called a contractor.

GSM Module

SIM900 A, PID based,12V(original version) Monitoring and controlling of substations are essential task for supplying healthy power to the consumers in this automated era. Depending on the voltage levels and end users, there are transmission or distribution substations those supply electrical power to various loads. Remote monitoring and control make these substations to be operated through wireless communication technologieslike GSM,GPR.

VC-PID controller

This controller here is a PID controller.the hardware module of this controller is shown in fig. 2. below It is used to control the supply to the distribution transformers. If there is rise or fall in the load voltage then the PID controller opens the contactor switch and once the fault is cleared then the supply is restored back. In the same way when there

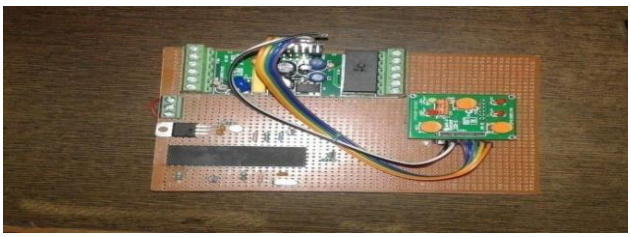

Fig.2. Hardware model of the VCPID controller

overloading condition the current in the supply lines increases and the PID controller operates the contactor to disconnect the supply. Once the fault is cleared then the supply is restored back. So with the help of this controller the fault is identified very quickly and also soon after the clearance of the fault the supply is restoredback.

Digital Timer-

A digital clock timer is used to set the load shedding schedule for the distribution transformer. Also the digital timer is used to set the delay of (say 7 seconds) to restore the supply after the fault is cleared.

The image of the digital clock timer is shown in the fig.3.

Fig.3.Digital clock timer

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III. METHODOLOGY

The complete Functional block diagram of the monitor and control system is shown in Fig.5. the data acquisition is done by sensors connected to the Arduino micro controller. Connection to the Sensor Cloud for data upload is achieved by GSM shield of Arduino. The data is visualized on the Sensor Cloud web application as well as its smart phone App. Alerts and notifications are sent to the user/operator from the GSM internet connection via SMS. From the alert received by the user/operator, he/she can take action on the substation.

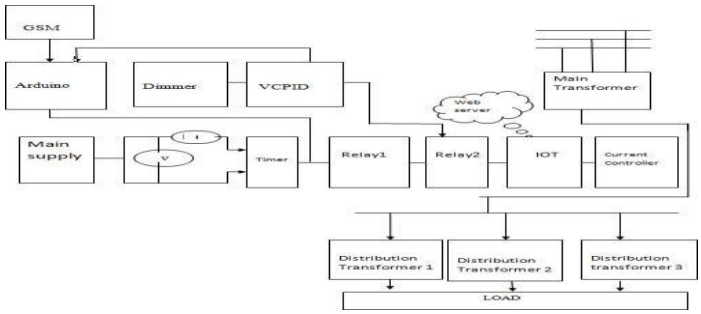

Fig.4. Functional Block diagram of the working model of automated substation

The main idea of any monitoring system is to be able to identify irregularities and abnormalities as they occur to prevent the events which could follow if they are not attended to. In this work, there are two types of notifications used in alerting personnel depending on the severity of the abnormality. One is by GSM and the other byIoT.
The Arduino microcontroller continuously compares the measured data with preset values to decide if the values are within the safe range or attention needs to be placed on it or immediate action is required. First alert is

generated when voltage values start to deviate slightly from its recommended range. This alert is achieved by sending message to operator(s) from Arduino. Second alerts occur when current values start to deviate slightly from its recommended range. Second alert is sent via IoT by using app i.e smart life app .The request to start or stop the substation is received by the Arduino Microcontroller which then, through relays, controls the contactors accordingly to perform the task.

IV. HARDWARE IMPLEMENTATION

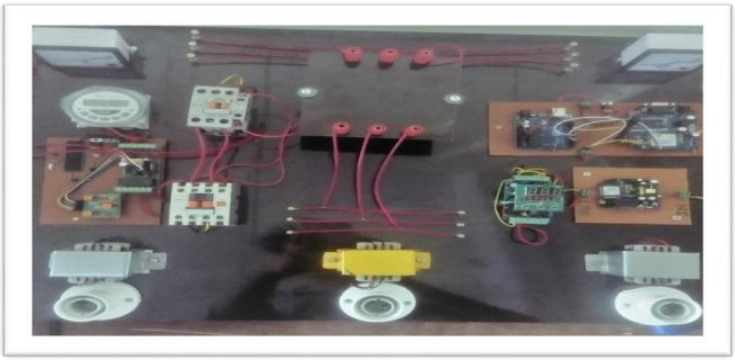

Fig.5.Hardware implementation of smart substation monitoring and control

The hardware implementation was carried out for testing the proposed idea and the final model is as shown in fig.5.With the help of this model the substation model was erected and the operating conditions were varied to verify the operation of the model as per expectations. The over voltage and under voltage

conditions were created by changing the applied voltage through a auto-transformer. Overload condition was simulated by adding the no of light bulbs on the 3 different feeders. Then timer was used to set different on off schedules. Also the timer was used to provide the delay for fault clearance before the supply was restored. The GSM

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module provided the alert SMS and parameter values on the predefined operator. As well as the IOT module continuous uploaded the realtime data on the cloud server.

V.RESULTS AND DISCUSSION

Table No. 1: Experimental data

Sr. No.	Parameter	I/P Value	O/P Value
1	Under Voltage	148v-150v	140v
	Over-Voltage	148v-150v	160v
2	current	0-5A	0-2A
3	GSM	Monitor	Message
4	IOT	Monitor	Control

To test the working of the system the input voltage was applied for a range of 148-150V. The under voltage limit was set at 140V and over voltage limit was set at 148V. With help of an auto-transformer the voltage was varied to create the over voltage and under voltage conditions.It was observed that as soon as the applied voltage fell below the under voltage limit the VCPID controller opened the contactor of the supply and wait for the preset delay of 7s then restore the supply voltage. Also when the applied voltage was above the over voltage limit, the VCPID controller would again operate the contactor to open the supply and wait for the preset delay of 7s before restoring the supply again. After restoring the supply the controller would wait for 3s to check whether the under voltage or over voltage condition is cleared or not and if the abnormal condition is cleared then the supply is restored or else the contactor opens the supplyagain.

For testing the over loading condition, the applied lamp load is increased so that current crosses the preset over current limit, when current crosses the limit the VCPID controller operates the contactor to open the supply to the load. When the over current condition is cleared by removing the load the supply is restored back. The over loading condition is also simulated for short circuiting case. In case of any kind of fault the controller operates to open the supply to theload.

Table No.1.clearly shows the preset values of applied voltage, under voltage, over voltage, the over loading current value and also the status of the substation through SMS and controlling through a IOT module

The above mentioned situations such as occurrence of faults and restoration of supply will be communicated to the predefined operator through SMS alerts. If the supply is shut off due to over voltage condition the corresponding message is sent to the operator number. Also when the supply is restored, another SMS is sent to inform operator. Also in our project it is demonstrated that the supply can be shut down or put on by using the app from a remote location. This provides the operator to control the system from any place in the world.

Fig.6.shows the image of the communication between the substation and and operator through SMS.

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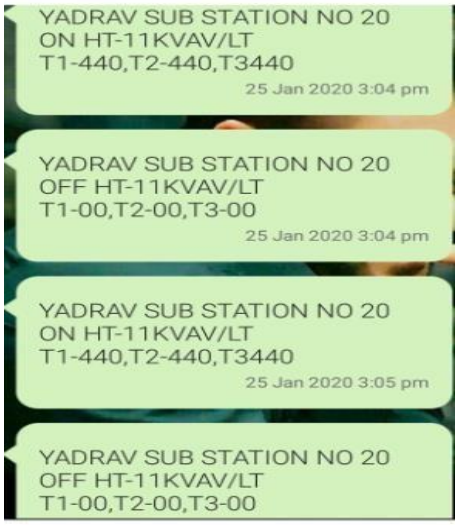

Fig.6. Image of SMS alerts received.

VI. CONCLUSION

This work is an attempt to provide a simplified and efficient system to make the substation smart and secure, the quality of the power delivered to the consumers is ensured by incorporation of VCPID controller which is capable mitigating the abnormal conditions on the system. Therefore the system is automated and also the real time values of the important line parameters are continuously monitored through IOT and cloud server. This provides the complete data of the systems operating conditions for the entire time of its operation. The SMS alert through GSM module keeps the operator informed about the status of the system in case of system is shut down or turned on. Also the operator can start or stop the system remotely with the help of IOT.

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