Centralized Automation and Control of Substations using ZigBee

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Abstract- **The aim of the project is to control different substation parameters at one location using ZigBee. This technology provides communication between two substations and improves the reliability and provides better efficiency. When an event is detected, the program will check necessary data of the overall system such as equipment status, data quality, etc. If any fault occurs, the program will send the message immediately and represent alarm to the dispatchers via data acquiring system display, for both text and acoustic alarm. There by facilitate in reducing the down-time of devices, reducing operator's workloads at the dispatching centre and enhancing utility reliability. This project proposes a centralized monitoring and controlling system for various substation parameters like voltage, current, temperature etc, using one server or at one location by regularly acquiring datasheet of substation using ZigBee.**

I. Introduction

Controlling of electric power substation equipments plays an important role in daily maintenance of electric power system. In substations of extra high voltage, the reliability and accessibility required from substation components is critical. Monitoring and controlling the base station from a single server could improve the quality of accelerating the process of any substation .Our aim is to control the Substation equipment through a single system.

Electrical power is one of the most important infrastructure inputs necessary for the rapid socio-economic development of a country. Currently it constitutes about 20% of the total annual energy consumption on a worldwide scale with an ever-rising demand. This increase in demand has led to the installation and incorporation of a large number of electrical power generation units with increased capacities in a common power grid. This makes the operation of the entire system very much sensitive to the existing conditions. As a result the prevailing extensive and complex power systems have become unmanageable using the conventional instrumentation and control schemes.

Intelligent systems based on microprocessors and computers have been employed for online monitoring and control of new large-scale power systems in generation, transmission and distribution systems. In this project, we propose a centralized monitoring with graphic interfaces and error warning incorporating the entire unmanned substation. It can monitor and control the entire substation within this server station.

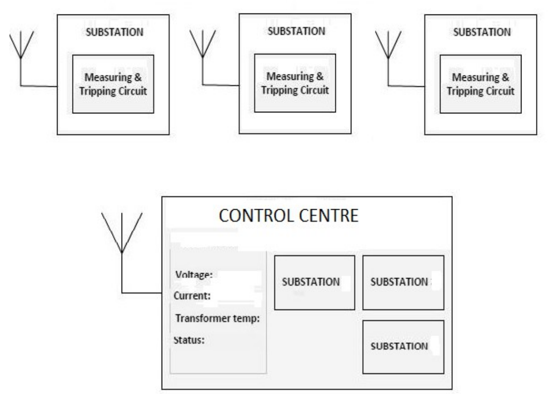


Fig 1: Basic block diagram of centralized monitoring unit

The operating program was developed to monitor the voltage, current and temperature values of the substations. If an error occurs in any part, the notification will be generated via the screen display on the controlling unit. For this system, the user interface graphic of each substation is created to display the connection between each substation and the objects created are linked to the database of the various signals including system status, data quality, and control devices status at the substations. The parameters from all the substations are monitored simultaneously and controlled using the microcontroller program. The program will send a notification to the server and server will send an alarm signal to the base station.

II. SYSTEM ANALYSIS

The electric power is inevitable for the daily life. Whenever, the power gets dropped due to transmission/distribution line faults, it makes many problems to the consumers themselves. Here fault detection and fault clearing are done by manual operations only. The existing system electrical substations require manual switching or adjustment of equipments and manual collection of data for load current, load voltage, and also test the frequency, energy consumption and abnormal events. The substation operations are manually done and man power is the major factor for monitoring, controlling and protecting the substation. The operating difficulties by the man power will leads to increase in the operating cost and decrease in the system efficiency. Due to this type of man power usage there may occurs manual errors while taking readings. The fault detection in the existing system may not be accurate and it will be a time consuming process. In some the manual reading cases of different parameters may not be accurate and interpretation is difficult. Hence the different labours may conclude at different understanding of a particular description. However, there are several unresolved issues which are occupied on the traditional system.

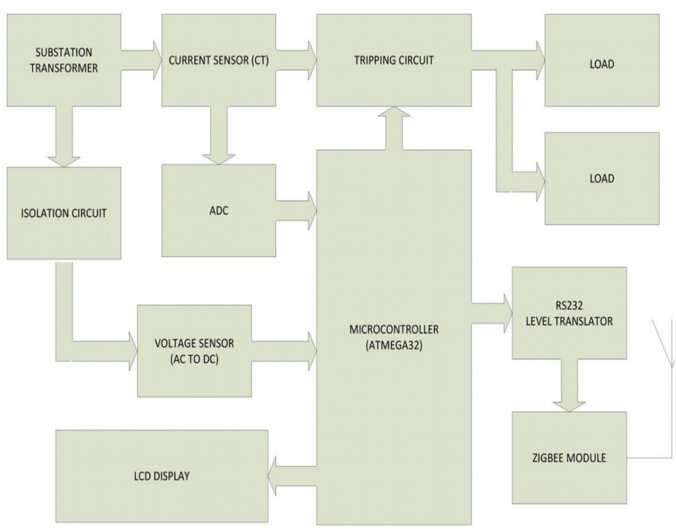


Fig 2: Detailed block diagram of proposed system

In this project an ATmega32A microcontroller is used with required board power supply section. The board power supply section which consists of a step down transformer, a bridge rectifier, filter capacitor and a voltage regulator. The step down transformer attenuates the AC to AC from high voltage to low voltage. The rectifier section along with a filter converts this AC voltage to unregulated DC voltage and the regulator produces a regulated DC voltage. The microcontroller is wired with all standard connections. OPTO-coupler is used which usually consists of a light emitting device, and a light sensitive device, all wrapped up in one package but with no electrical connection between the two. The light emitter is the internal LED used. The light sensitive device is a phototransistor. MAX232 is a level shifter IC which is used for interfacing the ZigBee RF Tranciever to the microcontroller. The GSM modem facilitates bi-directional data communication into the system. For display purpose an LCD is used which is interfaced to the micro- controller. The microcontroller operates a relay driver and the relays are then driven by the relay driver. The relays in turn control the switching of loads.

III. COMPONENTS USED

A. ZigBee RF transceiver

ZigBeeRF transceiver is based on an IEEE 802.15.4 standard. It is a specification for a suite of high-level communication protocols used to create personal area networks. ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking.

Fig 3: ZigBee Module

B. ATmega32A microcontroller

ATmega32A is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32A achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. The device is manufactured using Atmel's high-density non volatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin-out. The on-chip flash allows the program memory to be reprogrammed in-system or by a conventional non volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

C. Level Shifter IC MAX232

The MAX232 is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V.

D. Relay Driver ULN2003

Relay Driver ULN2003 is a high voltage, high current Darlington transistor array containing seven open collector Darlington pairs with common emitters. It consists of seven NPN Darlington pairs that feature high voltage outputs with common cathode Clamp diodes for switching inductive loads. The collector current rating of a single Darlington pair is 500mA. For higher current capabilities, the pairs can be paralleled. ULN2003 is used to interface relays with the microcontroller since the maximum output of the microcontroller is 5V with too little current delivery and is not practicable to operate a relay with that voltage.

E. Temperature sensor- TMP36

TMP36 is a low voltage, low precision centigrade temperature sensors. They provide a voltage output that is linearly proportional to the Celsius (centigrade) temperature. The TMP36 do not require any external calibration to provide typical accuracies of ±1°C at +25°C and ±2°C over the −40°C to +125°C temperature range. The low output impedance of

Fig 4: TMP36

TMP36 and its linear output and precise calibration simplify interfacing to temperature control circuitry and ADCs. All three devices are intended for single-supply operation from 2.7 V to 5.5 V maximum. The supply current runs well below 50µA, providing very low self-heating of less than 0.1°C in still air.

IV. CIRCUIT IMPLEMENTATION

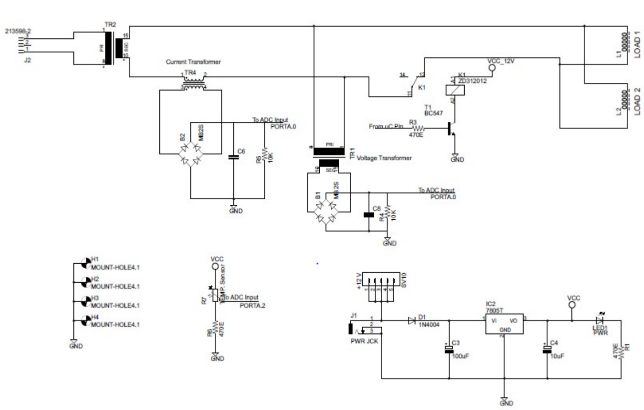


Fig 5: Circuit diagram for the proposed work

The circuit implementation of the proposed work is shown in Fig 5. The connection diagram of various components is showed in the figure. The controlling parts of different parameters are tested with load.

V. EXPERIMENTAL SETUP

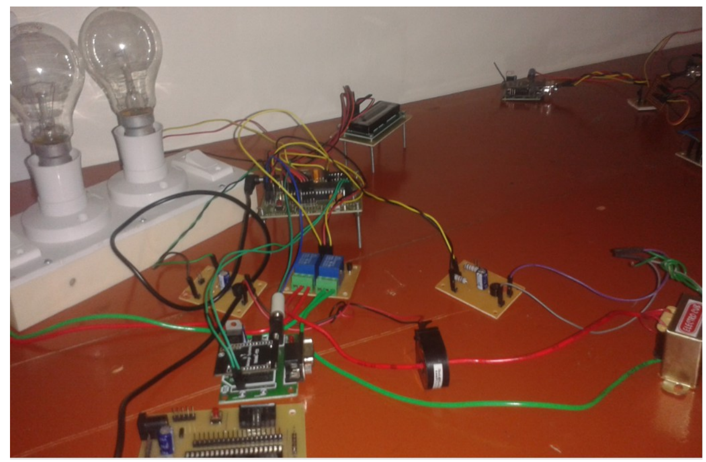
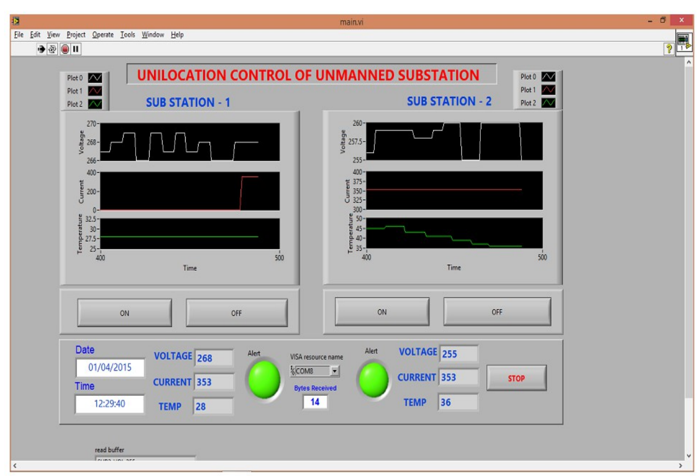


Fig 6: Experimental setup for the proposed work

VI. RESULTS AND DISCUSSION



The control station shows us a plot of mechanical parameters which are being measured. The real trend of voltage, current and temperature has been shown. In this project we are using LabVIEW software as a user interface between the proposed hardware and data indicators. LabVIEW software contains integrated tools for accurate measuring, acquiring, analysing, transferring and indicating. LabVIEW is a flexible programming environment that can help in the successful building of our application and taking simple measurements or prototyping. Controlling and testing is monitored in the server using LabVIEW software.

VI. CONCLUSION

In this project we have done the automation of substations with the help of LabVIEW software. Data quality is acquired from different locations and they are monitored and controlled using a single server. It is a smart automated process instead of manual work which provides accurate information from the network load. We have tested and verified the outputs for two substations and the system is working satisfactorily. Through this project we can remotely connect and disconnect the substations from control centre. Our project is a low cost reliable in power system. This project can be enhanced for load sharing with other substations.

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