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Data Acquisition and Control Using Microcontroller

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Abstract— this paper discusses the way to employ the microcontroller device for data acquisition and control operations in electricity transportation process. A Supervisory Control and Data Acquisition (SCADA) system is always used with Programmable Logic Control (PLC) to control electric power stations. In this paper, a microcontroller is used with SCADA system instead of PLC to control the whole electric network. Design of the implemented modules is introduced. It consists of three units: a collecting data/transmitter unit, a receiving unit and storage/dispatch unit. The reason for using wireless communication instead of Ethernet connection is increasing the data rate and making the cost of cables for network is lying down. The best wireless communication is Global System for Mobile (GSM)/General Packet Radio Switching Service (GPRS). The target for using microcontroller instead of PLC is proving that a microcontroller can do all what PLC could do; also it is much easier to implement a microcontroller network than it is to implement a series of PLCs. In addition the microcontroller is cheaper than PLC. It is very important to express a new type of Remote Transmission Unit (RTU) consists of a microcontroller integrated with GSM/GPRS module. MikroC compiler is the easiest program used in programming the microcontroller. Integration of microcontroller with Lab view program produces a new simulation for the fact event.

Index Terms— Fiber optics, GSM, GPRS, Microcontroller, Data Acquisition, Dispatching and Wireless control.

1 INTRODUCTION

Traditional data acquisition and controlling processes of electric power stations need three main things: SCADA system, PLCs and connections between electric power stations and dispatching center. SCADA system is used for storage and dispatching data. It screens all the electric network transformers which are connected to PLCs. It is used to monitor transformers operation focusing on the coil temperature due to step-up or step-down electrical transformation, oil temperature, the status of the transformer circuit breakers, the input electric potential difference and the output electric potential difference in voltages. It could be called a real time monitor. A SCADA software application is implemented with the interface to the hardware to create a comprehensive real-time applications management environment for a control operation. Multi electric transformers in the electric power stations are controlled by SCADA system via PLCs which are placed in the electric power stations. The SCADA and PLC control loop has been implemented with a real time data analysis, set point modifications, and automatic report generation. Remote controlling of electrical power stations is extremely important because it immunes the workers in the power stations from approaching a high voltage area. This is achieved by the interface between PLC of the electric power station and the sensors placed on the transformer. Using a microcontroller instead of PLC will give the same result but it has a little cost and better execution time than PLC. This paper will explain difference between using a microcontroller and PLC. There are different ways to connect between electric power stations and dispatching center to get data from the electric power stations, also do the control process for the whole equipment in the electric network even transformers in the power stations. The famous methods for connections are the wired cables, an Ethernet cables, an optical fiber cables, and a wireless communications.

The old method of communication is the wired cables which constructed from a copper core and a shield. The Ethernet cables came to solve some problems of the wired method where the Ethernet system is more reliable and has better data rate (10 / 100 Mbps) than normal wired system, but the signal is down each 100 m. It needs a repeater each 100 m to amplify and resend the signal, so it costs more for a long distance data transmission. Now optical fiber cables are used to enhance the data transmission rate, its speed is up to 1015 bits per second. It has many defects: price, fragility, affected by chemicals, opaqueness, expensive and requires special skills in case of welding. It is influenced by environmental factors such as temperature, humidity and drilling works. The wireless communication solves the problem of using any of the methods which is illustrated previously. This paper focuses on the GSM/GPRS system to be used as wireless communication method for transmitting data. GSM/GPRS system speed is up to 296 kbps for down-link and 118 kbps for up-link. It overcomes the long distance problem and more reliable for data transmission. It is worth mentioning that wireless communication is very dangerous in case of transporting important data, especially data belongs to the government. Security ways to ensure that the system could not be hacked or losing any data is considered in the design. This paper will discuss the way to construct a complete system consists of the

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equipment in the electric network connected to the microcontroller which integrated with GSM/GPRS module to transmit data between two different sites safely. RTU is the responsible of data transmission, also the processing operation before sending it, so it encodes the data to protect information from theft. Data received by RTU in the dispatching center is processed again i.e. decoding signal before sending data to the SCADA screen or real time monitor to appear. The enhancement in data analysis is done through the integration of microcontroller with Lab view program which gives a typical simulating environment like electric power station content as shown in figure 1.

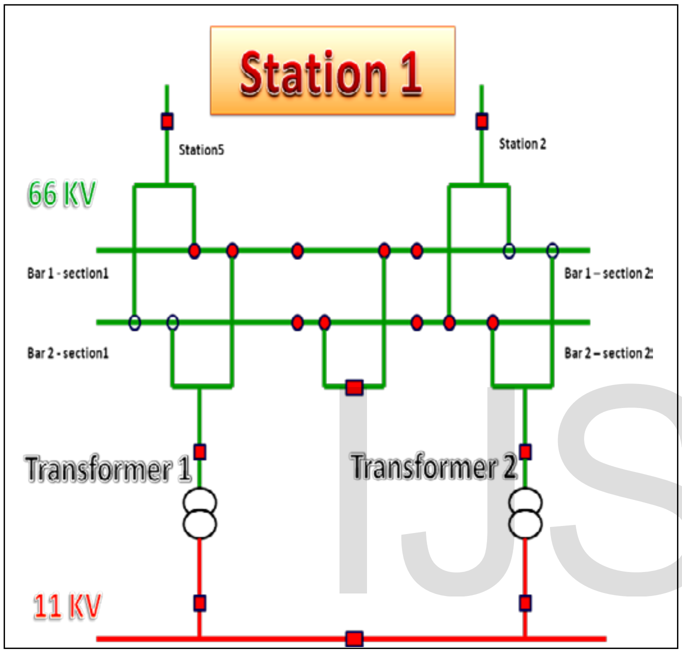

Fig.1. Electric power station components

The purpose of this system is to design and integrate a new system which is integrated with GSM [1] to provide real time monitoring and controlling the power station devices via SMS or through internet using GPRS and controlling the power station devices. The implemented system has basic and optional features as we operate in real time monitoring and control tracking solution, use GPRS communication [2].

2 SCADA SYSTEM

SCADA system is used to monitor the electric network power stations and to reduce the errors caused by human. First the designer plan which shapes are needed to view in the screen. The shape is determined by dispatcher engineer who will deal with the system in case of data acknowledgement. Dispatcher engineer uses the simple ways to get the required information from the desired electric power station. He uses the available buttons in the screen which is provided by the SCADA system to control devices connected to the electric network. SCADA system includes collecting information via a Remote Terminal Unit (RTU), PLCs and Intelligent Electronic Devices (IED) and transferring it back to the central site which is called dispatching center to carry out any necessary analysis and control so it can display that information on a number of operator screens. Three of the most important parts of a SCADA system are Master Station, remote terminals (RTU, PLC, and IED) and the communication between them [3 - 4]. Lab view is used in this paper for implementation of electric power stations and transformers units as a Graphical Unit Interface (GUI). Microcontroller integrated with GSM/GPRS module is used to communicate between different instruments in the electric network and dispatching center. The interface between Lab view and microcontroller is RTS 232 cable and baud rate is 9600.

3 SYSTEM OPERATION

3.1 Data acquisition

Data acquisition is the process of sampling signals that measures real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer [5, 6], as shown in figure 2. It will be better if we use wireless sensors. The emergence of wireless sensor networks has enabled new classes of applications for distributed systems that filter into very many interdisciplinary fields [7]. The measurements provided by the sensing networks are conceived for post-processing by a Decision Supporting System (DSS) which will automatically assess the condition state and suggest an optimal maintenance strategy for the building [8].
First, the microcontroller in the module placed at the power station scans its terminals each many seconds (set by programmer). SO it collects data (readings, measurements, indications) from sensors, circuit breakers, disconnections bars, transformer tap changer, and protection devices. The microcontroller programmed to compare the data collected by its terminals with old one. If there is a change from the old status, the microcontroller converts the new data to strings compatible with GSM/GPRS module (AT commands) and sends it to the GSM/GPRS module via the communication protocol (Tx, Rx). If there is no change, no sending happens to the GSM/GPRS module. GSM/GPRS module is configured by the programmer to be in GSM or GPRS mode. In one site the power station module sends data as SMS if it configured to be in GSM mode (Circuit Switching), and sends data as a stream of packets if it configured to be in GPRS mode (Packet Switching). On the other site the reverse process done. The module in this site (control center room module) acts as a receiver module. It configured to be in the same mode as the transmitter module (power station module) to receive data accurately as sent.

3.2 GSM mode

A GSM digitizes and compresses data, then sends it down through a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800MHz frequency band [1]. GSM gives a maximum throughput for 14.4 kbps. It is a circuit-switched technology. In GSM mode each indication from microcontroller sent via GSM/GPRS module as SMS messages one by one. It makes delay in time and sometimes makes conflicts between orders, especially if there are many SMS messages from different sites. GPRS mode solved this problem (will be discussed).

As shown in figure 2 there are symbols of sensors in the power station (SW1, SW2). The switches symbols pointing that they act as well as transformer circuit breakers and disconnections bars.

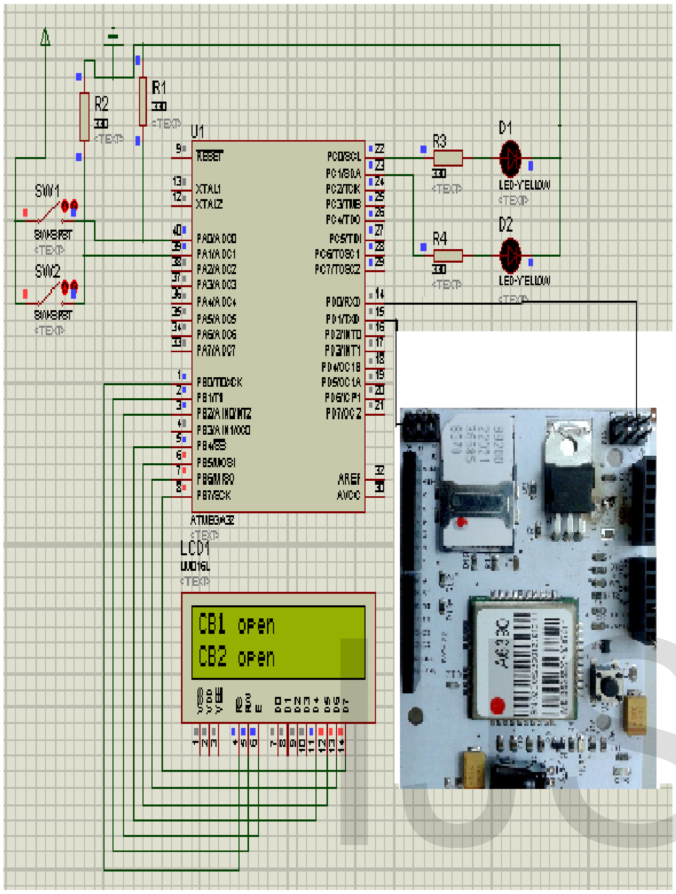

Fig.2. Software sample for the power station module

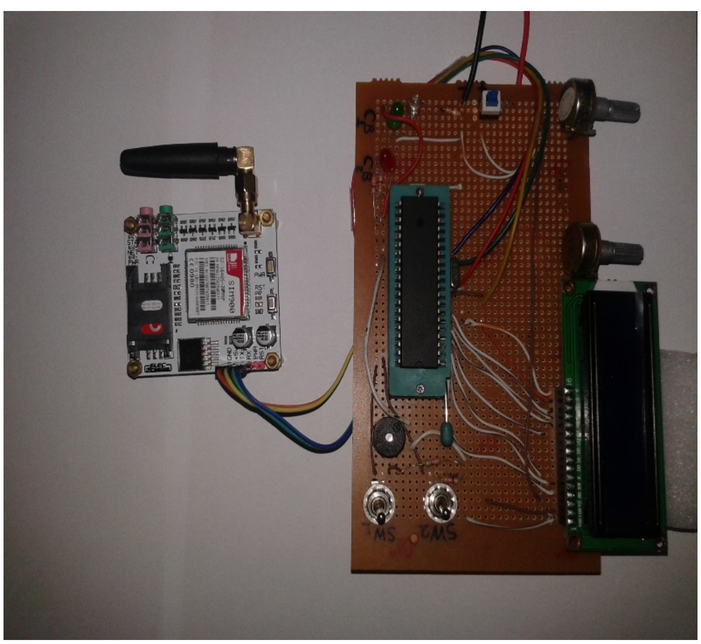

Fig.3. Hardware sample of power station module

In the control center room there is another module contains the same components (GSM/GPRS module, microcontroller, LEDs, and LCD) to assure that data is received, as shown in figure 4. This module may be boxed in the communication room in the control center building and connected to (Supervisory Control and Data Acquisition) SCADA system.

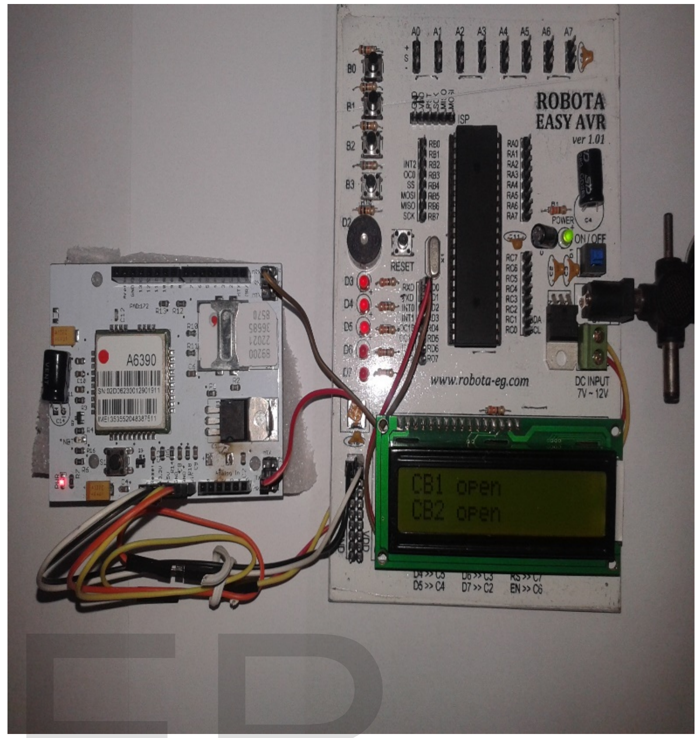

Fig.4. Hardware sample of control center room module

SCADA system used for monitoring and controlling a plant or equipment in industries such as water and waste water control, energy, oil, telecommunications and gas refining and transportation [9]. SCADA system gives a real time monitoring for each component in the electrical network such as power planets, generators, transformers, bus bars and circuit breakers. It helps the operator (dispatcher engineer) to detect the events in the network simply by viewing them in the computer screen. He can acquire the data through this system as he can control the network devices.

If the status of any sensor in any power station in the network changes, the microcontroller will discover this change at scanning process. So it executes some instructions in the code as it is programmed as shown in figure 5, Then it sends the new status of this sensor by SMS message to the control center that acquires the data of the power station.

Liquid Crystal Digital (LCD) which used as a display in the RTU module is called a local display and LEDs which are placed in the RTU module in the power station site help for assuring that outputs of microcontroller is true before sending data. So it helps to trace the fault, if data wasn't received in the other site or data acquisition was not achieved, as shown in figure 3.

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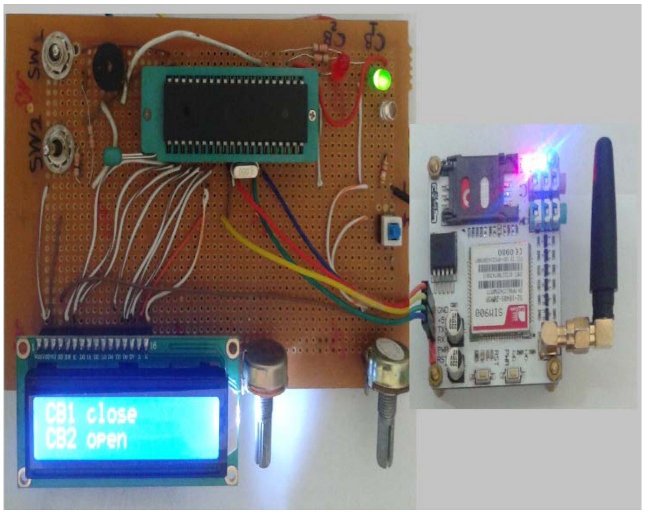

Fig.5. LCD and LED indications in the power station hardware sample

Each power station module has an ID (SIM card number) the SMS sent from. In the control center the receiving module receives SMS message, then sends it to the microcontroller via the communication protocol (Tx, Rx) as strings (AT commands) including the SIM card number and the text message content. The microcontroller programmed with a code contained certain numbers for comparison process. The microcontroller reviews the strings and must be assured from the ID of the SIM card that sent the message. If the comparison gives a positive result, the microcontroller displays on the LCD that there is a new message from (ID number) as shown in figure 6.

Fig.6. the microcontroller displays ID of power station

Then it translates the received strings to do the corresponding order like:

1. Running alarm via buzzer or horn to warn the operator (dispatcher engineer) in the control center room
2. Emitting led to help the operator (dispatcher engineer) for determining the event location
3. Displaying the message on LCD as shown in figure 7
4. Sending this data to SCADA system to display the event in the real time monitor

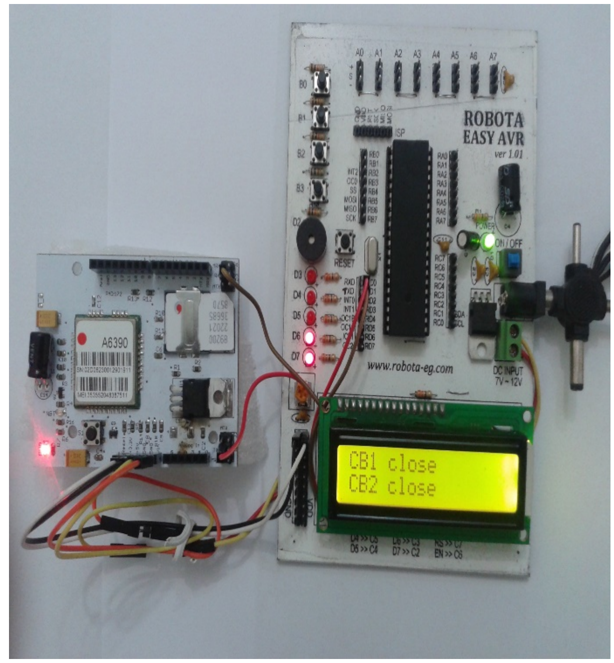

Fig.7. The microcontroller takes action after comparison process

If the comparison gives a negative result, the microcontroller gives no response; LCD and SCADA system have no change. The system depend on wireless communication, thus the comparison is useful for saving the system from hacking.

3.3 GPRS mode

GPRS system is an integrated part of the GSM network switching subsystem [1]. GPRS is a packet-switched technology that enables data transfers through cellular networks [1]. It is a new non-voice value added service that allows information to be sent and received across a mobile telephone network. This technology is very useful for using internet through mobile. In theory the speed limit of GPRS is 115 kbps, but in most networks it is around 35 kbps [1]. GPRS is based on IP communication and the connected module must provide an IP address before a connection be established. Thus in this system the GSM/GPRS module do three steps as shown in figure 8 to communicate with others via GPRS communication:

5. Connecting to the GPRS network.
6. A dynamic IP address is assigned.
7. The exchange of data can take place.

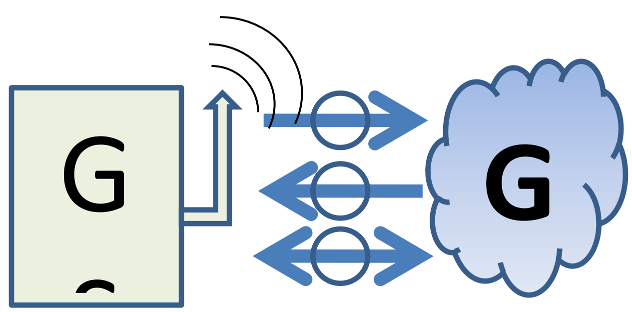

Fig.8. Communications via GPRS

The connection is established by reference to its access point name (APN). The APN defines the services such as wireless application protocol (WAP) access [1]. A user name and password, and very rarely an IP address, all provided by the network operator [1]. So, to make

the module in the power station work in the GPRS mode, the microcontroller programming code must contain certain instructions. These instructions forcing the microcontroller to send some strings (AT commands) to GSM/GPRS module connected to establish a connection between the power station module and the control center module at the first run time to get its IP address. The connection still open till the module powered on. After getting the IP address, the microcontroller sends unlimited information via GPRS to the control center room module without any delay. Also the control center room module can receive unlimited information from various sites modules at the same time without any conflict, because of the high response of the microcontroller. In addition the GPRS technology allows high information transmission due to its bandwidth and its bit rate. So any change of any sensor status in the power station could be sent very fast to the control center room monitor and this is thanks to GPRS technology. This technology solved the problem of the delay if the GSM technology used. For saving the system from hacking, the microcontroller in each module should be programmed by a code containing certain IP addresses used in comparison process when any information received. This comparison ensures that connecting channel will establish with authenticated IP addresses only. Response of microcontroller is measured by microseconds. If any simple encryption method used to encrypt data, there is no problem in the receiving and code instructions processing times.
GPRS equipment is available in three categories; these are defined as Class A, B and C as the following:

1) Class A: Supports simultaneous GSM and GPRS operations
2) Class B: Supports GSM and GPRS operations, but not simultaneously
3) Class C: The connection only supports GPRS or GSM data, When switching is necessary between GPRS and GSM you must reconnect the connection

The suitable category for the system refers to the designer, though the best category is Class A.

- GSM vs. GPRS in this system

	GSM	GPRS
Features	One timeslot is used which gives a maximum throughput of 14.4 kbps 1 2 3 4 5 6 7 8	By using four timeslots and Coding Scheme 4 the maximum throughput will be 85.6kbps. 1 2 3 4 5 6 7 8
Band width	900/ 1800 MHz	850/ 900/ 1800/ 1900 MHz
Conflict	Yes	No
Reliability	Low	High
Response	Low	High
Cost	Cost depends on number of messages	Depend on Subscribing plane

Cost wise	Bad	Suitable

B. Control of power stations

Dispatcher engineer review the network through real time monitor where the stations and transmission lines even the control center appear as blocks, as shown in figure 9.

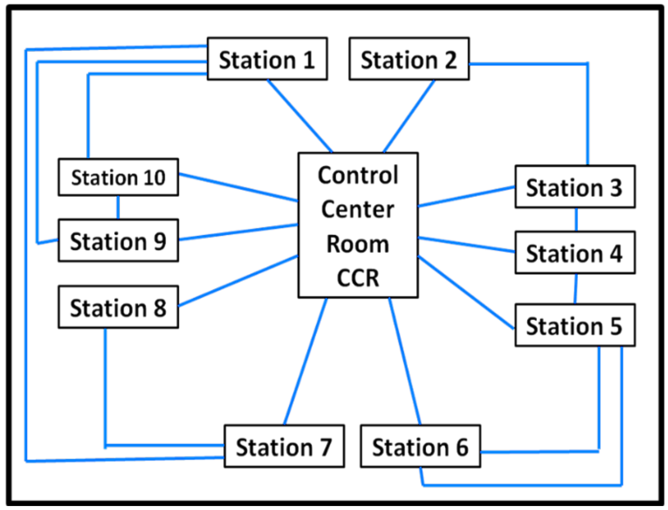

Fig.9. Network in real time monitoring

When he clicks on the desired block, a new window opened to show the content or devices in the desired station in SCADA monitor as shown in figure 10.

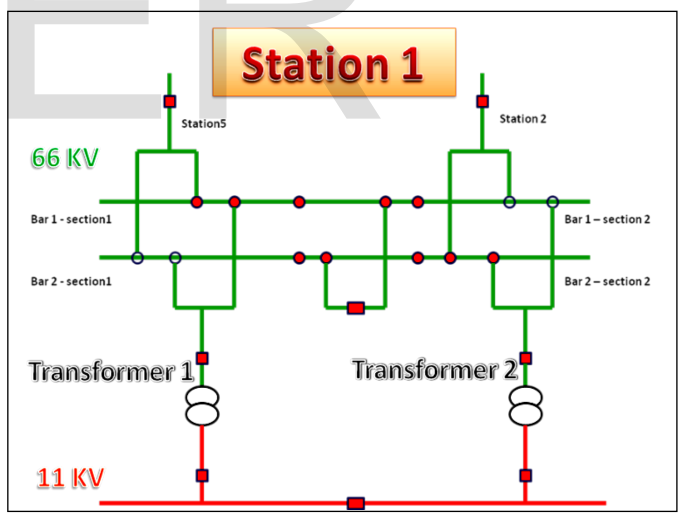

Fig.10. Station components in SCADA monitor

So he can change the status remotely as he can acknowledge it by real time monitor (SCADA) software buttons as shown in figure 11.
Open button: for disconnecting any part of the transformer like circuit breaker
Close button: for connecting any part of the transformer like circuit breaker
OK button: for acknowledge any event appears in real time monitor
Up button: for increasing the output voltage of the transformer
Down button: for increasing the output voltage of the transformer

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The operation of control summarized in few steps:

1. Opening the desired station as shown in figure 9.
2. Choose the transformer be controlled as shown in figure 10.
3. Choose the part of the transformer to be disconnected as shown in figure 10.
4. Pressing the suitable button to do certain action as shown in figure 11.

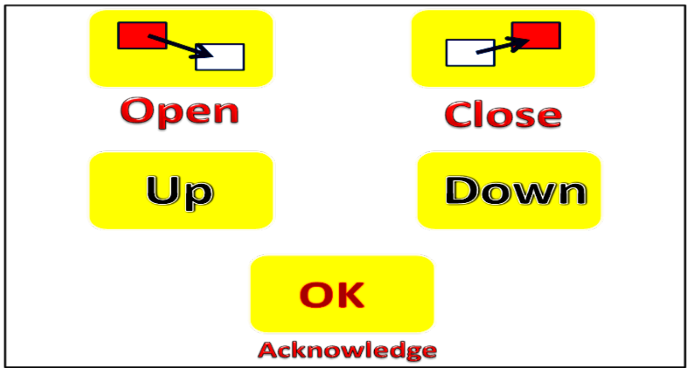

Fig.11. Real time monitor buttons

5. The status of the part changed in the real time monitor as shown in figure 12, and a signal sent to the microcontroller which takes the suitable action and sends it via GSM/GPRS module to the station module.

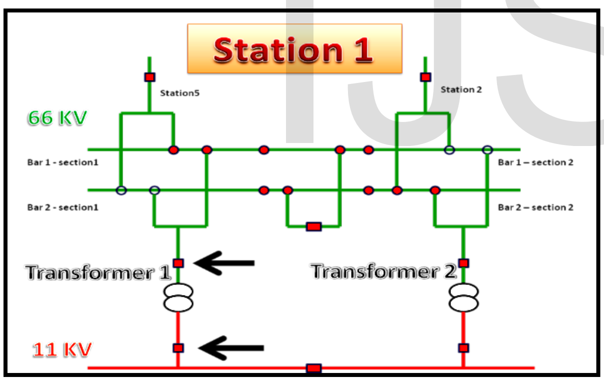

Fig.12-a. Desired parts

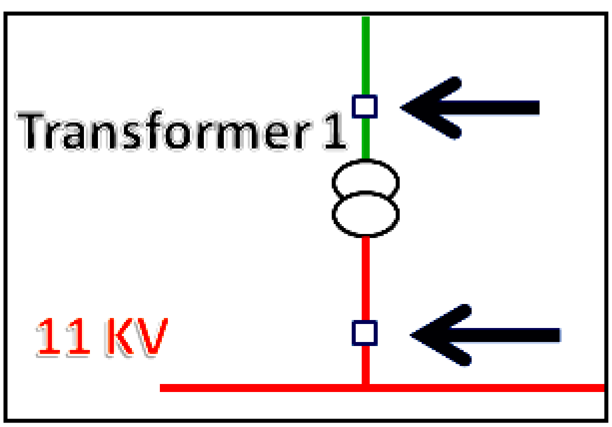

Fig.12-b. Status changed to opened

6. The station RTU module receives the signal and translates it to a suitable action via the microcontroller in the module.
7. The microcontroller sends the signal to the desired part in the transformer be controlled to do the desired order.

The main usage of the control operation is isolation for any device in the network such as generators, transmission lines, transformers, etc. for maintenance operation. But if there is any failure in a device in the network, the control operation is very important for protecting the whole network from this failure by isolating the failed device.

4 LOCAL AND REMOTE POWER STATION INTERACTION

4.1 Wired Interaction

The wired interaction could be summarized in:

1. Copper cable: it is a traditional method and low speed throughput due to little bit rate, because it depends on electrical signals only between transmitter and Receiver.
2. Ethernet cable: it has better data rate (10 / 100 Mbps) than normal wired system, but the signal is down each 100 m. It needs a repeater each 100 m to amplify and resend the signal, so it costs more for a long distance data transmission.
3. Optical fiber cable: it is a modern method to transmit high data via its cable due to high band width and very high bit rate up to 155Mbps depending on electromagnetic signal used. Optical fiber is more expensive method and need high protection.

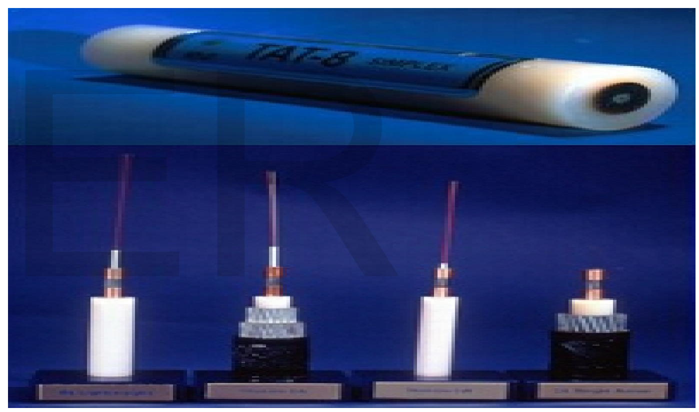

Fig.13. Optical fiber cables

4.2 Wireless Interaction

It is sending data via channel with large bandwidth through carrier. A wireless sensor network plays an important role in such strategies [7]. We can send data via (Wi-Fi) such as X-Bee, (Wi-Max), GSM, GPRS, or Satellite. Most common way is X-Bee, but it is limited in range (max range about 300 meters). Suitable ways is GSM or GPRS due to large bandwidth (850-1900 MHz). Using GSM or GPRS bandwidth is the best way to send large number of data samples for long distances in millisecond. We use GSM-GPRS with SIM 900 chip module in our research to transmit data from one site to another, as shown in figure 14. This is a growing technology, which has changed the way people live [10].

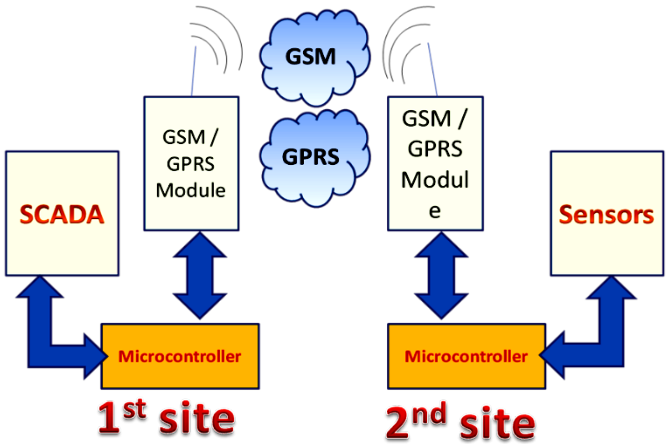

Fig.14. Wireless communications

5 GSM/GPRS AND MICROCONTROLLER MODULES

5.1 GSM/GPRS module

With the alliance of microcontroller, GSM MODEM could be further used for some of very innovative applications including, GSM based home security system, GSM based robot control, GSM based DC motor controller, GSM based stepper motor controller, GSM based voting machine control etc. [12]. This GPRS Shield is compatible with all boards which have the same form factor (and pin out) as a standard Arduino Board. GPRS module delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor. The GPRS Shield is configured and controlled via its UART using simple AT commands. Figure 15 shows the GSM/GPRS module with its component.

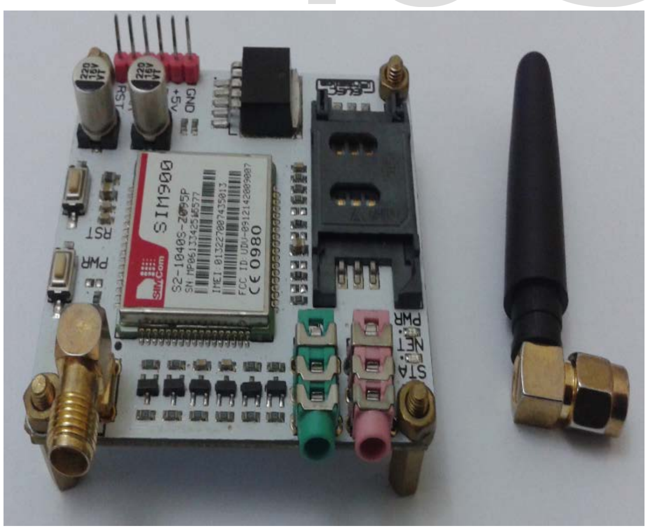

Fig.15. GSM – GPRS with SIM 900 chip module

5.2 Microcontroller

There are thousands models of microcontroller, each has its own peripherals, design, pins (I/Ps – O/Ps), and features. The most used types of microcontrollers are PIC and AVR.

AVR is more flexible than PIC especially in programming. The AVR enhanced RISC microcontrollers [14] are based on a new RISC architecture that has been developed to take advantage of semiconductor integration and software capabilities of the 1990's [15]. In our research we use AVR ATmega32.

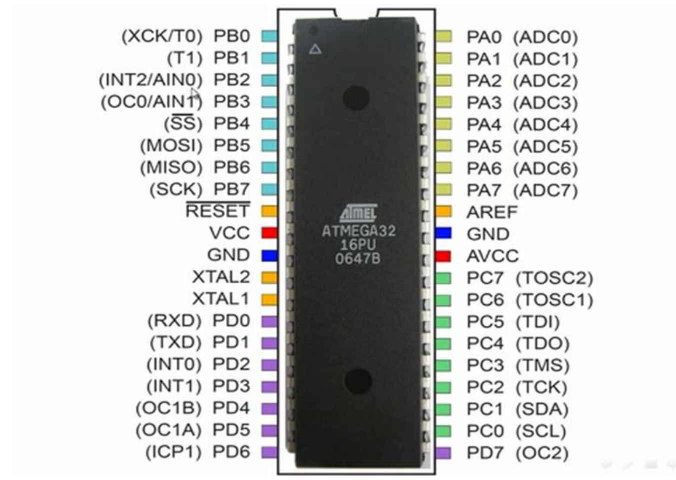

Fig.16. Pinout of ATmega32 microcontroller

5.3 Connection between microcontroller and GSM module

In the microcontroller, the serial USART is used for full duplex (two-way) communication between a receiver and transmitter [16]. The ATmega32 can also be used for serial communication, but it is very important to connect the receiving pin of the microcontroller with transmitting pin of the GSM/GPRS module and transmitting pin of the microcontroller with receiving pin of the GSM module card. The GSM module can get its power from the microcontroller terminal (VCC, GND) or from separate power supply with 5V. The GSM module has two buttons for power and reset, if hanging occurred [2].

5.4 Software programming

Using C language and suitable compiler, we can program the microcontroller to achieve our demands. We choose MiKroC compiler to program the microcontroller due to its simpler facilities, which helps any microcontroller programmer (beginner or expert) to program microcontroller easier than any other compiler. We use LCD in each site connected to the microcontroller to display the results of each case to assure that the microcontroller worked properly. If the message was not sent or received then the problem could be solved easily.

6 CONCLUSION

The SCADA real system for data acquisition and control is designed to monitor and control all the system process instead of the conventional control through DCS. This research serves to find that the wireless control is the future way to control cars, home doors, any machine, even factories at any site from any site. Microcontroller can be used rather than PLC to save money in the designed project, and it can deal with transistors while PLC cannot. Just set what you want to control, choose the suitable sensors then setup your system and connect it to microcontroller that connected to a wireless module you choose, finally set your commands in the programmed will be compiled with the microcontroller to do certain actions for signals received from the other site. So any high voltage electrical network device can be controlled without need of human mediation at power stations. This technology helps to transmit data easier than wired cables, lower costs and more reliable, especially when GSM or GPRS systems are used in communications between far sites. It prevents the system from hacking via the assurance process which is done for each signal or message arrives from the sender by checking the number. Generally it is a good way to use this technology, even using GPRS instead of GSM will reduce the coast. In this paper GSM and GPRS are the best wireless ways to communicate between sites rather than micro wave or RF, because RF circuits in wireless transmission due to the interference with (E-M) electromagnetic waves. Hence the signal may be distorted while transmission, or received as unknown signal, it increases the chance of error. Using microwave needs special tower with Line Of Sight (LOS) transmission and has low bit rate (64kbps).

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APPENDIX A

```
// GSM mode code for power station
// 1st  code for sending
void gsm_init(){
uart1_write_text("AT");  // init GSM
uart1_write(13);
uart1_write_text("AT");  // init GSM
uart1_write(13);
uart1_write_text("AT+IPR=9600");
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CMGF=1");
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CNMI=2,1,0,0,0");
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CMGD=4,4");
uart1_write(13)}
void send_SMS(char desired_mob_no[12],char
msg_to_send[70]){
uart1_write_text("AT+CMGF=1");
uart1_write(13);  // enter key
uart1_write_text("AT+CMGS=\"");
uart1_write_text(desired_mob_no); // mobile No.
uart1_write('\"');
uart1_write(13);  // enter key
uart1_write_text(msg_to_send); // message text
uart1_write(26);  // ctrl+z      to send  message    }
// 2nd code for sending
```

```
void receive_SMS(){
for(i=0;i<70;i++){msg_content[i]=0;},,,
for(i=0;i<16;i++){mob_no[i]=0;},,,
xx=0;
while(xx!='+'){run();xx=uart1_read();}
uart1_write_text("AT+CMGR=1");
uart1_write(13);
xx=0; time=0;
while(xx!=','){xx=uart1_read();time++;if(time>=50000)break;} ,
for(i=0;i<16;i++){
        while(uart1_data_ready()==0);
        if(uart1_read()==',') break;
        else mob_no[i] = uart1_read();    }
for(i=0;i<11;i++){mob_no[i] = mob_no[i+4];       }
xx=0;   time=0;
while(xx!=10){xx=uart1_read();time++;if(time>=50000)break;}
while(uart1_data_ready()==0);    uart1_read();
for(i=0;i<70;i++){
        while(uart1_data_ready()==0);
        if(uart1_read()==10) break;
        else msg_content[i] = uart1_read();        }
mob_no[11]='\0';
msg_content[10]='\0';
lcd_out(1,1,"New msg from ") ;
lcd_out(2,1,mob_no);
delay_ms(2000);
lcd_cmd(_lcd_clear);
lcd_out(1,1,msg_content);
delay_ms(3000);
lcd_cmd(_lcd_clear);
uart1_write_text("AT+CMGD=4,4");
delay_ms(100);
uart1_write(13);
delay_ms(2000);
count_mob_no=0;
for(i=0;i<11;i++){
        if(mob_no[i] == mob_no_ok[i]) count_mob_no++;
}
if(count_mob_no==11) {buz=1 ; delay_ms(2000);
buz=0;control();}    }
```

APPENDIX B

```
// GSM mode code for control center room
// 1st code for sending
void send_SMS(char desired_mob_no[12],char
msg_to_send[70]){
uart1_write_text("AT+CMGF=1");      // text mode  format
uart1_write(13);  // enter key
uart1_write_text("AT+CMGS=\"");
uart1_write_text(desired_mob_no); // mobile No.
uart1_write('\"');
uart1_write(13);  // enter key
uart1_write_text(msg_to_send); // message text
uart1_write(26);  // ctrl+z }
// 2nd code for sending
void receive_SMS(){
for(i=0;i<70;i++){msg_content[i]=0;},,,
for(i=0;i<16;i++){mob_no[i]=0;},,,
xx=0;
while(xx!='+'){run();xx=uart1_read();}
uart1_write_text("AT+CMGR=1");
uart1_write(13);
xx=0; time=0;
while(xx!=','){xx=uart1_read();time++;if(time>=50000)break;},
for(i=0;i<16;i++){
        while(uart1_data_ready()==0);    // waiting till one
char received
        if(uart1_read()==',') break;
        else mob_no[i] = uart1_read();  }
```

Appendix C

```
// GPRS mode
void WriteComm(char c){
ES = 0;
SBUF = c;
while(TI==0);
TI=0;
ES = 1;
}
void transmit (char *data) {
Delay (250);
while (*data) {
WriteComm (*data++);
}
}
BYTE GPRSDial (void) {
signed char delayCount = 80;
transmit ("ATV0"); //
if (!Waitfor ("0", 30)) { // OK
return -1;
}
DTR_ON;
transmit ("ATD*99***1#"); // GGSN
GPRSBuffFlush (); // buffer
//

while ((!GPRSBuffNotEmpty()) && (--delayCount > 0)) {
Delay (250);
}
if (delayCount) {
return GPRSGetch (); //
}
return -1; // ,
}
void GPRSHangup (void) {
DTR_ON; // DTR
Delay (40); //
DTR_OFF; //
} BYTE GPRSDial (void) {
signed char delayCount = 80;
transmit ("ATV0"); //
if (!Waitfor ("0", 30)) { // OK
return -1;
```

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```
}
DTR_ON;
transmit ("ATD*99***1#"); // GGSN
GPRSBuffFlush (); // buffer
//
while ((!GPRSBuffNotEmpty()) && (--delayCount > 0)) {
Delay (250);
}
if (delayCount) {
return GPRSGetch (); //
}
return -1; // ,
}
void GPRSHangup (void) {
DTR_ON; // DTR
Delay (40); //
DTR_OFF; //
} BYTE GPRSDial (void) {
signed char delayCount = 80;
transmit ("ATV0"); //
if (!Waitfor ("0", 30)) { // OK
return -1;
}
DTR_ON;
transmit ("ATD*99***1#"); // GGSN
GPRSBuffFlush (); // buffer
//
while ((!GPRSBuffNotEmpty()) && (--delayCount > 0)) {
Delay (250);
}
if (delayCount) {
return GPRSGetch (); //
}
return -1; // ,
}
void GPRSHangup (void) {
DTR_ON; // DTR
Delay (40); //
DTR_OFF; //
}
```