Wireless control operation of power stations using modern sensors

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Abstract— This paper considers a practical implementation of wireless control of electrical power stations, data acquisition based on multiple used sensors, and data acquisition based on multiple used sensors and protection devices.

The system implementation depends on collecting data of different used sensors and controlled devices from the local power station then correlating these data with stored ones, the result of correlation is transmitted to a remote station for observation and remote control.

We use different types of microcontrollers, and Micro C compiler program for this operation.

Keywords: GSM, GPRS, Sensors, Microcontroller, Data transmission, and Wireless control.

I. INTRODUCTION

In most high voltage networks for electricity transmission, more projects use the wired system for transmit data, data acquisition, and control power station devices [1].

The main type of cables used for data transmission is the fiber optics, which is more reliable and has a very large bandwidth, so it can carry more and more data via many frequencies, it is the best media to transmit data from one site to another, but it is expensive to execute small project with star connected network containing one control center and many sites attached to this center. This is most reliable, if the way to implement the binding process is done correctly to ensure best protection from environmental factors, but in fact sometimes the networks connecting between cities, must go underground inside cities and used overhead towers in the way between cities in the highway roads to save money. But the data transmission, data acquisition and control of power station is lost if the fibers were cut or break happens, and it takes long time to trace and predict the place of the fault of the cable, and to fix or change the failed fiber and needs more cost and efforts, so we use wireless communications for data transmission, data acquisition, and control. GSM communications help to implement large systems connecting between huge numbers of power stations and one control center called (control room). It depends on the GSM towers locally built everywhere, so we need not to set up special towers or antennas for our system, we just need SIM cards (special SIM cards) for security of data transmission, as well as encoding system adding to the data message before sending it from one site to another (control center to power stations and vice versa). We put each SIM card into the GSM / GPRS SIM 900 module which is connected to a microcontroller connected to the sensors, circuit, disconnectors, and protection devices of the transformers in the power station. We program the microcontroller to send data collected from its terminals by SMS messages via GSM module to a certain number (control center SIM card number) which is placed in the GSM module in the control center site, which receives the message, then interprets it to suitable code to the microcontroller connected to it, then the microcontroller does its role to send the data interpreted to real time monitor, and from the monitor we can follow the case of each device in each power station, and we can control it by the reverse process.

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II. USED SENSORS

Sensors are essential components of automotive electronic control systems. Sensors are devices that transform physical quantities such as pressure or acceleration into output signals (usually electrical) that serve as inputs for control systems [2, 3]. Famous types of sensors are temperature, proximity, magnetic, optical, and capacitive sensors. We need temperature sensors to measure the temperature of both oil in the transformers used for cooling its internal windings, and the temperature of the windings. Proximity sensors used to detect the presence of metal disconnectors at connecting and disconnecting. Also we use capacitive sensors to detect the oil level inside transformers. Limit switches, magnetic proximity, passive optical, infrared sensors can be used for detection of real connection of transformer disconnectors and circuit breaker

III. SYSTEM OPERATION

A. *Data acquisition*

Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer [4, 5], as shown in figure 1.

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 [6]. 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 [7]. First, the microcontroller in the power station scans its terminals each many seconds (set by programmer), then collects data (readings, measurements, indications) from sensors, circuit breakers, disconnectors, transformer tap changers, and protection devices, and then converts the data to strings compatible with GSM module (AT commands), then the GSM module executes the commands (as set by the programmer) as they are sent to it, so the data are sent as SMS messages to another GSM module (control center) which receives the SMS messages one by one and sends them to the microcontroller connected to it to do a certain mission. As shown in figure 1 there are symbols of sensors in the power station (SW1, SW2) we used the switches symbols pointing that they act as well as transformer circuit breakers, and disconnectors. Local display (LCD) and LEDs connected used in the power station site for assuring that outputs of microcontroller is true before sending data, so it helps us to trace the fault, if data wasn't received in the control center or data acquisition was not achieved, as shown in figure 2.

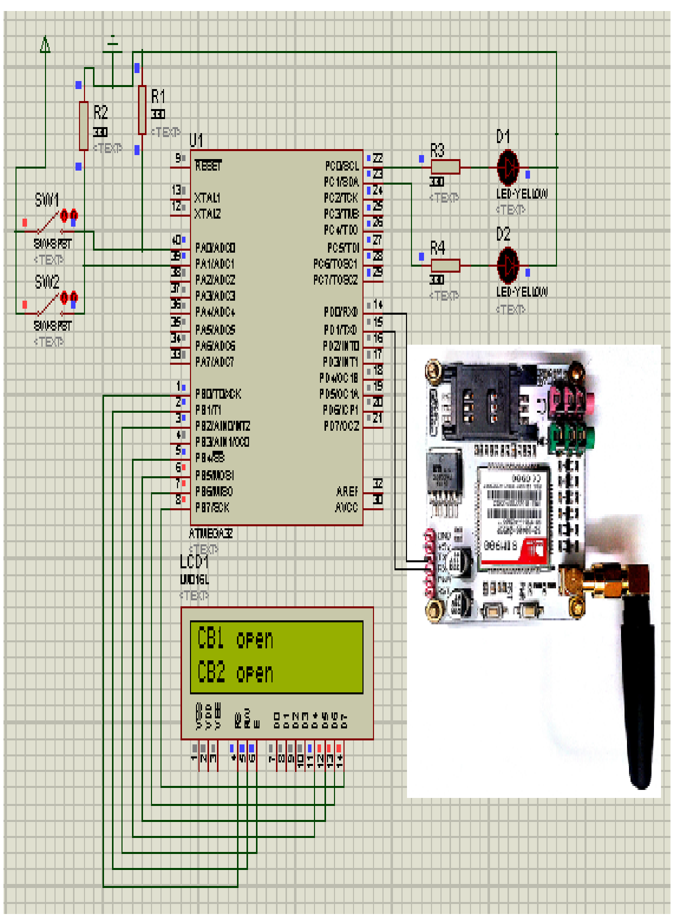

Fig. 1 Displays the status of the sensors connected to microcontroller terminals

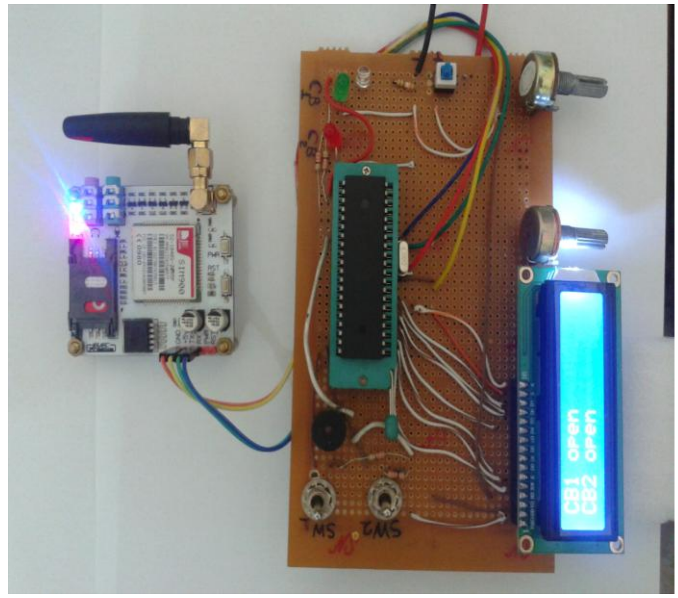

Fig. 2 Displays the hardware sample of power station module

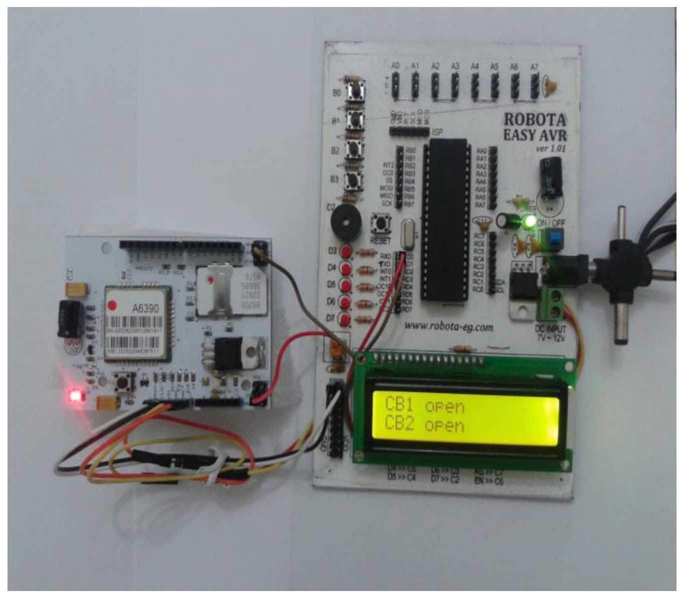

Fig. 3 Displays the hardware sample of control center module before receiving SMS message

In the control center, there is another GSM module, as shown in figure 3, that receives the SMS, and then sends it to the microcontroller connected to it, which translates the message received, then do the order corresponding to the received message, like emitting alarm via buzzer connected to its terminal, making certain led powered on, and displays the message on the LCD connected to it. When the status of any sensor changes, the microcontroller senses the change at scanning, so it executes some instructions in the code it is programmed, as shown in figure 4 and 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. SCADA is Supervisory Control and Data Acquisition. SCADA systems that use to monitor and control a plant or equipment in industries such as water and waste water control, energy, oil, telecommunications and gas refining and transportation [8].

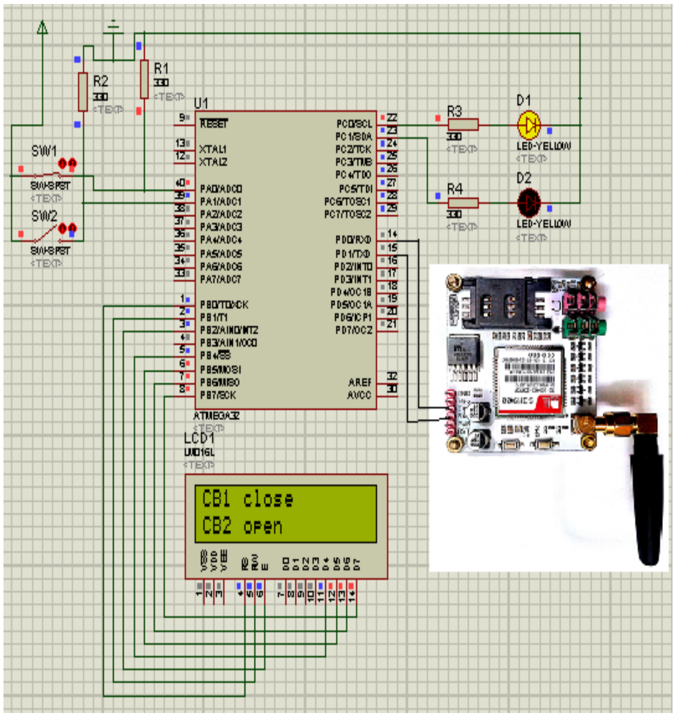

Fig. 4 Displays new status of a sensor in the power station

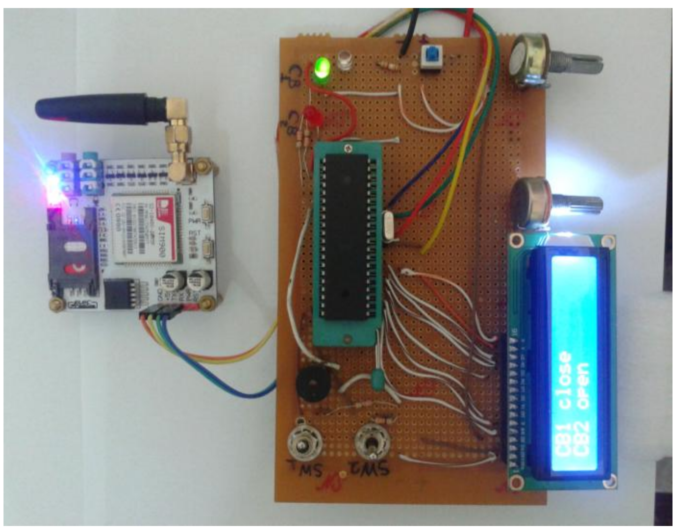

Fig. 5 Displays LCD and LED indications in the power station hardware sample

At the control center, when the GSM module receives the new SMS message from the power station. It must be assured of the ID of the SIM card that sends the message, and it cannot do anything before assurance of number of SIM card. The detection of ID is done by comparing the SIM card number with numbers stored in the microcontroller code, and if the comparing is OK, the microcontroller displays that there is new message from certain power or its number (as programmed), as shown in figure 6, interprets the message to its commands, executes them, lightening certain LED on the card, as shown in figure 7, and sends indication via real time monitor to the operator to alarm him for the new status of the sensor of certain power station.

If the comparing results that no compatibility of the SIM card number that sends the message the microcontroller does nothing and the system is still stable, thus this comparing is useful for saving the system from hackers.

Fig. 6 The microcontroller displays ID of power station

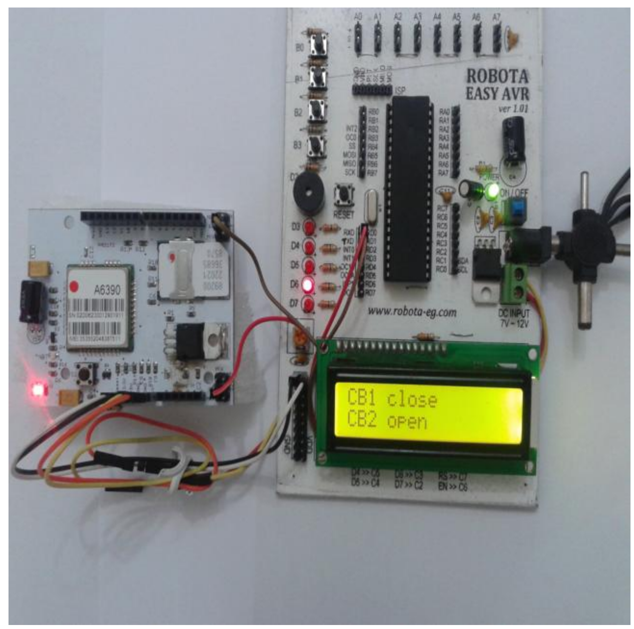

Fig. 7 The microcontroller takes action after comparing

B. Sensors and devices control

The previous operation could be reversed, meaning that operator can monitor all power stations data and status of any sensor, and then can change the status remotely as he can acknowledge it by real time monitors (SCADA) software buttons, or by the switches placed on the control panel at the control center. When the operator changes a certain switch, a signal goes to specified terminal of the microcontroller placed in the control center. The microcontroller sends corresponding message to this order via GSM module connected to it to the GSM module in the other site (power station) which receives the SMS message then sends it to the microcontroller, and so on.

IV. LOCAL AND REMOTE POWER STATION INTERACTION

A. *Wired*

Using cupper wires, fiber optical cables, or PLC (Power Line Carrier) the power stations and control centers are connected together.

B. *Wireless*

We can send data via channel with large bandwidth through carrier. A wireless sensor network plays an important role in such strategies [6]. We can send data via (Wi-Fi) such as ZigBee, (Wi-Max), GSM, GPRS, or Satellite. Most common way is ZigBee. Suitable ways is GSM or GPRS due to large bandwidth. We can use GSM or GPRS bandwidth 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 8. This is a growing technology, which has changed the way people live [9].

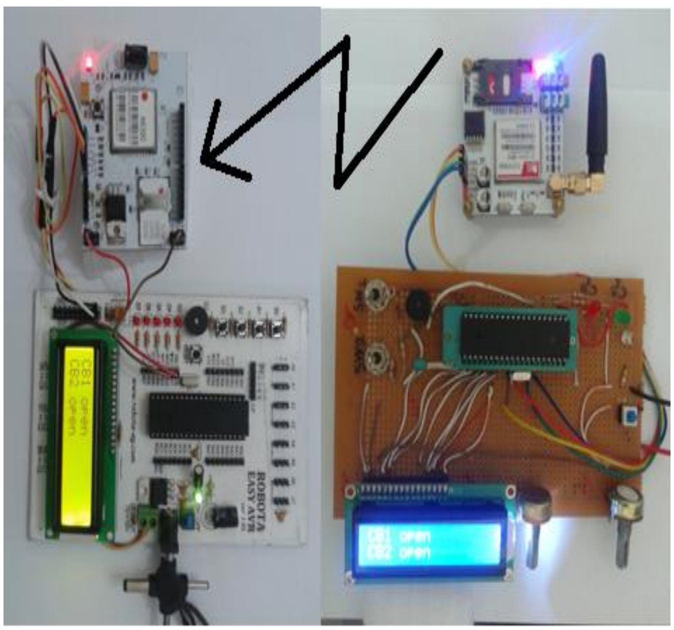

Fig. 8 Wirless communications using GSM module

By connecting this card with microcontroller, the data can be sent or received to or from the GSM module, but it needs to write certain code to make the GSM module understands the commands from microcontroller as strings (AT command). We use MicroC [10] compiler to create code to make the GSM module understand it like a string (AT command).

V. GSM AND MICROCONTROLLER MODULES

A. 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. [11].

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. We can use the 2 jumper block to connect the SIM900 URAT post to any pins within D0-D3 (for Hardware/Software serial port). EFCom not only can use the S_PWR button for power on, but also can use the digital pin (D6) of Arduino to power on and reset (D5) the SIM900 module [12], as shown in figure 9.

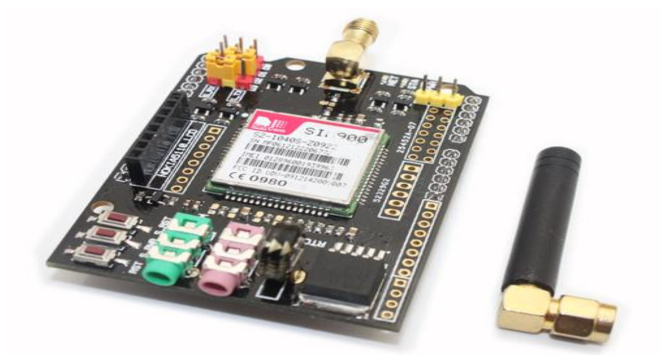

Fig. 9 GSM – GPRS with SIM 900 chip module

GSM-GPRS Shield is an ultra compact and reliable wireless module. It is based on SIM900 4 Frequency GPRS module. The GSM-GPRS Shield configured and controlled via its UART using simple AT commands. We can use the 2-jumper block as switch on board to connect the SIM900 URAT post to any pins within D0-D3 (for Hardware/Software serial port). We can use it to select the connection of the UART port or Debug port, even set on Arduino. The shield allows us to achieve this via any of the three methods: Short Message Service, Audio and GPRS. The super capacitor power supply for the RTC can work more than 1 day by the power supply of super capacitor. So the SIM900 can keep the time and day when power went off [12]. Figure 10 shows the hardware design.

A.1. Features [12]

1. Fully compatible with Arduino / Uno and Mega.
2. Free serial port connecting, you can select Hardware Serial port (D0/D1) control or Software Serial port (D2/D3) controls it, as shown in figure 11.
3. SIM900 all pins breakout. Not just the UART port and debug port be layout, but also all pins on SIM900
4. Be layout to the 2.54 standard pitches.
5. Super capacitor power supply for the RTC.
6. EFCom not only can use the button for power on, but also can use the digital pin of Arduino to power
7. On and reset the SIM900 module.
8. Quad-Band 850/ 900/ 1800/ 1900 MHz.
9. GPRS multi-slot class 10/8.
10. GPRS mobile station class B.
11. Compliant to GSM phase 2/2+.
12. Control via AT commands (GSM 07.07, 07.05 and EFCOM enhanced AT Commands).
13. SIM application toolkit.
14. Supply voltage range: 3.1 … 4.8V.

15. Low power consumption: 1.5mA (sleep mode).
16. Operation temperature: -40°C to +85 °C.
17. Dimension: 68.33x53.09mm (Same dimension of Arduino main board).

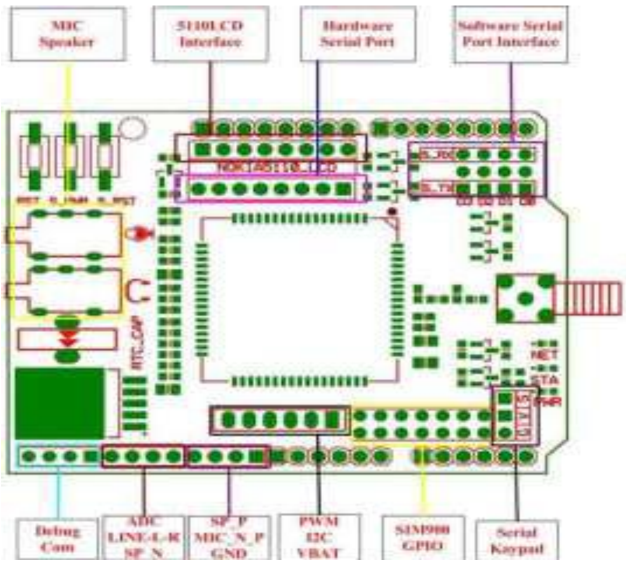

Fig. 10 Hardware design


Fig. 11 LCD5100 interface and serial port

The SIM card connector in the module should be used carefully, because it designed from weak material, as shown in figure 12.


Fig. 12 SIM card connector

Today the available card of GSM-GPRS SIM900 module is new type (last version) but does not differ from the original one, as shown in figure 13; absolutely it is simple in connection so we use it in our research.

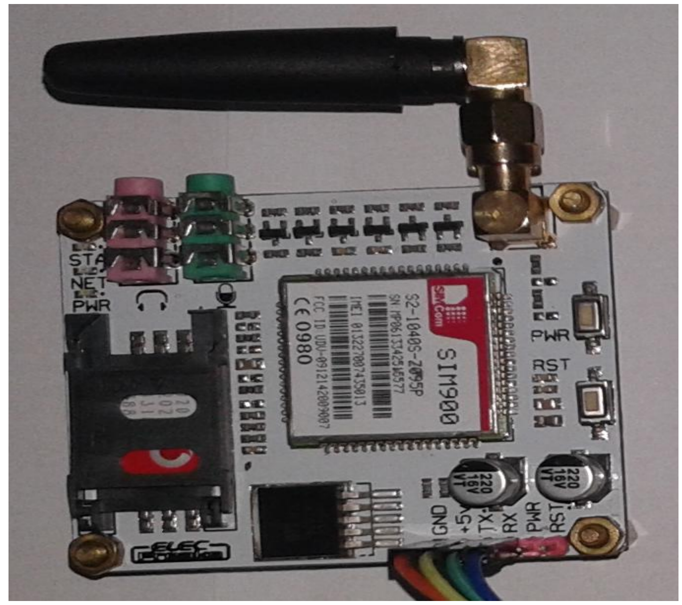
Fig. 13 Final model

B. 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 [13] are based on a new RISC architecture that has been developed to take advantage of semiconductor integration and software capabilities of the 1990's [14]. In our research we use AVR ATmega32.

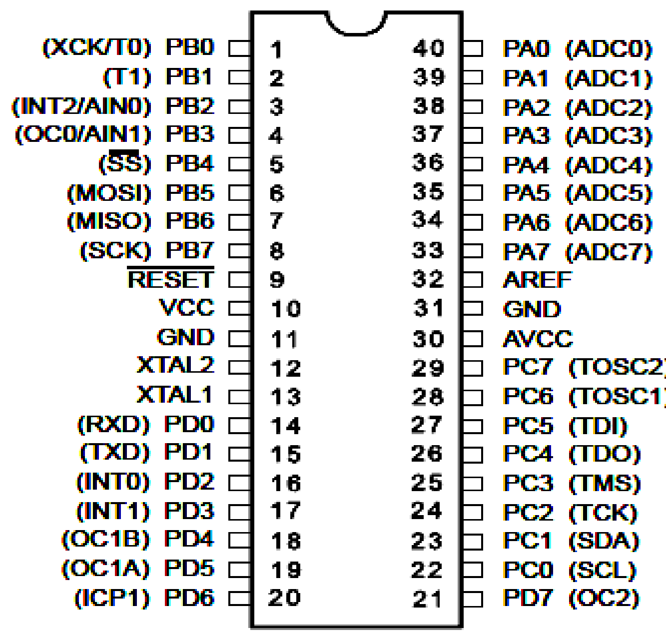

Fig. 14 Pinout of ATmega32 microcontroller

The Atmel AVR ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture, as shown in figure 14. By executing powerful instructions in a single clock cycle, the ATmega32 achieves throughputs approaching one MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

C. Connection between microcontroller and GSM module

In the microntroller, the serial USART is used for full duplex (two-way) communication between a receiver and transmitter [15]. The ATmega32 can also be used for serial communication, just connect the receiving pin of the microcontroller with transmitting pin of the GSM module card and transmitting pin of the microcontroller with receiving pin of the GSM module card, as shown in figure 15.

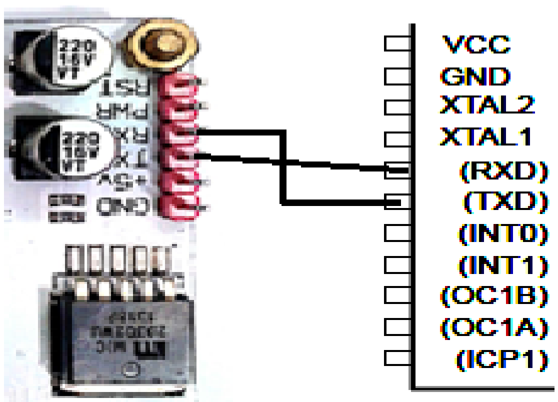

Fig. 15. Connection between R_x, T_x of both microcontroller and GSM module

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 [1].

VI. SOFTWARE PROGRAMMING

Using C language and suitable compiler, we can program the microcontroller to achieve our demands. We choose MicroC 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.

VII. CONCLUSION

This research helped us 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. 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 program the microcontroller to do certain actions for signals received from the connected sensors. So we can control any high voltage electrical network without need of human mediation at power stations. This technology helps to transmit data easier than wired cables, lower costs and more reliable. It prevents the system from hacker by assurance from the sender number, so we can apply simple encoding just to protect data from stolen at air not more. Generally it is a good way to use this technology, and if we develop it to use GPRS instead of GSM, then the cost wise will occur better than it. The question here "Why RF is not suitable to this system?", the answer there are a number of advantages of RF circuits such as Low cost, Ease of Construction & design, easy decoding, less maintenance cost etc. [16], but we cannot depend on 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.

REFERENCES

[1] Mohamed Saad Zaghloul, "GSM-GPRS Arduino Shield (GS-001) with SIM 900 chip module in wireless data transmission system for data acquisition and control of power induction furnace", International Journal of Scientific & Engineering Research, Volume 5, Issue 4, April-2014.

[2] William J. Fleming, "Overview of Automotive Sensors", IEEE SENSORS JOURNAL, VOL. 1, NO. 4, DECEMBER 2001.

[3] H. Norton, "Transducer fundamentals," in *Handbook of Transducers*. Englewood Cliffs, NJ: Prentice Hall, 1989, ch. 2.

[4] Sarita Kumari, "Wireless Biometric Data Acquisition System, International Journal of Power System Operation and Energy Management (IJPSOEM)", Volume-1, Issue-1, 2011

[5] Data acquisition [online]. Available: http://en.wikipedia.org wiki/Data_acquisition

[6] Sathish Kumar, "Lab view Based Wireless Sensor for Monitoring the Building", IJMEIT Vol. 2 Issue ***4***, April, 2014.

[7] A. Amditis, Y. Stratakos, Dr. Bairaktaris, M. Bimpas, S. Camarinopolos, S. Frondistou-Yannas, etal., "An overview of MEMSCON project an intelligent wireless sensor network for after earthquake evaluation of concrete buildings", Proc."14th European Conference on Earthquake Engineering (14ECEE)", Ohrid, FYROM, 30 Aug - 03 Sep, 2010.

[8] Mohamed Saad Zaghloul, "Online Ship Control System Using Supervisory Control and Data Acquisition (SCADA)**",** International Journal of Computer Science and Application (IJCSA) Volume 3 Issue 1, February 2014.

[9] Thoraya Obaid, Haliemah Rashed, Ali Abu El Nour, Muhammad Rehan, Mussab Muhammad Saleh, and Mohammed Tarique, "ZIGBEE BASED VOICE CONTROLLED WIRELESS SMART HOME SYSTEM", International Journal of Wireless & Mobile Networks (IJWMN) Vol. 6, No. 1, February 2014

[10] Micro C for AVR [online]. Available: http://www.mikroe.com/downloads/get/300/mikroc_pro_avr_manual_v100.pdf

[11] Smt.M.Baby, P.Harini, P.Harini, Y.Eleena Slesser, Y.Tejaswi, K.Ramajyothi, M.Sailaja, K.Annie Sumantha, "SMS Based Wireless E-Notice Board", International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 3, March 2013.

[12] GSM shield datasheet Arduino tutorial [online]. Available: http://www.fut-electronics.com/wp-content/plugins/fe_downloads/Uploads/GSM-shield-datasheet-Arduino-tutorial.pdf

[13] ATMEL Corporation. *AVR Enhanced RISC Microcontrollers Data Book*. May 1996.

[14] Gaute Myklebust, "The AVR Microcontroller and C Compiler Co-Design", ATMEL Development Center, Trondheim, Norway [online]. Available: http://www.atmel.com/images/compiler.pdf

[15] Morgan & Claypool, "Atmel AVR Microcontroller Primer Programming and Interfacing", 2008.

[16] Kunal Borker, Rohan Gaikwad, Ajaysingh Rajput, "Wireless Controlled Surveillance Robot", IJARCSMS, Volume 2, Issue 2, February 2014.

[17] Pranesh.S, Mr. P. Saravana Kumar," A MASSIVE VEHICLE THEFT CONTROL SYSTEM USING EMBEDDED AND MOBILE

TECHNOLOGIES", International Journal of Advanced Research, Volume 2, Issue 4, 53-59, 2014

[18] Bhavyashri S Bedve , Divya Vardhamane and Shruti Khuba," GSM BASED REMOTE PROCESS CONTROL AND MONITORING", Indian Streams Research Journal, Volume 4, Issue 3, April 2014

[19] Akbar Majidi, Hamid Mirvaziri, "A New Mechanism for Congestion Control in Wireless Multimedia Sensor Networks for Quality of Service and Network Life Time", American Journal of Computing Research Repository, 2014, Vol. 2, No. 1, 22-27 Available online at http://pubs.sciepub.com/ajcrr/2/1/5

[20] Swastik Brahma, Mainak Chatterjee, Kevin Kwiat, Pramod K. Varshney. Traffic management in wireless sensor networks: Decoupling congestion control and fairness. Computer Communications 2012; 35: 670-681.

[21] Smt.M.Baby, P.Harini, P.Harini, Y.Eleena Slesser, Y.Tejaswi, K.Ramajyothi, M.Sailaja, K.Annie Sumantha, "SMS Based Wireless E-Notice Board", International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 3, March 2013

APPENDIX A

```
// Programming code for power station
sbit LCD_RS_Direction at DDB0_bit;
sbit LCD_EN_Direction at DDB2_bit;
sbit LCD_D4_Direction at DDB4_bit;
sbit LCD_D5_Direction at DDB5_bit;
sbit LCD_D6_Direction at DDB6_bit;
sbit LCD_D7_Direction at DDB7_bit;
sbit sw1 at pina.b0;
sbit sw2 at pina.b1;
sbit led1 at portc.b0;
sbit led2 at portc.b1;
sbit led3 at portd.b7;
sbit buz at portc.b4;
int flag1 = 0;
int flag2 = 0;
unsigned int time=0;
int time2=0;
char rx_data[200];
char pot_txt[7];
char mob_no[16];
char mob_no_ok[] = "01093695588";
char msg_content[70];
char i,xx , an_val, pot_val;
char count1,count2, count_mob_no;
char msg1[8]="LED ON " ;
char msg2[8]="LED OFF" ;
void gsm_init(){
uart1_write_text("AT");  // init GSM
delay_ms(100);
uart1_write(13);
delay_ms(1000);
uart1_write_text("AT");  // init GSM
delay_ms(100);
uart1_write(13);
delay_ms(1000);
uart1_write_text("AT+IPR=9600");
delay_ms(100);
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CMGF=1");
delay_ms(100);
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CNMI=2,1,0,0,0");
delay_ms(100);
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CMGD=4,4");
delay_ms(100);
uart1_write(13);
delay_ms(5000);        }
void send_SMS(char desired_mob_no[12],char msg_to_send[70]){
uart1_write_text("AT+CMGF=1");
delay_ms(300);
uart1_write(13);  // enter key
delay_ms(300);
uart1_write_text("AT+CMGS=\"");
uart1_write_text(desired_mob_no); // mobile No.
uart1_write('\"');
delay_ms(100);
uart1_write(13);  // enter key
delay_ms(500);
uart1_write_text(msg_to_send); // message text
delay_ms(300);
uart1_write(26);  // ctrl+z       to send  message
delay_ms(3000);        }
void run(){
if(sw1==0 && flag1==1) {
                flag1=0;
                led1=0;
                lcd_out(1,1,"CB1 open ");
                send_SMS(mob_no_ok , "CB1 open");
                 } // end if
if(sw1==1 && flag1==0) {
                flag1=1;
                led1=1;
                lcd_out(1,1,"CB1 close");
                send_SMS(mob_no_ok  , "CB1 close");
                 } // end if
if(sw2==0 && flag2==1) {
                flag2=0;
                led2=0;
                lcd_out(2,1,"CB2 open ");
                send_SMS(mob_no_ok , "CB2 open");
                 } // end if
if(sw2==1 && flag2==0) {
                flag2=1;
                led2=1;
                lcd_out(2,1,"CB2 close") ;
                send_SMS(mob_no_ok, "CB2 close");
                 } // end if           }
void control(){
lcd_cmd(_lcd_clear);
count1=0; count2=0;
for(i=0; i<7; i++){
      if(msg_content[i]==msg1[i]) count1++;
      if(msg_content[i]==msg2[i]) count2++;
      }
   if(count1==6){led3=1;delay_ms(100);}
   else if(count2==7){led3=0;delay_ms(100);}
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();}
delay_ms(1000);
uart1_write_text("AT+CMGR=1");
delay_ms(100);
uart1_write(13);
delay_ms(20);
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();}        }
void main() {
DDB1_BIT = 1;
PORTB1_BIT = 0;
LCD_INIT();
LCD_CMD(_LCD_CURSOR_OFF);
UART1_INIT(9600);
lcd_out(1,1,"welcome");
DELAY_MS(1000);
lcd_cmd(_lcd_clear);
  //end
DDC0_BIT = 1;
DDC1_BIT = 1;
DDd7_BIT = 1;
DDC4_BIT = 1;
buz=0;
delay_ms(10000);
GSM_INIT();
led3 = 1;
lcd_out(1,1,"System Ready");
delay_ms(1000);
lcd_cmd(_lcd_clear);
led3 =0;
while(1) {
if(sw1==1){led1=1; lcd_out(1,1,"CB1 close");    }
else {led1=0; lcd_out(1,1,"CB1 open ");}
if(sw2==1){led2=1; lcd_out(2,1,"CB2 close");    }
else {led2=0; lcd_out(2,1,"CB2 open ");        }
receive_SMS();
delay_ms(500);              }        }
```

Appendix B

```
// Programming code for control center
sbit LCD_RS at PORTC7_bit;
sbit LCD_EN at PORTC6_bit;
sbit LCD_D4 at PORTC5_bit;
sbit LCD_D5 at PORTC4_bit;
sbit LCD_D6 at PORTC3_bit;
sbit LCD_D7 at PORTC2_bit;
        sbit LCD_RS_Direction at DDC7_bit;
sbit LCD_EN_Direction at DDC6_bit;
sbit LCD_D4_Direction at DDC5_bit;
sbit LCD_D5_Direction at DDC4_bit;
sbit LCD_D6_Direction at DDC3_bit;
sbit LCD_D7_Direction at DDC2_bit;
sbit buz at portd.b2;
        sbit led1 at portd.b6;
sbit led2 at portd.b7;
        sbit sw1 at pinb.b0;
sbit sw2 at pinb.b1;
        int flag1 = 1;
int flag2 = 1;
        int time=0;
char rx_data[200];
char mob_no[16];
char mob_no_ok[] = "01000659865"; // mob no to control from
char msg_content[70];
char i,xx;
char count1,count2,count3,count4, count_mob_no;
char msg1[10]="CB1 open " ;
char msg2[10]="CB1 close" ;
char msg3[10]="CB2 open " ;
char msg4[10]="CB2 close" ;
void send_SMS(char desired_mob_no[12],char msg_to_send[70]){
uart1_write_text("AT+CMGF=1");     // text mode  format
delay_ms(300);
uart1_write(13);  // enter key
delay_ms(300);
uart1_write_text("AT+CMGS=\"");
uart1_write_text(desired_mob_no); // mobile No.
uart1_write('\"');
delay_ms(100);
uart1_write(13);  // enter key
delay_ms(500);
uart1_write_text(msg_to_send); // message text
delay_ms(300);
uart1_write(26);  // ctrl+z
delay_ms(3000);        }
void run(){
if(sw1==1 && flag1==1) {
          flag1=0;
          send_SMS(mob_no_ok , "LED ON");
           } // end if

      if(sw1==0 && flag1==0) {
                flag1=1;
                 }
      if(sw2==1 && flag2==1) {
                flag2=0;
                send_SMS(mob_no_ok , "LED OFF");
                 }
      if(sw2==0 && flag2==0) {
                flag2=1;
                 }        }
      void control(){
      lcd_cmd(_lcd_clear);
      count1=0; count2=0; count3=0; count4=0;
      for(i=0; i<10; i++){
          if(msg_content[i]==msg1[i]) count1++;
          if(msg_content[i]==msg2[i]) count2++;
          if(msg_content[i]==msg3[i]) count3++;
          if(msg_content[i]==msg4[i]) count4++;      }
        if(count1==9){led1=0;}
      else if(count2==10){led1=1;}
      else if(count3==9){led2=0;}
      else if(count4==10){led2=1;}        }
      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();}
      delay_ms(1000);
      uart1_write_text("AT+CMGR=1");
      delay_ms(100);
      uart1_write(13);
      delay_ms(20);
      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();          }
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;}  // wait to receive Enter
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();          }
lcd_cmd(_lcd_clear);
lcd_out(1,1,msg_content);
delay_ms(1000);
mob_no[11]='\0';
msg_content[12]='\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(1000);
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();}     }
void gsm_init(){
uart1_write_text("AT");  // init GSM
delay_ms(100);
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+IPR=9600");
delay_ms(100);
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CMGF=1");
delay_ms(100);
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CNMI=2,1,0,0,0");
delay_ms(100);
uart1_write(13);
uart1_read_text(rx_data , "OK" , 200);
uart1_write_text("AT+CMGD=1,4");
delay_ms(100);
uart1_write(13);
delay_ms(5000);       }
void main() {
ddrd.b2=1;  // buz output
ddrd.b6=1;  // led 1 output
ddrd.b7=1;  // led 2 output
portd=0;       // clear all outputs
uart1_init(9600);
lcd_init();
lcd_cmd(_lcd_cursor_off);
lcd_out(1,4,"welcome :)");
delay_ms(2000);
lcd_cmd(_Lcd_clear);
delay_ms(1000);
gsm_init();
delay_ms(500);
while(1){
if(led1==0){lcd_out(1,1,"CB1 open ");}
        else       {lcd_out(1,1,"CB1 close");}
        if(led2==0){lcd_out(2,1,"CB2 open ");}
        else       {lcd_out(2,1,"CB2 close");}
        receive_SMS();
        delay_ms(500);      }     }

        // end
```

BIOGRPHIES

Mohamed S. Zagloul was born in 1954 in Alex, Egypt, graduate as electrical engineer in 1977has his master from Alexandria University in 1990 has his PhD in Surface Acoustic wave in 2002 he works as doctor at Arab academy for science and Technology in electronic and communication department He has published more than 30 technical papers.

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