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

Dr. Mohamed Saad Zaghloul

Abstract— This paper concerns the practical design and implementation of professional tool using GSM-GPRS Arduino Shield (GS-001) with SIM 900 chip module in wireless data transmission system for data acquisition and control of power induction melting furnace, We will respond with innovative, value added technique and services that improve quality, productivity, costs, environmental protection and working conditions. An induction heater (for any process) consists of an electromagnet, through which a hi gh-frequency alternating current (AC) is passed. Heat may also be generated by magnetic hysteresis losses in materials that have significant relative permeability. The frequency of AC used depends on the object size, material type, coupling (between the work coil and the object to be heated) and the penetration depth. To ensure the quality of molten steel, its temperature and chemical composition must be constantly monitored. Using immersion sensors like Heraeus ones to take precise measurements of these parameters within seconds directly in the molten steel, rendering time-consuming sample analyses in laboratories unnecessary. This increases throughput and lowers energy consumption during steel making. Normally the obtained measurement data is sent locally to the control station through wires or fibre optics, Our mission is to proactively find and satisfy the measurement, monitoring and control needs of the molten metal processes by sending these data to a remote station using SIM 900 chip module in wireless data transmission system for data acquisition and control of high power induction melter. For soft ware part we will use GSM-GPRS Arduino Shield (GS-001), Using C language to program microcontroller, we put some strings in the program to make the GSM module understands them like AT commands. The complete designed system has basic and optional features as we operate in real time monitoring and control, use GPRS communication.

Index Terms— GSM, GPRS, sensors, Safety and protection, microcontroller, Signal Processing, Data transmition

1 INTRODUCTION

Generally the Induction heating is the process of heating an electrically conducting object (usually a metal) by electromagnetic induction, where eddy currents (also called Foucault currents) are generated within the metal and resistance leads to Joule heating of the metal. Our intension is to develop product solutions that contribute significantly to greater efficiency and higher quality in production processes, as well as improving working conditions and protecting the environment. Normally the obtained measurement data is sent locally to the control station through wires or fibre optics, our mission is to proactively find and satisfy the measurement, monitoring and control needs of the molten metal processes. Sending these data to a remote station using SIM 900 chip module in wireless data transmission system for data acquisition and control of high power induction melter

The complete designed system has basic and optional features as we operate in real time monitoring and control tracking solution, use GPRS communication [1] which is a packet oriented mobile data service on the 2G and 3G cellular communication system's global system for mobile communications (GSM), furnace status report, two way communication, automatic reports and alarm. This allows a safe and precisely timed monitoring and control of testing facilities and devices under test.

2 Sensors for Molten Metals

There are different types of sensors like Capacitive, Capacitive displacement sensor, Inductive, temperature, Laser rangefinder, Magnetic, including Magnetic proximity fuse, Passive optical (such as charge-coupled devices), Passive thermal infrared, Sonar (typically active or passive), Ultrasonic sensor , the fiber-optic-based measurement probes provide a field-tested reliable solution for measurement tasks in these areas. Environmental conditions with high voltages, high currents or both require special precautions for humans as well as electronically devices. Sensors for Molten Metal's which are Quality probes of ever improving technology to satisfy increasingly diverse applications as Steel, Zinc Galvanizing, Iron, Aluminium, and Copper The widespread availability of miniature wireless devices that can sense their surroundings and wirelessly communicate with the rest of the world is generating tremendous interest in it. It is giving the vision of anywhere and anytime with pervasive access and computing a reality [2]

Fig 1 represent (Heraeus Electro-Nite) quality probes sensor for molten metal's (Steel, Zinc Galvanizing, Iron, Aluminium, and Copper)

Fig. 2 Represent SEMC medium power 0.5 T induction melting furnace

3 Microcontrollers and Arduino

There many types of microcontroller, mainly types are (PIC – AVR), AVR microcontroller is chosen in our research because it has more features than PIC microcontroller, where AVR has more flexibility in programming, number of I/O ports and it is used in famous electronic card called Arduino.

Fig. 3 Represent Arduino MEGA and Arduino UNO

Arduino is a Micro Controllers Development board, where we can edit, develop and change the program on the microcontroller. There are many types of Arduino cards, each type used due to the number of terminals connected in the control system. The Arduino types (Arduino UNO, Arduino Mega, Arduino Nano, Arduino Mini, Arduino Lilypad, ArduinoDemulive, Boarduino).The difference between types is number of I/O terminals, microcontroller type and processing speed. Famous type of Arduino is (Arduino UNO) because it is available, and has a good coast. Arduino cards can be programmed by MATLAB, Java, VB.NET and mainly C language. We will use (Arduino UNO) card and C language to program it.

4- Operation and practical design

Data will be collected from sensors placed in the furnace station and connected to the microcontroller through Arduino card. The circuit diagram shown in the figure 5, we demonstrate the sensors by switches which have two positions as circuit breaker on or off in the furnace station adding to that local display (LCD) is used for monitor the output before transmition. The microcontroller scan its terminal each certain seconds (due to programmer) and send status of the sensors to another site in the control room which to follow and track the furnace station. Dispatcher engineer or an operator engineer in the control room monitors the furnace stations through SCADA system (System Control and Data Acquisition), then can control the switches (C.B.), sensors and some machines in the furnace stations remotely.

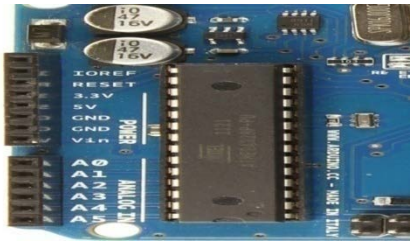

Fig 4 represents the microcontroller Power and Analog pins

For any change in the furnace station like (C.B. closed) this is send to microcontroller so the new status is sent to the control room in the other site directly, In the control room operator can monitor all furnace stations data and status of any switch or sensor, then can change the status remotely or acknowledge it.

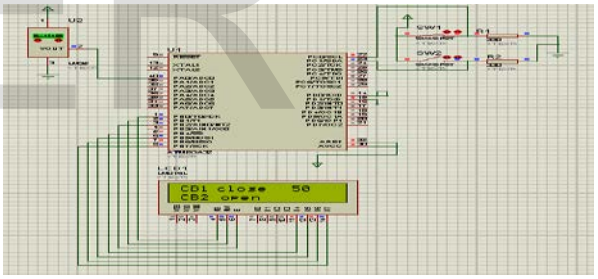

Fig 5 represents the data obtained and monitored in furnace local display location

5. Methods of sending data

5.1 Wiring: Sending data via wiring system using coaxial cables or fibre optical cables but it needs using RTU (Remote Transmission Unit) which is placed in the both sites (furnace station and control room), It collects all sensors and switches data and sending it through the wire connected to another RTU placed in the other site. We can use Arduino card to send data via wired cables also without RTU but need amplifiers in the way between furnace station and control room sites.

5.2 Wireless: Sending data via channel with bandwidth through carrier such as (Wi-Fi – Wi-Max – GSM – GPS – GPRS – Satellite). Suitable ways are GSM or GPS due to large bandwidth which

helps to send more data in a little time. We can use GSM-GPRS Arduino Shield (GS-001) with SIM 900 chip module in our wireless data transmission system for data acquisition and control power stations. The wireless medium is inherently less secure because its broadcast nature makes eavesdropping simple. Any transmission can easily be intercepted, altered, or replayed by an adversary. The wireless medium allows an attacker to easily intercept valid packets and easily inject malicious ones. Some work may include the implementation of suitable security mechanisms for the better performance and the outcome of the WSANs in all their applications. [3]

6 GSM-GPRS Arduino Shield (*GS-001*)

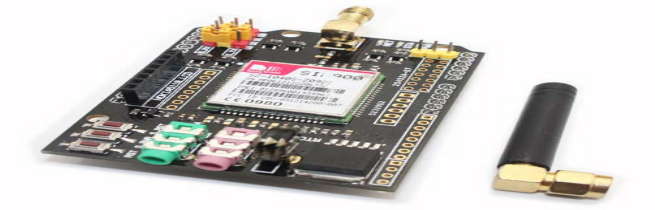

Fig 6 represents GSM-GPRS Arduino Shield (GS-001) [4]

GSM-GPRS Shield is an ultra compact and reliable wireless module. It is based on SIM900 4 Frequency GPRS module. The GSM-GPRS Shield is configured and controlled via its UART using simple AT commands. [5] 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 be set on Arduino. The shield allows you to achieve this via any of the three methods: Short Message Service, Audio and GPRS. There is super capacitor power supply for the RTC. 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 off. Features are Fully compatible with Arduino UNO and MEGA, Free serial port connecting, you can select Hardware Serial port (D0/D1) control or Software Serial port (D2/D3) controls it, SIM900 all pins breakout. Not just the UART port and debug port be layout, Super
capacitor power supply for the RTC, Not only can use the button for power on, but also can use the digital pin of Arduino to power on and reset the SIM900 module, Quad-Band 850/ 900/ 1800/ 1900 MHz, Control via AT commands, Supply voltage range: 3.1 … 4.8V, Dimension: 68.33x53.09mm (Same dimension of Arduino main board) [4]

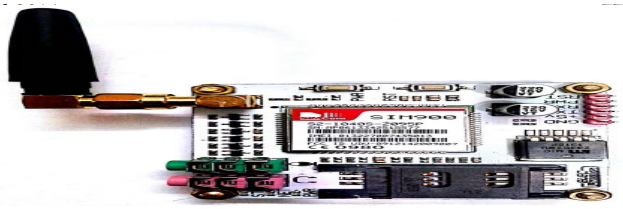

Fig. 7 GSM-GPRS SIM900 last models [4]

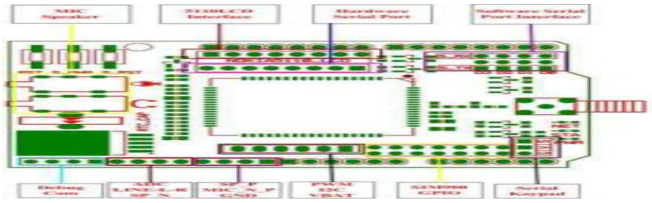

Fig. 8 Card design

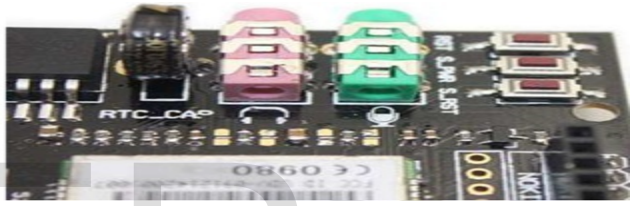

Fig. 9 Super RTC _ CAP and Line In

Fig. 10 LCD5100 interface and serial port

Fig. 11 represents SIM Card Connector [4]

ISSN 2229-5518

7 Circuit Connections

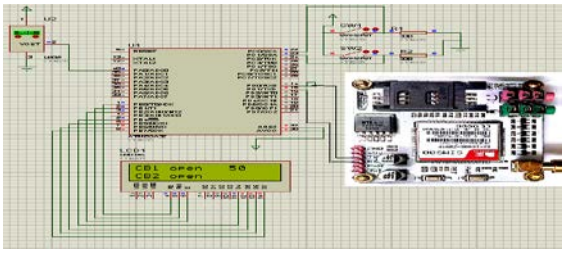

Fig. 12 represents the complete circuit connection in furnace station

We connect the Rx pin of the microcontroller card with Tx pin of the GSM module and Tx of the microcontroller card with Rx pin of the GSM module. When the GSM module in one site (furnace station) receives the commands from the micro controller it sends a message contains the data want to send to another GSM module in the other site (remote control room).

8. Programming

Using C language to program microcontroller, we put some strings in the program to make the GSM module understands them like AT commands. The software offers ready-to-use data analysis and reporting packages for applications

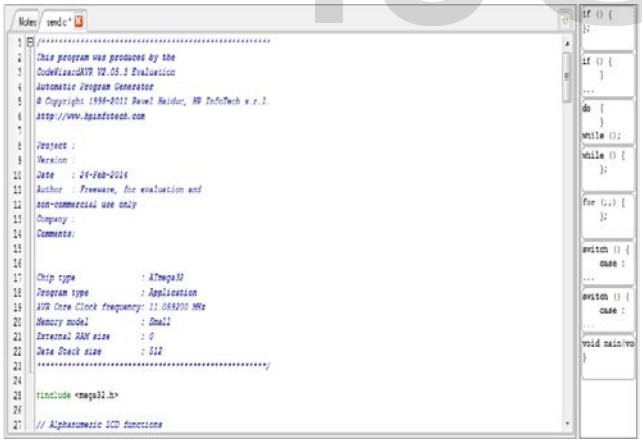

Fig. 13 Programming using AVR Code Vision

Programming using AVR Code Vision# include <mega32.h>// Alphanumeric LCD functions

The complete program code is shown in appendix A

9. Conclusion

In this design, a practical design and implementation of professional tool using GSM-GPRS Arduino Shield (GS-001) with SIM 900 chip module in wireless data transmission system for data acquisition and control of high power induction furnace, this design was developed as a technology improve quality, productivity, costs, environmental protection and working conditions. The widespread availability of miniature wireless sensor devices that can sense their surroundings and wirelessly communicate with the rest of the world is generating tremendous interest in it. [6] By applying this system we have Modern local and remote monitor, control and alarm System using modern GSM-GPRS Arduino Shield (GS-001) with SIM 900, this system will help observer in control to get fast and reliable data about furnace station, increase the efficiency of operation. It will economize electricity consumption, the status of each sensor or switch is known, it will improve safety, security of furnace operation, and facilitate supervision process. But due to the resource constraints, the sensor devices are not responding immediately and need constant monitoring [7].Moreover; it can send warning massage at certain condition. System provide high quality, cost effective solution backed by open architecture design and can be used for a wide variety of application. The system proved high level of security, cheap and can be used to more complex designs according to requirements. It can be used in wide scale in commercial as remote and local control and monitor application. with GPRS and the data is transmitted by GPRS technology to sent data tagged with time to the control data centre for the required action.[8] We use the satellite in case of no mobile cover; also the sent data can be encrypted for more security. More over the system can be used for management using the furnace status. [9]

References

[1] GPRS and EDGE multi slot classes, by Martin Sauter, April 02, 2007

[2] Guest Editorial Security in Wireless Ad Hoc Networks, IEEE Journal On Selected Areas In Communications, Vol. 24, No. 2, February 2006

[3] Binodkumar, Malathi Balaji, R. Dbalaji, Ramkumar Lakshminarayanan, Wireless Sensor and Actor Network – Security Analysis, Journal of Wireless Networking and Communications, Vol. 4 No. 1, 2014, pp. 1-6. doi: 10.5923/j.jwnc.20140401.01

[4] GSM-shield-datasheet-Arduino-tutorial, SIM900_AT Command Manual_V1.03, SIM900_EVB kit User Guide_V1.03. and ATmega32 datasheet.

[5] M S Zaghloul Modern architecture tracking system using modern GPS, USA , International Journal of Scientific and Engineering Research ,Vol.5, Issue 1,Jan.2014

[6] Wireless sensor network. http://en.wikipedia.org/wiki/Wireless_Sensor_Networks

[7] YunhoLee, Soojin Lee," A New Efficient Key Management Protocol for Wireless Sensor and Actor Networks", (IJCSIS) Vol. 6, No. 2, 2009.

[8] ETSI Summit on future mobile and standard for 3G Nov.25, 2013, Kevin Flynn

[9] M. S. Zaghloul, design of open architecture system to reduce the likelihood of vehicle getting stolen or carjacking, Journal of computer science and application 2014, 1st international conference in computer science and application, Indiana, USA.

Appendix A

Programming Code

```
#include <mega32.h>// Alphanumeric LCD functions
#include <alcd.h>// Standard Input/Output functions
#include <stdio.h>
#include <delay.h>
#include <stdlib.h>
#define ADC_VREF_TYPE 0x40
// Read the AD conversion result
unsigned int read_adc(unsigned char adc_input)
{
ADMUX=adc_input | (ADC_VREF_TYPE & 0xff);
// Delay needed for the stabilization of the ADC input voltage
delay_us(10);
// Start the AD conversion
ADCSRA|=0x40;
// Wait for the AD conversion to complete
While ((ADCSRA & 0x10)==0);
ADCSRA|=0x10;
ADCW = (ADCW*5)/(0.01*1023);  // eqn for LM35 temperature sensor reading
Return ADCW;
}
Void main (void)
{
Unsigned int i;
Unsigned char str[10];
PORTA=0x00;
DDRA=0x00;
PORTB=0x00;
DDRB=0x00;
PORTC=0x00;
DDRC=0x00;
PORTD=0x00;
DDRD=0x00;
UCSRA=0x00;
UCSRB=0x18;
UCSRC=0x86;
UBRRH=0x00;
UBRRL=0x47;
lcd_init(16);
ADMUX=ADC_VREF_TYPE & 0xff;
ADCSRA|=0x83;
While (1)
    {
    i = read_adc(PINA.0);
    itoa(i,str);
    lcd_gotoxy(11,0);
    lcd_puts(str);
   if(PINC.0 == 0)
    {
    lcd_gotoxy(0,0);
    lcd_puts("CB1 open");
    }
    Else if (PINC.0 ==1)
{
    lcd_puts("CB1 close");
    printf("at+cmgf=1\r");
    delay_ms(1000);
    printf("at+cmgs=\"+201006083150\"\r");
    delay_ms(1000);
        printf("CB1 close\r\x1A");
    }
        lcd_gotoxy(0,1);
    if(PINC.1 == 0)
    {
    lcd_puts("CB2 open");
    }
    else
    lcd_puts("CB2 close");
        delay_ms(100);
    lcd_clear();
        lcd_gotoxy(0,0);
        }
```