Demand Side Management by Using GSM Interfacing with Arduino (UNO)

[1]Madhuri Mahajan, [2]Swati Patharwat, [3]Anuruddha Ingale, [4]Rohit Chaudhari, [5]Ishwar Patil, [6]Prof. Atul Barhate
[1,2,3,4,5,6]Department of Electrical Enginnering, GF's G.C.O.E Jalgaon, Maharashtra, India.
mmadhuri78@gmail.com

Abstract- **Demand management is vast topic in supply chain management. It is concentrated on a fast and adequate integration of customer needs in order to balance, strategically align demand with operational capability in the supply chain. The project gives direction towards the maximum demand of the industry. It is essential to indicate the demand of the total system, rather than the load of the system is increased. We need to run this system with proper operation. Therefore, the indication of the extended power demand is to be done under a predetermined limit. The current sensor senses the current from the given load and sends the signal to the interfacing of the GSM and Arduino in the proportion of the current. The interfacing of the GSM SIM900 and ARDUINO (UNO) is used to send and receive the SMS (Short Message service) of extended power demand. GSM stands for Global System for Mobile Communication. It is a digital cellular technology, used for transmitting mobile voice and data services. It is the most widely accepted standard in telecommunications and it is installed globally. It operates on the mobile communication bands 900 MHz and 180SS0 MHz in most parts of the world. The Arduino is open-source, which means hardware is reasonably priced and development software is free. The Arduino uses a simplified variation of the C programming language. The technology of this project may employee and certain substation of power bank and application utilized anywhere the operation want.**

Keywords- maximum demand, current sensor, GSM (Global System for Mobile Communication.), Arduino (UNO), interfacing, predetermined limit.

I. INTRODUCTION

The extreme average value of the power (apparent power or current) consumed by a customer of an electric power system. This average value being taken over successive time periods, usually 15 to 30 minutes in length. It is the highest request of load on the power station during a given period, i.e., the maximum of all the demands that have occurred during a given period (may be a day, may be an hour, etc). This project suggests a control system that addresses these requirements in which GSM/SMS is used for data reading and control, thus giving the flexibility for the operator to be available anywhere away from the vicinity of the process.

The Arduino GSM Shield allows an Arduino board to connect to the internet, make/receive voice calls and send/receive SMS messages. It is possible to communicate with the board using AT commands. The GSM collection has a large number of techniques for communication with the shield. GSM is the dominant global mobile phone network which allows exchange of short text messages economically. In Remote Monitoring and Control application, various methods have been employed and each method has its own ply chain level of success in terms of implementation, cost effectiveness and reliability.

The aim of this project is to propose a simple and cost effective system implementation of Remote Industrial Process Monitoring, Controlling using GSM and Web Technology. To deliver data direct from field sites to an operator, the GSM technology utilizes the GSM cell phone network.

A. Necessity

With the growth and widespread reach of cellular network and web Technology, its application has extended to process plant control. Industrial Automation is an ideal solution for cost effective Process Parameter monitoring and control since it requires minimum human presence in the vicinity of the process set up. But there are instances where critical human decision is required to control the process and also logging of data required for later reference. The system needs to implement in automation industry for the updates of parameters regarding the load viz. current, voltages, active power, and power factor in case. Due to this, operator may

control the demand manually or automatically. This system may be implemented with respect to time. The technology may prove very cost effective and practical in areas served by cell phone data services.

C. Objectives

ARDUINO AND GSM BASED MAXIMUM DEMAND CONTROLLER is a microcontroller based project. Many companies in the mining, automobile, textile and paper industry have to pay an additional charge over and above the normal charge for units of electricity consumed as max22imum demand charge. This charge often forms a large part of the bill which can be tracked at times to only one 30 minute instance of high power usage. This is because the utility company charges a penalty when the factory draws more power than the contracted maximum demand.

The maximum power consumed in factories over a calculated period of time, which is normally anywhere between 8 to 30 minutes is known as maximum demand. In many countries, 15 minutes is considered as the most common time period. There are three terms that appear on majority of the company electric bills, Active energy consumption (kWh), reactive energy consumption (kVARh) and Maximum demand. Traditionally companies have concentrated their energy saving efforts on two terms, Reduction of Kilowatt Hour Consumption and improving the electrical systems Power Factor.

II. SYSTEM DEVELOPMENT

A. Block diagram of the system

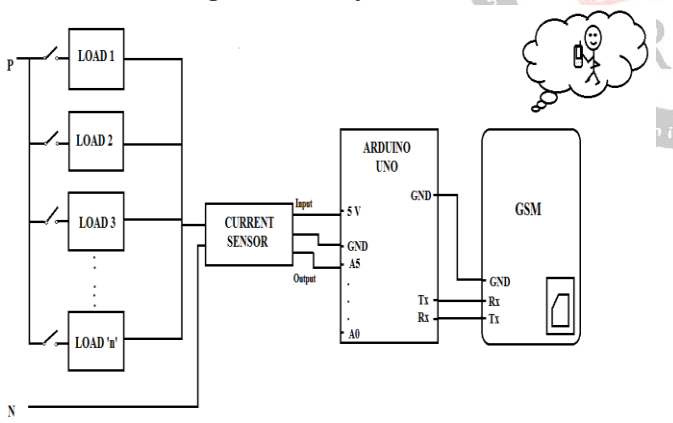


Fig.1 Block diagram of the system

B. Block diagram description

- **Load**

The load of 1 phase, 230V, 10A, 1500Watt is used to execute the project.

- **Current sensor**

A current sensor is a device that detects electric current (AC or DC) in a wire, and generates a signal proportional to it.

The produced signal could be analog voltage or current or even digital output. It provides economical and prise solution for AC or DC current sensing in industrial, commercial, and communication system. Individual application include motor control, load detection and management, and over current fault protection.

This current sensor base on linear Hall sensor circuit. Applied current flowing through copper conductor produce a magnetic field which is sensed by the integrated Hall IC and converted in a proportional voltage is provided by the low offset, copper stabilized BICMOS Hall IC, which is programmed for accuracy after packaging.[1]

Selection Guide

Part No.	Packing*	T_A (^oC)	Optimized Range, Ip (A)	Sensitivity, Sens (Typ) (mV/A)
ACS712ELCTR-30A-T	Tape and reel, 3000 places/reel	-40 to 85	±30	66

Table 1

- **Microcontroller (Arduino UNO)**

Arduino is a prototype platform (open-source) base on hardware and software. It contain of a circuit board, which can be programmed and a ready-made software called Arduino Integrated Development Environment, which is used to write and upload the computer code to the physical board.
Arduino provides a standard form factor that breaks the function of microcontroller into a more accessible package. The various kinds of Arduino boards are available depending on different microcontroller used.

Following are the different components used on the Arduino board.

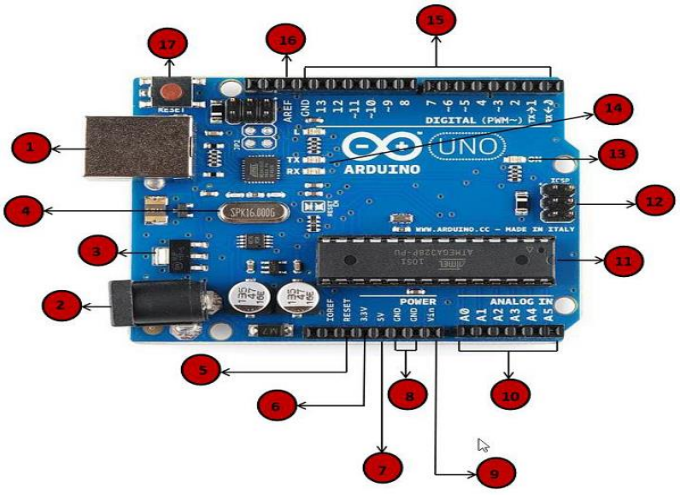


Fig.2 Arduino (UNO) board

1. Power USB:

Arduino board can be powered by using the USB cable from computer i.e., at point 1.

2. Power (Barrel Jack)

Arduino board can be powered directly from the AC mains power supply by connecting it to the barrel jack i.e., at point

3. Voltage regulator

The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages use by the processor and other elements.

4. Crystal oscillator

The crystal oscillator help Arduino in dealing with time issues.

5. Arduino Reset (pin 5, 17)

We can reset our Arduino board i.e., start our programme from the beginning. We can reset the Arduino board in two ways. First by using the reset button (17) on the board. Second we can connect an external reset button to the Arduino pin labelled RESET (5).

6. Pins (3.3, 5, GND, V_{in})

- 3.3 V (6): supply 3.3 output volt
- 5V (7): supply 5 output volt
- Most of the components used with Arduino Board work fine with 3.3V and 5V.
- GND (8) (Ground): There are several GND Arduino, any of which can be used to ground our circuit.
- V_{in} (9): This pin also can be used to power the Arduino board from an external power source, like AC mains power supply.

7. Analog pins

The Arduino UNO board has 5 analog input pin A0 through A5. This pin can be read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

8. Main microcontroller

Each Arduino board has its own microcontroller (pin 11). You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is marginally different from board to board. The microcontrollers are usually of the ATMEL company. You must know what IC your board has before loading up a new program from the Arduino IDE. This information is available on the top of the IC. For more detail about the IC construction and functions, you can refer to the data sheet.

9. ICSP pin

Mostly, ICSP is an AVR, a tiny programming header for the Arduino involving of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the master of the SPI bus.

10. Power LED indicator

This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection.

10. TX and RX LEDs

On your board, you will find two labels: TX (transmit) and RX (receive). They perform in two places on the Arduino UNO board. Frist, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led. The TX led flashes with dissimilar speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process.

12.Digital I/O

The Arduino UNO board has 14 digital I/O pins (of which 6 provide Pulse Width Modulation output. These pins can be configurator to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relay, etc. the pins labelled can be used to generate PWM.

13.AREF

AREF stands for Analog Reference. It is sometime, use to set an external reference voltage (between 0 and 5 volts) as the upper limit for the analog input pins.[2]

- ***GSM (Global System for Mobile Communication)***

GSM is globally accepted standard for digital cellular communication. GSM uses slight band time division, multiplication access (TDMA) or providing voice and text based services over mobile phone network.

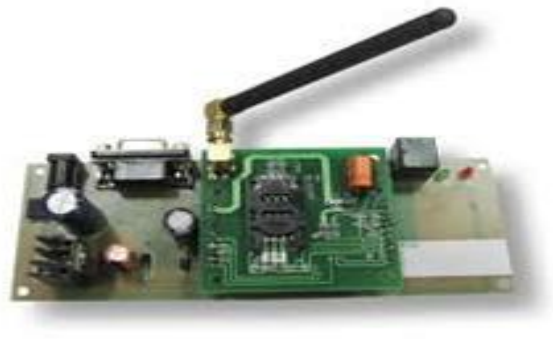


Fig. 3 GSM Model

- **1. What is GSM?**

If you are in Europe or Asia and using a mobile phone, then most probably you are using GSM technology in your mobile phone.

- GSM views for **G**lobal **S**ystem for **M**obile Communication. It is a digital cellular technology used for transmitting mobile voice and data services.
- The concept of GSM emerged from a cell-based mobile radio system at Bell Laboratories in the early 1970s.

- GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard.
- GSM is the most widely accepted standard in telecommunications and it is implemented globally.
- GSM is a circuit-switched system that divides each 200 kHz channel into eight 25 kHz time-slots. GSM works on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. In the US, GSM operates in the bands 850 MHz and 1900 MHz.
- GSM owns a market share of more than 70 percent of the world's digital cellular subscribers.
- GSM makes use of narrowband Time Division Multiple Access (TDMA) technique for transmitting signals.
- GSM was developed using digital technology. It has ancapacity to carry 64 kbps to 120 Mbps of data rates.
- Presently GSM supports more than one billion mobile subscribers in more than 210 countries throughout the world.
- GSM provides basic to advanced voice and data services including roaming service. Roaming is the ability to use your GSM phone number in another GSM network.
- GSM digitizes and compresses data, then leads it down through a channel with two other streams of user data, each in its own time.[3]

C. Working of System

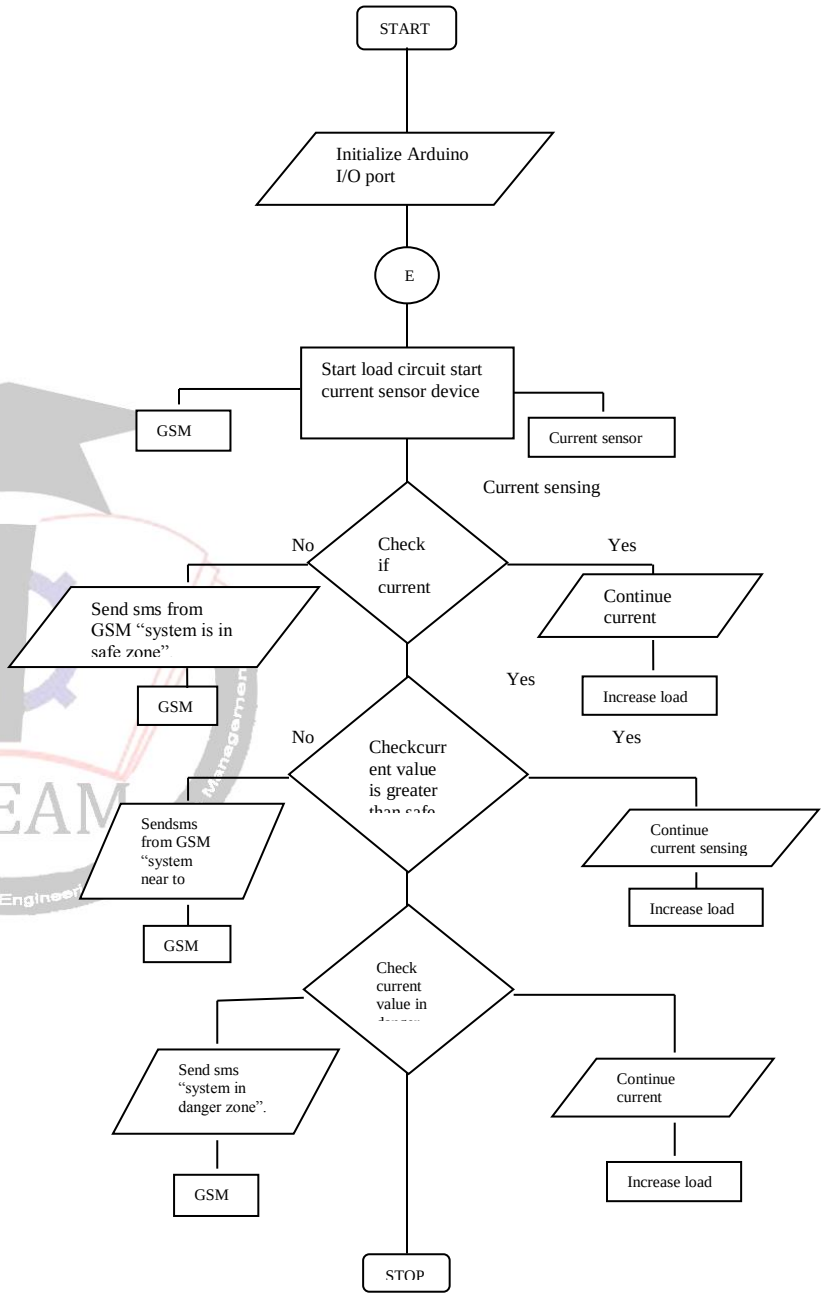
Day to day the utilization of electricity is increased due to heavy use of load which work on electrical energy. The power station has to increase the production of energy to fulfill the requirements of the industry, domestic and commercial purposes. And hence the power demand increase and its much higher products reduced the analysis of the power.

This project is done to analyse the use of demand. It also shows the different parameters from which the graph of utilization can be seen. The reading of parameters can be send by using Ethernet or by GSM which are interface with Arduino.

The Arduino UNO is interface with GSM Module so that the required parameters can be taken on mobile phone by SMS. This arduino is supplied by USB cable or by an adaptor of +9V. The Arduino is a microcontroller which is used for programming or (coding) different languages of program.

Here Arduino is programmed such as the input to arduino can be send through SMS on different devices. Input is given by current sensor (ACS712) which has three pin they are VCC, GND, OUTPUT. This current is supplied by arduino (+5V) and the input is taken by pin A0 of arduino board. The ground is connected to ground pin at arduino board. This input is calculated by default program and shown at the serial monitor, as the current increase above the defaults reading at an instant accurate reading is send (through GSM device) by SMS. The difference stages are defined at the program they are safe zone, near about danger zone, system at danger zone, near to safe zone. This three stage are defined so that the system will never cross the defined danger zone.

D. Flowchart



1. Start the programme.
2. Initialize Arduino board & GSM also current sensor.
3. Check load is on.
4. Connect load with current sensor & Arduino board.
5. Check if first condition is satisfied, then current sensor will display value I.
6. SMS is send to operator through GSM modem.

7. If load is increases the value of current sensor will increases.
8. It gives to next SMS through the GSM modem to operator.
9. The load is then handled manually by operator.
10. Stop the programme.

III. ADVANTAGES AND DISADVANTAGES

A. Advantages

1. This system does not affected by any environmental conditions such as moisture, temperature, vibrations, etc.
2. The transmission of data from transmitter to receiver does not affected by any obstacle.
3. The transmitted data can be obtained anywhere from the working shield.
4. System is compact and hence economical.
5. Effective and efficient data transmission.

B. Disadvantages

1.Sometimes it shows the error for the uploading program to Arduino (UNO) board.

2. Sometime network problem for rural areas may happen.

IV. RESULT AND CONCLUSION

A. Result

Sr. no.	Power (Watt)	Current (Amp)
1	300	0.77
2	500	1.54
3	900	2.60
4	1100	3.59
5	1300	3.86

Table 2

The reading of the whole system is observed and not down in the above table no. 2. It show the reading of current in amp. In step by step increasing load. At First load, the system is stable till somehow low load.

According to programming the first SMS from GSM to the operator is send at the load 500 watt. That "the system is in safe zone". After 900, SMS is reached on to operator mobile is that, "the system is near to danger zone take some valid action". And before the current limit reached to extreme load condition it continuously send alert SMS. For taking fast quick action to protect the system by the operator from any kind of damage.

B. Conclusion

In most of industries there has defined maximum demand. This demand should not cross the defined value, if so then company can charged by MSCB. This project reduce the risk of crossing the defined value by receiving SMS which makes demand management economic and reliable.

This SMS is been take on mobile phone at every climatic condition. The risk of human error is also been reduce, and the accuracy of the system is increases. The required rate of system is very low then other wireless system. Surrounding effect does not affect this wireless system. The required power supply is very low for operation of this system, it near by 12V. The required equipment for the operation of this system are very chip and available in market easily.

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