POWER GRID CONTROL USING GSM TECHNOLOGY FOR MODERN POWERSYSTEM APPLICATIONS-A NEW APPROACH

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Abstract: Nowadays there are various electronic equipments available for remote operation of grid control. However, the main disadvantage of these systems is that they can be operated only from short ranges and also less reliable. Thus, to overcome the above drawbacks, we are using one of the wireless communication technique i.e., GSM (Global System for Mobile communications) is a digital cellular communications system which has rapidly gained acceptance and market share worldwide. The development of GSM is the first step towards a true personal communication system that will allow us to communicate anywhere, anytime and with anyone.

GSM (Global Systems for Mobile Communication) is vastly used because of its simplicity in both transmitter and receiver design, can operate at 900 or 1800MHZ band, faster, more reliable and globally network.

Index Terms: Power grid, GSM modem, MAX232, RS232 Cable, LCD Screen, Rectifier, Transformer, and LM32

1. INTRODUCTION

An embedded system is a combination of software and hardware to perform a dedicated task. An embedded system can be defined as a computing device that does a specific focused job. Appliances such as the air-conditioner, VCD player, DVD player, printer, fax machine, mobile phone etc. are examples of embedded systems. Each of these appliances will have a processor and special hardware to meet the specific requirement of the application along with the embedded software that is executed by the processor for meeting that specific requirement. The embedded software is also called “firm ware”. The desktop/laptop computer is a general purpose computer. You can use it for a variety of applications such as playing games, word processing, accounting, software development and so on. In contrast, the software in the embedded systems is always fixed listed below:

Embedded systems do a very specific task; they cannot be programmed to do different things. Embedded systems have very limited resources, particularly the memory. Generally, they do not have secondary storage devices such as the CDROM or the floppy disk. Embedded systems have to work against some deadlines. A specific job has to be completed within a specific time.

In some embedded systems, called real-time systems, the deadlines are stringent. Missing a deadline may cause a catastrophe-loss of life or damage to property. Embedded systems are constrained for power. As many embedded systems operate through a battery, the power consumption has to be very low. Some embedded systems have to operate in extreme environmental conditions such as very high temperatures and humidity.

2. OVERVIEW OF EMBEDDED SYSTEM ARCHITECTURE

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the ‘firmware’. The embedded system architecture can be represented as a layered architecture as shown in Fig.

The operating system runs above the hardware, and the application software runs above the operating system. The same architecture is applicable to any computer including a desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system. For small appliances such as remote control units, air conditioners, toys etc., there is no need for an operating system and you can write only the software specific to that application. For applications involving complex processing, it is advisable to have an operating system. In such a case, you need to integrate the application software with the operating system and then transfer the entire software onto the memory chip. Once the software is transferred to the memory chip, the software will continue to run for a long time you don’t need to reload new software.
Now, let us see the details of the various building blocks of the hardware of an embedded system. As shown in Fig. the building blocks are:

- Central Processing Unit (CPU)
- Memory (Read-only Memory and Random Access Memory)
- Input devices
- Output devices
- Communication interfaces
- Application-specific circuitry

Central Processing Unit (CPU):

The Central Processing Unit (processor, in short) can be any of the following: microcontroller, microprocessor or Digital Signal Processor (DSP). A microcontroller is a low-cost processor. Its main attraction is that on the chip itself, there will be many other components such as memory, serial communication interface, analog-to-digital converter etc. So, for small applications, a microcontroller is the best choice as the number of external components required will be very less. On the other hand, microprocessors are more powerful, but you need to use many external components with them. DSP is used mainly for applications in which signal processing is involved such as audio and video processing.

Memory:
The memory is categorized as Random Access Memory (RAM) and Read Only Memory (ROM). The contents of the RAM will be erased if power is switched off to the chip, whereas ROM retains the contents even if the power is switched off. So, the firmware is stored in the ROM. When power is switched on, the processor reads the ROM; the program is program is executed.

Input devices:
Unlike the desktops, the input devices to an embedded system have very limited capability. There will be no keyboard or a mouse, and hence interacting with the embedded system is no easy task. Many embedded systems will have a small keypad—you press one key to give a specific command. A keypad may be used to input only the digits. Many embedded systems used in process control do not have any input device for user interaction; they take inputs from sensors or transducers and produce electrical signals that are in turn fed to other systems.

Output devices:
The output devices of the embedded systems also have very limited capability. Some embedded systems will have a few Light Emitting Diodes (LEDs) to indicate the health status of the system modules, or for visual indication of alarms. A small Liquid Crystal Display (LCD) may also be used to display some important parameters.

Communication interfaces:
The embedded systems may need to, interact with other embedded systems at they may have to transmit data to a desktop. To facilitate this, the embedded systems are provided with one or a few communication interfaces such as RS232, RS422, RS485, Universal Serial Bus (USB), IEEE 1394, Ethernet etc.

Application-specific circuitry:
Sensors, transducers, special processing and control circuitry may be required fat an embedded system, depending on its application. This circuitry interacts with the processor to carry out the necessary work. The entire hardware has to be given power supply either through the 230 volts main supply or through a battery. The hardware has to design in such a way that the power consumption is minimized.

3. SYSTEM FOR MOBILE COMMUNICATION

It is a globally accepted standard for digital cellular communication. GSM is the name of standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900MHZ.

Throughout the evolution of cellular telecommunications, various systems have been developed without the benefit of standardized specification. This presented many problems directly related to compatibility, especially with the
development of digital radio technology. The GSM standard is intended to address these problems.

GSM System Architecture-1

- Mobile Station (MS)
- Mobile Equipment (ME)
- Subscriber Identity Module (SIM)
- Base Station Subsystem (BSS)
- Base Transceiver Station (BTS)
- Base Station Controller (BSC)
- Network Switching Subsystem (NSS)
- Mobile Switching Center (MSC)
- Home Location Register (HLR)
- Visitor Location Register (VLR)
- Authentication Center (AUC)
- Equipment Identity Register (EIR)

System Architecture Mobile Station (MS)

The Mobile Station is made up of two entities:
1. Mobile Equipment (ME)
2. Subscriber Identity Module (SIM)

Mobile Equipment

- Portable, vehicle mounted, hand held device
- Uniquely identified by an IMEI (International Mobile Equipment Identity)
- Voice and data transmission
- Monitoring power and signal quality of surrounding cells for optimum handover
- Power level : 0.8W – 20 W
- 160 character long SMS.

Subscriber Identity Module (SIM)

- Smart card contains the International Mobile Subscriber Identity (IMSI)
- Allows user to send and receive calls and receive other subscribed services
- Encoded network identification details - Key Ki,Kc and A3,A5 and A8 algorithms
- Protected by a password or PIN
- Can be moved from phone to phone – contains key information to activate the phone

System Architecture Base Station Subsystem (BSS)

Base Station Subsystem is composed of two parts that communicate across the standardized Abis interface allowing operation between components made by different suppliers

1. Base Transceiver Station (BTS)
2. Base Station Controller (BSC)

System Architecture Base Station Subsystem (BSS)

Base Transceiver Station (BTS):

- Encodes, encrypts, multiplexes, modulates and feeds the RF signals to the antenna.
- Frequency hopping
- Communicates with Mobile station and BSC
- Consists of Transceivers (TRX) units

Base Station Controller (BSC)

- Manages Radio resources for BTS
- Assigns Frequency and time slots for all MS’s in its area
- Handles call set up
- Transcoding and rate adaptation functionality
- Handover for each MS
- Radio Power control
- It communicates with MSC and BTS

System Architecture Network Switching Subsystem (NSS)

Mobile Switching Center (MSC)

- Heart of the network
- Manages communication between GSM and other networks
- Call setup function and basic switching
- Call routing
- Billing information and collection
- Mobility management - Registration - Location Updating - Inter BSS and inter MSC call handoff
- MSC does gateway function while its customer roams to other network by using HLR/VLR.

4. OPERATION OF GSM:

Mainly this operation is based on GSM wireless technology and 8051 micro controller. This application works for seven power grids. This system works by sending message to the GSM modem and it will communicate with MCU which will check is the number whether it is authorized or not and if the number is from authorized user grid control system working starts.

Grid position is calculated every moment using EEPROM which is connected to micro controller. Information is stored in EEPROM so even the power is lost there will be no chances of losing data.

This system is attached to a key pad which will work as a keyboard for modifying and deleting mobile numbers. Information is displayed on 16x2 LCD screen. Load controller and Triac drivers are used in this project.
Security in GSM

- On air interface, GSM uses encryption and TMSI instead of IMSI.
- SIM is provided 4-8 digit PIN to validate the ownership of SIM
- 3 algorithms are specified:
  - A3 algorithm for authentication
  - A5 algorithm for encryption
  - A8 algorithm for key generation

Characteristics of GSM Standard

- Fully digital system using 900/1800 MHz frequency band.
- TDMA over radio carriers (200 KHz carrier spacing).
- 8 full rate or 16 half rate TDMA channels per carrier.
- User/terminal authentication for fraud control.
- Encryption of speech and data transmission over the radio path.
- Full international roaming capability.
- Low speed data services (upto 9.6 Kb/s).
- Compatibility with ISDN.
- Support of Short Message Service (SMS).

RAM and ROM are inbuilt in the microprocessor.

Advantages of GSM over Analog system:

- Capacity increases
- Reduced RF transmission power and longer battery life.
- International roaming capability.
- Better security against fraud (through terminal validation and user authentication).
- Encryption capability for information security and privacy.
- Compatibility with ISDN, leading to wider range of services

GSM Applications

- Mobile telephony
- GSM-R
- Telemetry System
  - Fleet management
  - Automatic meter reading
  - Toll Collection
  - Remote control and fault reporting of DG sets
- Value Added Services

Transformer:

Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly. Thus the a.c input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Thus, a step down transformer is employed to decrease the voltage to a required level.

Rectifier:

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification.

Filter:

Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore a regulator is applied at the output stage.

Voltage regulator: As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. In this project, power supply of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels.
MICROCONTROLLERS:

Microprocessors and microcontrollers are widely used in embedded systems products. Microcontroller is a programmable device. A microcontroller has a CPU in addition to a fixed amount of RAM, ROM, I/O ports and a timer embedded all on a single chip. The fixed amount of on-chip ROM, RAM and number of I/O ports in microcontrollers makes them ideal for many applications in which cost and space are critical.

The Intel 8051 is a Harvard architecture, single chip microcontroller (µC) which was developed by Intel in 1980 for use in embedded systems. It was popular in the 1980s and early 1990s, but today it has largely been superseded by a vast range of enhanced devices with 8051-compatible processor cores that are manufactured by more than 20 independent manufacturers including Atmel, Infineon Technologies and Maxim Integrated Products. 8051 is an 8-bit processor, meaning that the CPU can work on only 8 bits of data at a time. Data larger than 8 bits has to be broken into 8-bit pieces to be processed by the CPU. 8051 is available in different memory types such as UV-EPROM, Flash and NV-RAM. The microcontroller used in this project is AT89C51. Atmel Corporation introduced this 89C51 microcontroller. This microcontroller belongs to 8051 family. This microcontroller had 128 bytes of RAM, 4K bytes of on-chip ROM, two timers, one serial port and four ports (each 8-bits wide) all on a single chip. AT89C51 is Flash type 8051. The present project is implemented on Keil Uvision. In order to program the device, Proload tool has been used to burn the program onto the microcontroller. The features, pin description of the microcontroller and the software tools used are discussed in the following sections.

RS232 CABLE:

To allow compatibility among data communication equipment, an interfacing standard called RS232 is used. Since the standard was set long before the advent of the TTL logic family, its input and output voltage levels are not TTL compatible. For this reason, to connect any RS232 to a microcontroller system, voltage converters such as MAX232 are used to convert the TTL logic levels to the RS232 voltage levels and vice versa.

MAX 232:

Max232 IC is a specialized circuit which makes standard voltages as required by RS232 standards. This IC provides best noise rejection and very reliable against discharges and short circuits. MAX232 IC chips are commonly referred to as line drivers. To ensure data transfer between PC and microcontroller, the baud rate and voltage levels of Microcontroller and PC should be the same. The voltage levels of microcontroller are logic1 and logic 0 i.e., logic 1 is +5V and logic 0 is 0V. But for PC, RS232 voltage levels are considered and they are: logic 1 is taken as -3V to -25V and logic 0 as +3V to +25V. So, in order to equal these voltage levels, MAX232 IC is used. Thus this IC converts RS232 voltage levels to microcontroller voltage levels and vice versa.

LIQUID CRYSTAL DISPLAY:

LCD stands for Liquid Crystal Display. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons:

1. The declining prices of LCDs.
2. The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.
3. Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU to keep displaying the data.
4. Ease of programming for characters and graphics.

These components are “specialized” for being used with the microcontrollers, which means that they cannot be activated by standard IC circuits. They are used for writing different messages on a miniature LCD.

A model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 microcontroller (Hitachi) and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own. Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics.

LCD screen:

LCD screen consists of two lines with 16 characters each. Each character consists of 5x7 dot matrix. Contrast on display depends on the power supply voltage and whether messages are displayed in one or two lines. For that reason, variable voltage 0-Vdd is applied on pin marked as Vee. Trimmer potentiometer is usually used for that purpose. Some versions of displays have built in backlight (blue or green diodes). When used during operating, a resistor for current limitation should be used (like with any LED diode).

5. APPLICATION AREAS:

Computer networking: Computer networking products such as bridges, routers, Integrated Services Digital Networks (ISDN), Asynchronous Transfer Mode (ATM), X.25 and frame relay switches are
embedded systems which implement the necessary data communication protocols. For example, a router interconnects two networks. The two networks may be running different protocol stacks. The router’s function is to obtain the data packets from incoming pores, analyze the packets and send them towards the destination after doing necessary protocol conversion. Most networking equipments, other than the end systems (desktop computers) we use to access the networks, are embedded systems.

Telecommunications: In the field of telecommunications, the embedded systems can be categorized as subscriber terminals and network equipment. The subscriber terminals such as key telephones, ISDN phones, terminal adapters, web cameras are embedded systems. The network equipment includes multiplexers, multiple access systems, Packet Assemblers Dissemblers (PADs), satellite modems etc. IP phone, IP gateway, IP gatekeeper etc. are the latest embedded systems that provide very low-cost voice communication over the Internet.

Wireless technologies: Advances in mobile communications are paving way for many interesting applications using embedded systems. The mobile phone is one of the marvels of the last decade of the 20’th century. It is a very powerful embedded system that provides voice communication while we are on the move. The Personal Digital Assistants and the palmtops can now be used to access multimedia services over the Internet. Mobile communication infrastructure such as base station controllers, mobile switching centers are also powerful embedded systems.

Insemination: Testing and measurement are the fundamental requirements in all scientific and engineering activities. The measuring equipment we use in laboratories to measure parameters such as weight, temperature, pressure, humidity, voltage, current etc. are all embedded systems. Test equipment such as oscilloscope, spectrum analyzer, logic analyzer, protocol analyzer, radio communication test set etc. are embedded systems built around powerful processors. Thank to miniaturization, the test and measuring equipment are now becoming portable facilitating easy testing and measurement in the field by field-personnel.

Security: Security of persons and information has always been a major issue. We need to protect our homes and offices; and also the information we transmit and store. Developing embedded systems for security applications is one of the most lucrative businesses nowadays. Security devices at homes, offices, airports etc. for authentication and verification are embedded systems. Encryption devices are nearly 99 per cent of the processors that are manufactured end up in embedded systems. Embedded systems find applications in every industrial segment- consumer electronics, transportation, avionics, biomedical engineering, manufacturing, process control and industrial

CONCLUSION:

In this project work, we have studied and implemented a complete working model using a Microcontroller. The programming and interfacing of microcontroller has been mastered during the implementation. This work includes the study of GSM modem using sensors. GSM network operators have roaming facilities, user can often continue to use there mobile phones when they travel to other countries etc..

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