GSM DATA LOGGING SYSTEM

Chintankumar Amrutlal Patel
B.S., Sankalchand Patel College of Engineering, Visnagar, 2006

PROJECT

Submitted in partial satisfaction of the requirements for the degree of

MASTER OF SCIENCE

in

ELECTRICAL AND ELECTRONIC ENGINEERING

at

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

FALL
2009
GSM DATA LOGGING SYSTEM

A Project

by

Chintankumar Amrutlal Patel

Approved by:

____________________________, Committee Chair
Dr. Jing Pang

____________________________
Date

____________________________, Second Reader
Dr. Preetham Kumar

____________________________
Date
Student: Chintankumar Amrutlal Patel

I certify that this student has met the requirements for format contained in the University format manual, and that this project is suitable for shelving in the Library and credit is to be awarded for the Project.

__________________________________________, Graduate Coordinator

Dr. Preetham Kumar 

Department of Electrical and Electronic Engineering
Abstract

of

GSM DATA LOGGING SYSTEM

by

Chintankumar Amrutlal Patel

GSM automation and control has always been interesting and challenging area for me. After searching for adequate amount of time, I found a demanding project in the GSM automation and data logger designing. The aim of this project is to design a data logger system for a real time application such as smart vehicle tracking system and a weather data logger. Today, data loggers systems are popular but they are costly, and are limited in the sense of customer configurability. The design of such a data logger system, which can configure as per customer need is a challenging design and development task. This project will provide usage of historical database and client server architecture and give more flexibility to the users. It can serve as a real time data logger system, which can configure as per customer requirement and give more flexibility in terms of data display and storage of historical data.

______________________, Committee Chair
Dr. Jing Pang

_____________________
Date
ACKNOWLEDGMENT

Firstly, I thank to God for giving me patience, determination and the ability to complete this study successfully.

I would like to express my deepest gratitude to Dr. Jing Pang who allowed me to work on this project with her. Her valuable advice and guidance supported me to finish this project. I also want to give a special thanks to Dr. Preetham Kumar for reviewing my project report.

In addition, my sincere thanks are due to faculty members of Electrical Engineering department for helping me in finishing my graduation at California State University, Sacramento.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Acknowledgment</th>
<th>v</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Tables</td>
<td>viii</td>
</tr>
<tr>
<td>List of Figures</td>
<td>ix</td>
</tr>
</tbody>
</table>

## Chapter

1. INTRODUCTION ................................................................. 1
   1.1. GSM Data Logging Systems .................................................. 1
   1.2. Overview of Design ........................................................... 2
   1.3. Testing of Design ............................................................. 3

2. GSM MODULE FUNCTIONALITY AND FEATURES ................................... 4
   2.1. GSM Module Building Blocks .................................................. 4
   2.2. SIMODO GDT11 GSM Module ..................................................... 6
      2.2.1. Installation of SIMODO GDT11 GSM Module .......................... 6
      2.2.2. Testing the Installation ................................................... 8
   2.3. SIMODO GDT11 SMS FUNCTIONALITY .......................................... 11
      2.3.1. Understanding of SMS Functionality .................................. 11
      2.3.2. Usage of SMS Functionality .............................................. 12

3. BUILDING BLOCKS OF SIMODO GDT11 DATA LOGGING SYSTEM ............ 16
   3.1. Block Level Explanation of Data Logging System ....................... 16
   3.2. Data Types and SMS Format for Weather Data Tracking System .......... 17
   3.3. Data Types and SMS Format for Vehicle Tracking System .............. 18
3.4. Design Modules .................................................................................................. 18

4. INTERFACING OF GSM MODULE WITH DATA LOGGING SYSTEM .......... 21

4.1. Interfacing Module Using HTML Page for TEXT Mode.............................. 21

4.1.1. Installation and Configuration of HTML Module ..................................... 24

4.1.2. Simulation and Testing of Interfacing Module ......................................... 24

4.2. Interfacing Module Using C# .......................................................................... 27

4.2.1. Installation and Configuration of Interfacing Module in C# ................. 28

5. WEB BASED USER INTERFACE MODULE ......................................................... 29

5.1. Weather Data Logger Module ......................................................................... 29

5.1.1. Web Display Module ................................................................................ 29

5.1.2. Database Module ..................................................................................... 36

5.2. Vehicle Tracking Module ................................................................................ 39

5.2.1. Web Display Module ................................................................................ 39

5.2.2. Database Module ..................................................................................... 43

6. CONCLUSION AND FUTURE WORK ............................................................ 46

6.1. Conclusion ....................................................................................................... 46

6.2. Future Work .................................................................................................... 47

6.2.1. Expansion of GSM Data Logger to GIS System ................................... 47

References .............................................................................................................. 52
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1 SMS Format for Weather Data Tracking System</td>
<td>17</td>
</tr>
<tr>
<td>Table 2 SMS Format for Vehicle Tracking System</td>
<td>18</td>
</tr>
<tr>
<td>Table 3 GPX File Format</td>
<td>49</td>
</tr>
</tbody>
</table>
### LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Block Level Description of GSM</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>GSM Engine User Interface</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>SIMODO GDT11 Mechanical Drawing</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Open HyperTerminal Window</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Open Connections Window</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Connection Name</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>Select COM Port</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>Select COM Port Properties</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>SMS Read Functionality</td>
<td>13</td>
</tr>
<tr>
<td>10</td>
<td>SMS Delete Functionality</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>SMS Send Functionality</td>
<td>15</td>
</tr>
<tr>
<td>12</td>
<td>Functional Block Representation of Weather Data Logging System</td>
<td>16</td>
</tr>
<tr>
<td>13</td>
<td>Design Block Representation of Data Logging System</td>
<td>20</td>
</tr>
<tr>
<td>14</td>
<td>Flow Chart of Interface Module</td>
<td>23</td>
</tr>
<tr>
<td>15</td>
<td>Open a Port in HTML Module</td>
<td>25</td>
</tr>
<tr>
<td>16</td>
<td>Read a Port in HTML Module</td>
<td>26</td>
</tr>
<tr>
<td>17</td>
<td>Delete a SMS in HTML Module</td>
<td>27</td>
</tr>
<tr>
<td>18</td>
<td>Data Flow from GSM C# Module to Database Module</td>
<td>28</td>
</tr>
<tr>
<td>19</td>
<td>Site Owners and Site Entry Form</td>
<td>30</td>
</tr>
<tr>
<td>20</td>
<td>Master Page of GSM Weather Data Tracking System</td>
<td>31</td>
</tr>
</tbody>
</table>
Chapter 1

INTRODUCTION

This chapter provides an introduction about the GSM data logger system, the significance of the design and different potential of the design, application in real time, an overview of design components which are used in design, and the testing plans used during the designing process.

1.1. GSM Data Logging Systems

In the early 1980s, analog cellular telephone systems were at its rapid growth in Europe and United Kingdom. With more advanced development in this field, dual band, tri band and quad band GSM phones were invented. Currently dual band and tri band phones are available at low cost [1].

The use of GSM systems is now not only limited to the mobile phone customers but also expanded to the industries for data logging and secure communication gateways. Several industrial fixed terminal GSMs are in the market today and used in various applications.

Examples of diverse applications of GSM fixed terminal include [1]:

- Robotics and automation
- Data logging systems and tracking systems
- Industrial PLCs
- GSM/GPRS cell – cellular modules
- Cell phones, laptops and computers
- Satellites and aircrafts and image sensing systems
- Surveillance and Security systems

The basic function of a GSM module is to use appropriate band of frequency for communication using RF waves. Each GSM has its own subscriber identity module (SIM). The SIM is useful for identifying the subscriber on GSM network. Each GSM has built in functionality of voice call, short messaging service and file transfer service by means of digital communication [1]. In depth information about GSM services with features and its functionalities is covered in chapter 2.

1.2. Overview of Design

The objective of this project is to configure the GSM as a Data logging system. The sample applications are remote weather data tracking and GPS data tracking. There are two GSM systems placed for transmission as well as reception. GSM communication takes place using short messaging services. The design is also capable to collect and represent data to and from several networks as it is designed as client server architecture.

This project focused on interfacing the Matrix’s GSM module “SIMODO GD T11” with the data logging system and represented data using a web application. This GSM is a quad band GSM with file transfer, voice call and short messaging service facility. The data logging system design has two main modules.

1. Weather data tracking system.
It tracks and stores weather data from four different sites, it also displays results according to client’s requirement.

2. Vehicle tracking system

It stores vehicle location in database. It tracks and display path of a particular vehicle.

1.3. Testing of Design

Testing is critical for the design to be successful. In the hardware part as I needed to check communication and network protocol for GSM module, I used a hyper terminal to check connectivity, presence of module in the network, and transmission as well as reception of the commands and data through GSM to data loggers. After setting up the GSM module and its hardware, I started to work on HTML and C sharp code design. In this part I have used test programs to verify each module.
Chapter 2

GSM MODULE FUNCTIONALITY AND FEATURES

This chapter describes basic features and functionality of GSM module. This also covers basic design aspects of the GSM. It clearly explains how to select the particular GSM for specific requirements. It also gives details on the GDT11 GSM module with a block level explanation [2].

2.1 GSM Module Building Blocks

Design structure of GSM modem is as given in figure 1. The major functional blocks are as below [2]

1. Base band Block of GSM:

Base band module of GSM is a core processing module. It has a controller module which works on at 26 MHz and a Digital Signal Processor which operates at 78MHz. Operating frequencies are subjected to change depends on selection of frequency mode. Baseband module has inbuilt memory for storing internal control commands. This module runs on a battery power. There is a dedicated power supply ASIC for charging that battery.

2. RF section:

RF selection module includes a transceiver for RF communication and a power amplifier for a batter transmission and reception. This module is directly connected with the base band controller module and it gets send, receives and
control data from a controller module. Power amplifier is connected with an antenna.

Figure 1 Block level description of GSM [2]

3. Application Interface:

SIMODO GDT11 has inbuilt ZIF connector which is able to connect cellular platform. The figure describes user interface with the GSM engine through ZIF connector [2].
2.2 SIMODO GDT11 GSM Module

SIMODO GDT11 is a ready to use GSM module. It is equipped with 9 pin RS232 connector. The advanced version of it has RJ45 connectors also. After it is connected with an embedded system or a PC it serves the features described below [3].

- Browsing the Web and data transfer over the Network
- Short message services
- Image and data services
- Transmission and reception Fax

In this GSM data logger system, I have used short message servicing as a data logging communication medium.

2.2.1 Installation of SIMODO GDT11 GSM Module

In order to understand the installation of a GSM module, it is important to understand mechanical drawing of the GSM module. The figure below shows the mechanical drawing of GSM module. It is a compact module with length of
approximately 4 Inch and width of 3.15 Inch. The installation package includes an antenna of 3 Inch.

Figure 3 SIMODO GDT11 Mechanical Drawing [3]

Below are the installation steps of the GSM module

- Before power up, fix the GSM module to its physical location
- Check voltage and power settings for manual and make sure it is satisfied by the current installation. This module needs 9V DC 1Amp adapter for power supply.
- The SIM card holder is at bottom of the GSM module. Insert SIM card into the holder.
- Turn on the power supply.
- Connect the GSM com port to the com port of the data logger system.
• Check the network LED and system LED, as per manual the network LED should blinking and the power LED should be Green in color[3].

2.2.2 Testing the Installation

For testing the installation open the HyperTerminal and provide appropriate settings of baud rate, start/stop/parity bit, and the flow control will none. Type AT on the HyperTerminal and if you find response OK, then the GSM is successfully installed and configured for data logging. The detailed testing description is as below [3].

1. Click on Start then Programs. Click Accessories and Communication and then select HyperTerminal[3]

![Figure 4 Open HyperTerminal Window](image)

3. Give appropriate name for the new connection for Ex. SIMODO GDT11.

4. In this “Connect to” Window, fill up the last text box “Connect using” with relevant COM Port. All other options are disabled automatically [3].
5. In the COM port Properties, edit the following entries. Bits per seconds=9600, Data bits = 8, Parity = None, Stop bits = One, Flow control = none [3].
Baud Rate: Baud rate means number of symbols transferred per second or per time unit. Here a symbol represents a bit.

Data bits: Data bits mean number of data bits transferred or received per data frame.

Parity Bit: Parity Bit is generally calculated from the data bits. It is used for error detection and correction.

Stop bit: stop bit is inserted after each frame to detect end of frame.

Flow control: It is a technique of managing communication between two nodes.

2.3. SIMODO GDT11 SMS Functionality

2.3.1 Understanding of SMS Functionality

The GDT11 supports short messaging servicing feature. It allows sending and receiving of messages through the computer’s Hyper Terminal. The sending can be edited via PC terminal and a user can be notified using a PC terminal. Each SIM card has its own locations to store the received messages. Each location is referred to an index. As per memory allocation of the SIM card it has 8 or 10 indexes. Before receiving the message at the same location first we have to delete the previously stored message in that particular indexed memory location. From HyperTerminal we can send, edit and receive the SMS [3].
2.3.2 Usage of SMS Functionality

First, we need to connect the GSM module with computer using appropriate settings of baud rate, parity bit, start and stop bit and flow control. After that open HyperTerminal and type AT, whatever typed in HyperTerminal is not visible to the operator. To visualize the commands we have typed we need to go to settings for ASCII setup and enable “Echo typed Character Locally”.

After typing AT, the GSM will respond with OK, as shown in the figure below.

Read SMS:

For reading a particular SMS of any index, the command is

AT+CMGR=index

Where index represents the location of stored SMS in the SIM card memory. Generally it stands in the range of 1 to 10[4].

After executing above command in HyperTerminal the SMS will be displayed in the terminal window. This time the displayed SMS contains the data, time and the sender SIM number [3].
Figure 9 SMS Read Functionality [3]

Delete a SMS:

Deleting a particular SMS is necessary when the data logging system wants to read the new SMS from the same location [3].

For deleting SMS, the command is

AT+CMGD="Index"

Index is the location of the stored SMS in the SIM card memory. Its range is between 1 and 10.

After executing above command in HyperTerminal, the SMS will be deleted from the SIM memory. This time the result displays OK.
Send a SMS:

Sending a particular SMS is necessary when the data logging system wants to make a two way communication with the sender.

For sending SMS, the command is

AT+CMGS="Telephone Number"

Here the telephone number is the receptionist’s SIM number [4].
After executing the above command in HyperTerminal, the SMS will be sent to the receptionist and this time the result displays OK.
Chapter 3

BUILDING BLOCKS OF SIMODO GDT11 DATA LOGGING SYSTEM

3.1 Block Level Explanation of Data Logging System.

![Diagram of weather data logging system](image)

Figure 12 Functional Block Representation of Weather Data Logging System [5]

The above figure shows block level representation of data logging system using SIMODO GDT11 GSM module.

For weather data logging system, there are totally four data channels which are responsible for submitting data to the reception system. Site A, B, C and D are four remote sites. The reception system GSM is connected with the web portal server and
database server. The web server and database server either on different or be on the same system. The web portal server can be accessed by organization intranet or internet depending upon the network’s range.

For vehicle tracking system, there are a number of transmission channels or vehicles; we can set them as per user requirement. The vehicles send data in form of longitude and latitude and the web server module will display it on a Google map API and also store the locations in the database. So, the location of a particular vehicle is displayed on the web based user interface.

3.2 Data Types and SMS Format for Weather Data Tracking System

For any data logging system, it is necessary to define a data format that can periodically sent to reception system and it can be logged in database.

The unique SMS format for SIMODO GDT11 is as below.

AUV2LWS7H65P2981D47V9.0T58D09/09/0912:00

Table 1 explains the data gathered from the received SMS.

<table>
<thead>
<tr>
<th>Site No</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV index</td>
<td>2 Low(uv2l)</td>
</tr>
<tr>
<td>Humidity</td>
<td>65%(h65)</td>
</tr>
<tr>
<td>Pressure</td>
<td>29.81 in.(p2981)</td>
</tr>
<tr>
<td>Dew point</td>
<td>47°F(d47)</td>
</tr>
<tr>
<td>Visibility</td>
<td>9.0 miles(v9.0)</td>
</tr>
<tr>
<td>Temperature</td>
<td>58°F</td>
</tr>
<tr>
<td>Date</td>
<td>9/9/2009</td>
</tr>
<tr>
<td>Time</td>
<td>12:00</td>
</tr>
</tbody>
</table>

Table 1 SMS Format for Weather Data Tracking System
The time reference is taken per 24 hour basis. Assume there are total 4 sites and the data reception is depends on how many times in the day the client wants to receive data from the particular site. The data can be logged per hourly basis and can be per daily basis it depends upon how much data form a particular sites needs to be stored in database.

3.3 Data Types and SMS Format for Vehicle Tracking System

The unique SMS format for vehicle tracking system is as below.

AL3557N8957WD09/09/0912:00

Below table explains the data gathered from the received SMS.

<table>
<thead>
<tr>
<th>Vehicle No</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitude</td>
<td>35 57 N</td>
</tr>
<tr>
<td>Latitude</td>
<td>89 57 W</td>
</tr>
<tr>
<td>Date</td>
<td>9/9/2009</td>
</tr>
<tr>
<td>Time</td>
<td>12:00</td>
</tr>
</tbody>
</table>

Table 2 SMS Format for Vehicle Tracking System

3.4 Design Modules

The design modules are divided into two parts.

1. Interfacing GSM module with PC terminal.
   
   This module is common for both data logging system

2. Data logging and representation of received data on the Web server

   This module gives real time representation of the logged data on a web based user interface.
As shown in figure 13 below, there are total four design modules talks with each other periodically to log the real time data in to the database and display it on web server.

“Querydevice” is a module that is responsible for periodic SMS read and dumps it in a text file. A detailed operation is discussed in chapter 4.

The SMS from text file is read by “readfile” module and dumps it in a database. The database module connected with web server. The web server displays data from database on the display unit. A detailed operation of these three modules is discussed in chapter 5.

Querydevice and readfile modules are designed using C#. Querydevice module is also designed in HTML. Database module and web display modules are designed in C#.
Figure 13 Design Block Representation of Data Logging System [5]
Chapter 4

INTERFACING OF GSM MODULE WITH DATA LOGGING SYSTEM

The first module of the project is GSM interfacing with data logging system. This module is designed using HTML and C#. This module is common for both tracking system.

The advantage of designing the interfacing module in HTML is that this module can be used in client server application. As this module is designed in a HTML, it can easily embed with any web application.

The advantage of designing the interfacing module in c# is that the c# module is specially designed for PDU and text mode in GSM module. PDU mode is an information exchange protocol where information transferred in 7 bit or 8 bit binary format. The HTML module cannot work with scheduling. However, the data logging system needs scheduling such that it can read and delete SMS periodically [6].

4.1. Interfacing module using HTML page for TEXT mode.

This module includes installation of component library and then uses it in HTML coding. This module is specially designed to handle TEXT mode. This HTML page has capability to send and receive any amount of data serially [6].

This module is designed such that it can poll for data every 20 seconds, so the data logging system can receive the real time data.

The HTML interface module features following:
1. COM port functionality

2. Telephone support for RJ45 compatible GSM

3. Hayes AT commands support

4. Virtual COM port support

5. Software and Hardware flow control support

6. Editable baud/parity/start/stop bits

7. Buffered data transfer between two devices

8. Text and PDU mode support

The figure below describes the data flow and control flow of parameters throughout the HTML module. This module will read the SMS data and delete the SMS data. So the new data can occupy the indexed locations which are empty [6].
Figure 14 Flow Chart of Interface Module
4.1.1 Installation and Configuration of HTML Module

Installation and configuration of HTML module are divided into two steps.

1. Create COM port in HTML page

This module includes usage of Java script in HTML module. I have created object which is responsible for sending and receiving AT commands. I have used here DLL components from ActiveXperts software Inc [6].

2. Send Hayes AT commands to the serial port

In this module, configuration of baud rate, flow control, start/stop/parity bit are described. This module is responsible for flow control and sends periodic read and delete controls to the GSM [6].

4.1.2 Simulation and Testing of Interfacing Module

Simulation of GSM interfacing module required IE version 5.0 or higher with Active X enabled locally. The screenshot below shows the procedure of how to receive SMS data from the connected GSM device.

1. Opening the COM port
For opening the port, the port selection box is displayed. There are total 8 ports from com1 to com8. Each com port represents a data channel to receive and transmit data. If the port cannot open the error is displayed that “Result: 1001E generic port error: port cannot open”. Port may not open if it is receiving data from any other channel or if the com port is not properly installed on network [6].

2. Read SMS Data from SIMODO GDT11 GSM

There is a FOR loop written in HTML code, which is responsible for reading totally five SMSs in a single operation and log the results in log file. As shown in figure below total five SMSs are read. The GSM is connected to COM3 [6].
3. Delete SMS from the SIM indexes

There is a FOR loop written in HTML code same as the read operation, which is responsible for deleting totally five SMSs in a single operation along with reading those SMSs and log the results in log file. As shown in figure 16 total five SMSs are deleted. When the data is deleted from GSM, it will display OK after each delete [6].
4.2 Interfacing Module Using C#

Generally data logging systems are using text mode for data logging. But for old technology GSMs which are run on PDU mode data logging system may have compatibility issues. So, in this data logging system, there is a window application designed in C# followed by null modem concept to handle PDU and text mode data transfer. Null modem is a connection protocol for connecting to devices using RS232 serial port. This concept is actually a cabling concept and also referred as crossover cable. Main advantage is that this module can schedule periodic reading and writing of SMS.
4.2.1 Installation and Configuration of Interfacing Module in C#

The data flow from this module to final database module is as shown in the figure 18. The text messages are read from GSM by the C# module and dumped into a text file. A database module of the data logger system will automatically read this text file and update the database. This is an automated task and this task can be scheduled by user [6].

Figure 18 Data Flow from GSM C# Module to Database Module
Chapter 5
WEB BASED USER INTERFACE MODULE

5.1 Weather Data Logger Module

Weather data logger module mainly consists of two different modules

1. Web Display Module

Web display module is a user interface that enables different users to view and examine the logged weather data.

2. Database Module

Database module is partially visible to users and it needs administrative rights to view. It is responsible for logging the data from GSM into SQL database and generating web displays.

5.1.1 Web Display Module

This module provides a view of the logged data in forms of graphs and tables. This module has different building blocks described below.

1. Site Entry Form:

The form shown in figure 19 is site entry and site owner entry form. It will log the data into the database. Here the database is built for four sites A, B, C and D. Each site has its own owner name logged in the database.
2. Master Page of weather data tracking system

Figure 20 shows the master page of the GSM weather data logging system. This page has a tab of Admin, where the administrator can do site entry and the owner entry. It has a tab of View where all data will be displayed and the Report tab where all site reports can be viewed as per data and time selection.
3. Admin Page of GSM weather tracking system

Admin page has entry space for site and its owner name. The site name and site owner entry can be done here and they will be directly saved to the database. As shown in the below figure, this GSM system has totally 4 sites A, B, C and D. All sites and their owner name are displayed automatically on this page once it is saved in the database. More sites can be extended in this module.
4. View the current and historical data

The master page has a tab for viewing the current and historical data of all sites. After clicking on the view tab, an entry form is displayed on which the user needs to select the site. After selecting a particular site the page displays the current reading of all weather parameters and historical reading which are logged in the database through the GSM interface module.
For example as shown in the figure 23 the user has selected site A and the owner of that site is Mark. The current hourly readings are displayed in the main form. The historical data will automatically popup as the site selected and all tabs are shown.
5. Time and Date selection view

As the user click on the report tab, the site and date selection view is going to be displayed. The user can view reports and charts as he or she selects the date. The connection is made between database and display module such that, it can display the real time data which are directly logged into database via GSM interface module.
6. Graphical representation of the data

Figure 25 displays the graphical representation of the data stored in the database.

Users are allowed to choose any date from the calendar.
5.1.2 Database Module

Database module of weather data tracking system mainly consists of two tables. First table is responsible for site entry and its parameter logging operation and the second table is responsible for detailed logging operations from all sites.
As shown in figure 26, the user can add a new site id, site name and the owner of that particular site. So, this table allows a user to add a new site at any time for a weather tracking operation.

Figure 26 Database Table for Site Entry

The second table is displayed in the figure below. This table is responsible for logging site details from a GSM system. A user can add as many parameters as he wants to monitor. This database table has columns of site id, site owner name, site parameters
like humidity, temperature, visibility, wind, uv index, dew point and many more depending on the user’s requirement.

Figure 27 Database Table for Site Parameters Entry
5.2  Vehicle Tracking Module

Same as Weather data logger module, the Vehicle tracking system also consists of two different modules

1. Web Display Module

Web display module is a user interface that enables different users to view and examine the location of the vehicle depending on the time window selected.

2. Database Module

Database module is partially visible to users and it needs administrative rights to view. It is responsible for log the data from GSM into SQL database and displays it on web interface.

5.2.1 Web Display Module

This module provides a view of the logged data in forms of location of the vehicle in Google map. Building blocks of this module are explained below.

1. Master page of vehicle tracking system:

Figure 28 shows the master page of the vehicle tracking system. This page has a tab of Admin, where the administrator can do vehicle entry and its name and ID entry. It has a tab of View where all locations will be displayed in the Google Map.
2. Admin Page of GSM weather tracking system

Admin page has entry space for vehicle name, vehicle ID, vehicle number and its owner name. The vehicle entries can be done here and it will be directly saved to the database. As shown in figure 29, this vehicle tracking system has right now four vehicles to track. All vehicles and its parameters are displayed automatically on this page once it is saved in the database.
3. View the current and previous location of a particular vehicle

The master page has a tab of Map for viewing the current and historical location of all vehicles. After clicking on the map tab, an entry form is displayed on which the user needs to select the vehicle name. After selecting a particular vehicle, the page displays the time window in form of calendar. A user can select a time window and see the current and previous location of the vehicle.
For example as shown in the figure 31, the user has selected vehicle name `truck_ford`. The current and previous locations are shown in form of longitude and latitude on the page. All locations are displayed in the embedded Google map as shown in the figure 31.
5.2.2 Database Module

Database module of vehicle data tracking system mainly consists of two tables. First table is responsible for vehicle entry and its parameters logging operation and the second table is responsible for all vehicle location details and its logging operations.
As shown in the figure 32, the user can add a new vehicle id, its name, its number and the owner of that particular vehicle. So, this table allows a user to add a new vehicle at any time for a vehicle tracking operation.

Second table is displayed in the figure 33. This table is responsible for logging vehicle’s location details from a GSM system in the form of longitude and latitude. This database table has columns of vehicle id and vehicle location in form of longitude and
latitude on a particular time. For automatic data logging in this table task is scheduled in task scheduler who will automatically log the data from a text file. This text file is going to update periodically by GSM user interface module. A user can schedule this task of data logging as per his requirement. For example a data logging operation can be scheduled for every 10 seconds or every 20 seconds. So, the vehicle tracking system can track a vehicle with a latency of 10 seconds or 20 seconds.

Figure 33 Database Table for Vehicle Longitude and Latitude Entry
Chapter 6

CONCLUSION AND FUTURE WORK

This chapter will summarize the accomplishments and ongoing advancements of the GSM data logging system project. Future development and advancements in this design are also discussed.

6.1 Conclusion

The GSM interface implemented in this project easily manages all data channels from the reception systems. The reception system is capable of doing flow control on hardware as well as software level. During my background study of the GSM data loggers, I came to know that the data polling period is a critical component of the data loggers. This data logger system uses user defined polling period functionality. So, the data can be polled as much as the database can handle. The database and web server implementation of the design provided an excellent opportunity to learn web based programming. I learned how to make communication between web server and database server. I learned how to test the web based designs and how to show the historical data through graphs and charts on the web modules.

Finally, the data logger successfully designed and showed historical and current data on the user interface. I gained sufficient experience of serial port communication and web based application development and knows that I can go forward in the computer industry.
and make contribution in the field of GSM automation tool development and data loggers.

6.2 Future Work

In this project I have successfully designed the interface module with GSM and web display module for users. The limitation of this project is that the database has no archiving facility. Future modification in this design enables the archiving functionality. I would also like to design a GIS system. GIS system stands for geographical information system. The GIS system takes input from the database generated by the GSM data logger system and display more results than the Google API. Secondly this project needs user interference during data logging procedure. In the future this design can be enhanced to support multiple data channels at the same time. And designed in such a way that it automatically logs real time data and the automatical refresh can be set on Google Map API. The web display module design can also be expanded so it can show multiple visual results for more than two data logger systems.

6.2.1 Expansion of GSM Data Logger to GIS System

GIS system can be integrated with any tracking system for example GPS trackers, Vehicle Trackers and Natural resource tracking systems.

My main aim here is to explain how the GSM smart data logging system can be integrated with the GIS system. A vehicle tracking system database has longitude, latitude, time and description of that vehicle. This data logger is polling data from a GSM
system and the GSM system is getting data from a GPS system. By using GSM data logger’s database, it is possible to display and manipulate the data into a GIS system.

1. GIS data formats

A GIS data system can handle several types of data formats.

For Example:

1. GPS data format:

   GPS data format is known as GPX which means GPS exchange format. It is a XML data format. It is responsible for information exchange between GPS and GIS. This information can be in the form of latitude, longitude, way point, intersections and routes [8].

2. Text data format

   A GIS tracking system can fetch data from a text file also. This text file contains longitude and latitude information

3. KML files

   A KML file contains tags. These tags are responsible for displaying geographical data, same as the GPS data file. KML files can be viewed in Microsoft Excel. [9]

2. Display GPX format in a GIS Explorer:
Here for exporting .gpx file, I have used an ArcGIS explorer. ArcGIS is a free tool provided by the company named ESRI. The explanation below shows how to make and import a GPX file into a GIS system.

Format of a GPX file is shown below.

A GPX file can be created in a GPS utility. There are several GNU tools are available for creating a GPX file. The table below displays a format of GPX file[8].

<table>
<thead>
<tr>
<th>Creator</th>
<th>ns1:time</th>
<th>Lat</th>
<th>Lon</th>
<th>Sym</th>
<th>type</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIS Datalogger</td>
<td>2002-02-27T18:33Z</td>
<td>42.4388</td>
<td>71.1193</td>
<td>Crossing</td>
<td>Crossing</td>
<td>5066</td>
</tr>
<tr>
<td>GIS Datalogger</td>
<td>2002-02-27T18:33Z</td>
<td>42.4392</td>
<td>71.1197</td>
<td>Dot</td>
<td>Intersection</td>
<td>5067</td>
</tr>
<tr>
<td>GIS Datalogger</td>
<td>2002-02-27T18:33Z</td>
<td>42.4389</td>
<td>71.1161</td>
<td>Dot</td>
<td>Dot</td>
<td>5096</td>
</tr>
<tr>
<td>GIS Datalogger</td>
<td>2002-02-27T18:33Z</td>
<td>42.4439</td>
<td>-71.122</td>
<td>Dot</td>
<td>Dot</td>
<td>5142</td>
</tr>
<tr>
<td>GIS Datalogger</td>
<td>2002-02-27T18:33Z</td>
<td>42.4473</td>
<td>71.1214</td>
<td>Dot</td>
<td>Intersection</td>
<td>5156</td>
</tr>
<tr>
<td>GIS Datalogger</td>
<td>2002-02-27T18:33Z</td>
<td>42.4548</td>
<td>71.1251</td>
<td>Dot</td>
<td>Intersection</td>
<td>5224</td>
</tr>
</tbody>
</table>

Table 3 GPX File Format

A GPX file can have different parameters per location. These can be latitude, longitude, creator of that point, time and date; type of location, a URL, description of that location and image of location can be integrated with a particular point.

3. Importing a GPX file in to ARCGIS explorer [7]:

The figure below represents a graphical interface of ARCGIS explorer.
ARCGIS is a collection of GIS software packages. It provides a stand alone solution for viewing and managing geographical data files on the base map. A vehicle tracking system database can also imported same as a GPX file import. It has latitude, longitude, vehicle name and time to display on a GIS system [9].
As shown in above figure, the GPX file imported for more than 100 locations and different types like bridge, waypoints, water resource and gates. For Example as shown in the figure 35, the displayed point is bridge and the parameters associated with it are shown when the user clicks that particular location index 5236. A user can integrate a URL and also an EMAIL feature with a particular point.
REFERENCES


