Abstract: Errors, faults, and alarms occurring at satellite earth stations (SES) should be identified, avoided or corrected as fast as they occur so as these gateways can perform at high efficiency. To address this problem, error management system (EMS) has, in this work, been developed that make it easier for the SES attendant to detect and possibly correct, at right time, the occurrence of any faults at a given station and keep records of what has been going on in the system. The developed system has the following main modules; system and modem communication - used by this software to send and receive data from modem; known errors, attendant and administrator control - used for inserting, updating and deleting these static data into EMS database by the system administrator; errors and alarm status view for viewing the current and past status of errors and alarms together with the solution of known errors. In addition, the system has report viewing and printing options, where by attendant can view errors and alarms of specific date of occurring or the whole log of events. The developed system will be installed to the attendant computer and will be able to produce an alert message in case of errors that occur at the station. In this Computerized Fault Monitoring and Management Sub-system with Critical Solutions Archival Capabilities in a Satellite Earth Station, the step by step mechanism taken in the development of this system has been presented. The steps include system investigation, system analysis and design together with system implementation and testing. The main objective of this paper addresses the developed management system that will be monitoring the occurrence of every error, provide a set of critical solutions, and keep records for a reasonable period of time. The work has studied the errors and how they occur, detected and provide their critical solutions, automated error occurrence, automated set of solutions to those errors, automated recording and automated notification. Since the occurrence of error will be detected, followed up and corrected earlier, the problems of user to loose communication will be reduced. Also, short time alarms will be noticeable and recorded for counterchecking their solutions later.

1 General Introduction

1.1 Problem Overview

Designed for extra planetary telecommunication with spacecraft and reception of radio waves from an astronomical radio source is what we call a satellite earth station, ground station, earth terminal, or simply, earth station. It is a terrestrial terminal station which can be located either on the surface of the Earth or within earth's atmosphere. It communicates with manned space stations or unmanned space probes by transmitting and receiving radio waves in the super high frequency or extremely high frequency bands like microwaves.

When it successfully transmits radio waves to a spacecraft or vice versa, it establishes a telecommunications link. For that case errors occurring at satellite earth stations should be identified, avoided or corrected as fast as they occur so as the station can perform at high efficiency. To do so, the designed system, will make it easier for the SES personnel to possibly correct at right time, the occurrence of any faults at the station and keep records of what has been going on in the system. It will, in addition, facilitate better overall communication system that is indeed very much needed.

1.2 Descriptions of Error Occurrence

1.2.1 Sun Outages

Our commercial communications satellites of interest in this study are geostationary and, therefore, they have orbits that lie in the equatorial plane. During the spring and fall equinoxes, the Sun also passes through this plane. As seen from the ground, the Sun seems to pass behind the satellites once per day. During the time when both, the satellite and the Sun are in the ground station's field of view, the energy from the Sun can overpower the signal from the satellite. It is this loss or degradation of communications traffic from the satellite that is referred to as sun fade, sun transit or sun outage.
Fig. 1 describes the possibility of outage angle during the sun outage phenomenon.

The outage angle is defined as the separation angle, measured from the ground station antenna, between the satellite and the Sun at the time when sun outage or signal degradation begins or ends. A possible and traditional solution has been to get informed and wait for synchronization.

1.2.2. Tropospheric Scintillation
The other phenomenon that leads into error occurrence is the tropospheric scintillation which is a rapid fluctuation of signal amplitude and phase due to turbulent irregularities in temperature, humidity and pressure, which translate into small-scale variations in refractive index. The possible solution to this problem includes communicating with Intel Satellite to correct the carrier failure.

1.2.3. Jitter
Jitter is a distortion in a digital signal caused by a shift in timing pulses, which can cause data interpretation errors. This problem can be solved by using a specific Eb/No Ratio, 8, 9, and 10.

1.3. Problem Statement
Jitter, sun interference, and tropospheric scintillation, as briefly described in sub-sections 1.2.1 through 1.2.3, are among the hindrance or breakage of communications in the paradigm that the traffics rely on the channels through satellite earth stations. Currently, at the SESs, these errors are observed by the operator through small and thin interface of MODEM, as produced in Fig. 2. This has been a very tedious, cumbersome and prone to error work while determining the types of errors occurring and in the efforts to solve the problem, temporarily and keeping permanent records.

In addition, record keeping of the fault and errors occurring frequently at a few milliseconds durations is near impossible, since the MODEM does not have enough database storage capacity to keep these types of records and mechanisms to know how frequently the fault occurring. Consequently, the users get very disappointed since during occurrence of these errors take too long time to be corrected. This may cause the user data to be lost or poor communication to be experienced, which results into extended cost both to the user and to the company.

The proposal suggests that, to solve this problem, a management system is required, which is to be installed on every computer at SES, so that those errors can be detected and corrected earlier as they appear, and whereby the software will be capable of alerting the attendant in case of any error occurring within the system and display it with possible solution(s) on computer screen and keep record of every fault and errors that have occurred. This is a Computerized Fault Monitoring and Management Sub-system with Critical Solutions Archival Capabilities.
2. Related Works
The errors highlighted in 1.2 are, currently, manually observed by the operator through small and thin interface of MODEM as seen in Fig. 2. It is, in fact, a very tedious task. On the survey of other existing systems performing similar or equivalent work, NMS has been found to have some features in common to the intended proposal. The study on various errors on how they occur, how they can be detected and how they can be corrected has been done.

The system has considered the strength of the systems to perform the intended tasks. The development to computerize monitoring of the occurrence of faults and errors has been into consideration. The proposed system, thus, provides the systematic and professional means of carrying different aspects or error detection and reporting.

This work has used MySQL server database engine due to number of reasons. Microsoft MySQL Server is the best and simple to work with .NET language, supports triggers on table and views, supports stored procedure and views, supports SQL cursor, supports replication, and can output data in XML format.

In terms of software application architecture, the developed system has been designed using 3-tier architecture because of encapsulation and flexibility in features it provides.

2. The Proposed System

3.1 The Developed System
The system developed has three components - the user interface (on screen), the database (for storage), and the MODEM (for data sending to the system and receiving from the system). The components are depicted in Fig. 3 along with the logical flow of the information among the different entities of the components.

The system which has been developed is of several benefits. These include the capability of the system to manage the occurrence of errors and that there is almost no time that error will occur without being noticed by the system; the fact that there will be no unnecessary losses of records from the modem, since all the records will be kept very well with the archive in the system; the reality that in case of accidental losses, they will be quickly and easily identified for immediate action through notifications; errors will be reliably stored and follow up will be simplified, since there will be automatic notification on the occurrence; and in case of known errors, solution will be managed and full description will be enhanced.

3.2 Hardware and Software Requirements
The proposed SES-EMS system has the following minimal requirements in both software and hardware:

The essential software requirements include: (i) An operating system – Windows 98, 2000, XP. This is normally required to manage the standard computer operations; (ii) A relational database management software – MySQL which is required to enable data access and manipulation from the database; (iii) A wamp server 2.0 required to provide server for the database; (iv) MySQL Connector – Net -5.0.9 to facilitate connection between MySQL with VB.NET; and (v) MySQL Connector – odbc – 3.51.2 used in facilitating connection to the database in the MySQL server.
Table 1. Use case descriptions

<table>
<thead>
<tr>
<th>S/N</th>
<th>Use Case</th>
<th>Actor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Login</td>
<td>SES-Attendance</td>
<td>The SES-Attendance will be provided with login form where by he/she will be supposed to enter his/her username and password.</td>
</tr>
<tr>
<td>2</td>
<td>View new active error(s)</td>
<td>SES-Attendance</td>
<td>SES-Attendance will be able to view new active error(s) that noticed in the monitoring station by clicking the View New active link.</td>
</tr>
<tr>
<td>3</td>
<td>View current active error(s)</td>
<td>SES-Attendance</td>
<td>SES-Attendance will be able to view current active error(s) that noticed in the monitoring station by clicking the View Current active link.</td>
</tr>
<tr>
<td>4</td>
<td>View error status</td>
<td>SES-Attendance</td>
<td>SES-Attendance will be able to view error status through clicking the Active, latched and Clear alarm links.</td>
</tr>
<tr>
<td>5</td>
<td>View recorded errors</td>
<td>SES-Attendance</td>
<td>SES-Attendance will be able to view recorded errors by clicking the View recorded error link.</td>
</tr>
<tr>
<td>6</td>
<td>View solution(s) of current exist errors</td>
<td>SES-Attendance</td>
<td>SES-Attendance will be able to view solution link while in the corresponding registered error and view its solution.</td>
</tr>
<tr>
<td>7</td>
<td>Logout</td>
<td>SES-Attendance</td>
<td>By clicking the Logout button you will be closing the system.</td>
</tr>
<tr>
<td>8</td>
<td>Add new error(s)</td>
<td>Administrator</td>
<td>The system administrator will be able to add new error(s) to the database of the system.</td>
</tr>
<tr>
<td>9</td>
<td>Process errors solution</td>
<td>Administrator</td>
<td>Administrator will be able to feed the solution of the corresponding error to the database after being processed by both the staff member.</td>
</tr>
<tr>
<td>10</td>
<td>Update error(s)</td>
<td>Administrator</td>
<td>The system administrator also will be able to edit or delete error(s) from the system database.</td>
</tr>
<tr>
<td>11</td>
<td>Add /delete attendance</td>
<td>Administrator</td>
<td>Only the administrator will be able to add and delete the attendance to/from the access of the system.</td>
</tr>
<tr>
<td>12</td>
<td>Automate error occurrence</td>
<td>System</td>
<td>The system will be able to automatic being triggered by the modem and automatically pick the error occurred in the station and automatically notify the attendance on his/her personal computer.</td>
</tr>
<tr>
<td>13</td>
<td>Automate error(s) solution</td>
<td>System</td>
<td>The system will be able to pick the solution of the occurred error from its database and display to the attendance who want to view its solution(s).</td>
</tr>
<tr>
<td>14</td>
<td>Automate error status</td>
<td>System</td>
<td>Latched, active and cleared alarm from the stations will be automatically detected from the system through the modem.</td>
</tr>
<tr>
<td>15</td>
<td>Automate alarm generation</td>
<td>System</td>
<td>The system will be able to notify the user in case of any change concerned with errors by generating alarm which will be head by the attendance where he/she will be and the sound intensity will depend on the speaker of computer.</td>
</tr>
</tbody>
</table>

Based on the software requirements stipulated above, for the proposed EMS, the minimum hardware components required include: (a) the Intel Pentium III processor or compatible with 700 MHZ speed or higher; (b) at least 256 MB of RAM; (c) at least 5 GB of available hard disk space; (d) 800 x 600 screen resolution or higher; and (e) 9-pin serial port.

4. System Analysis, Implementation, and Evaluation

4.1. Analysis

The approach that has been used to analyze the EMS system is the modeling approach. This approach have more categories each of which used in the analyzing the structured software system which are classical mode approach and essential mode approach. Classical mode approach is faced by some disadvantages which include not providing effective support for understanding or modeling non functional systems requirements, often producing too much documentations and, hence, the essence of the system can be hidden in the mass of detail which is included and the model that is produced is very detailed and often users/attendants find them difficult to understand. Hence, essential mode will be used together with use case and state diagram deployed in the analysis of the proposed EMS.

The use case diagram shows how different actors interact with a system to accomplish the objectives for which the system is to be developed. In this case, the diagram is shown in Fig. 4 with the descriptions of the use Case given in Table 1. The details of each use case that appears

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in the system and the actors that are involved have been graphically illustrated.

![Use Case Diagram of the Proposed EMS](image1)

**Fig. 4. Use case diagram of the proposed EMS**

The environmental model is the first component of the essential model and, in respect to SES-EMS, will comprise: (i) the statement of purpose for the SES-EMS which is to computerize the entire aspect of satellite earth station error management process; (ii) the event list which is a narrative list of events that occur in the outside world of the SES-EMS and it has to respond to them and it includes the modem and the attendant; and (iii) the context diagram that represents the system through a single process view together with data flows, data stores, control flows, and terminators or entities and, for the SES-EMS system, it consists of the process: EMS for SES, the terminators - administrator and modem, and the data stores for currently exiting errors, new errors, registered attendant, recorded errors, active alarm, latched alarm, and cleared alarm. Fig. 5 illustrates the context diagram for the proposed SES-EMS.

![Context Diagram for the Proposed SES-EMS](image2)

**Fig. 5. Context Diagram for the Proposed SES-EMS**

The behavioral model is also the component of the essential model and it is aimed at describing the behavior of SES-EMS system. This model includes data flow diagrams (DFDs), entity relationship diagram (ERD), and data dictionary. The DFDs represent how data is processed by the SES-EMS system. The data is transformed at each step before moving on to the next step. The DFD for the SES-EMS system is presented using the ‘top-down’ approach. DFDs are drawn in different levels starting from level zero. For the SES-EMS system, level zero DFD is represented by the context diagram as described in the section above. Fig. 6 shows the representation of Level 1 DFD in the system while Fig. 7 shows the representation of Level 2 DFD for the process number 3.

![Representation of Level 1 DFD](image3)

**Fig. 6. Representation of Level 1 DFD**
Table 2. Data Dictionary for Entities of SES-EMS

<table>
<thead>
<tr>
<th>Entity</th>
<th>Entity’s role in the system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrator</td>
<td>This is a class which contains all the attributes that are necessary for the administrator to be identified and hence given all administrative rights</td>
</tr>
<tr>
<td>Attendance</td>
<td>This is a class that contains all the attributes necessary to identify the Attendance and hence give him all the of his rights in the system</td>
</tr>
<tr>
<td>Active new error(s)</td>
<td>This is a class that describes the detailed of all New error(s), Name which will be null before known, and date they occurred.</td>
</tr>
<tr>
<td>Recorded errors</td>
<td>This entity describes the details of all errors that are received from the modem where as the administrator is responsible to update them, and their descriptions together with their possible solutions</td>
</tr>
<tr>
<td>Active existing error(s)</td>
<td>This entity contains the detailed attributes for all exist error in the system database but are in effect at current time.</td>
</tr>
<tr>
<td>Active alarms</td>
<td>This entity contains the attributes that may contribute to the so called active New error(s) or/ and active exist error(s)</td>
</tr>
<tr>
<td>Latched alarms</td>
<td>This is a class of the past alarm whose a details of their occurrence are kept within the attributes</td>
</tr>
<tr>
<td>Cleared alarms</td>
<td>This entity contains the attributes that are necessary for keeping information that may be the causes of occurred errors in the station</td>
</tr>
<tr>
<td>Recorded alarms</td>
<td>This entity handles the attributes for all the alarms that are necessary for describing the occurrence of errors in the station</td>
</tr>
</tbody>
</table>

Fig. 7. Representation of Level 2 DFD for process 3

From Fig. 6 Level 1 DFD with four processes is shown. For the SES-EMS system processes number one and four are already fully described by the diagram. However, process number two and three requires more details and it hence lead into the Level 2 DFD as shown in Fig. 7. The entity relationship diagrams constitute a major data modeling tool and help to organize the data in any project into entities and define the relationships between the entities. This enables the analyst to produce a good database structure so that the data can be stored and retrieved in a most efficient manner [3]. For the case of our proposed SES-EMS, Fig. 8 shows the entity relationship diagram (ERD). The data dictionary, in our EMS analysis, is the analysis part which shows the description of each entity along with its role. Table 2 describes the systems data dictionary for the entities of the EMS.

4.2. System Implementation & Evaluation

The technology used in the implementation of the SES-EMS System involved the use of VB.net as coding language which provided both the front end and the interface to the back end as well as the satellite modem connected to the personal computer or a and interface terminal. The satellite modem is used to fulfill the automation requirement where by data from it could be received by the system via the serial (9-pin) cable. Nevertheless, for the part of demonstration, the testing data to be used could be generated manually by the operator to fulfill the automation of the system.

Fig. 8. SES-EMS Entity relationship diagram (ERD)

The system front end is implemented by using VB.Net. There are many reason why VB.Net was adapted for this part, the following lists depicts some of the reasons: (i) Provision of system development support as it is full of controls that are
ready for use with classes and codes for each included; (ii) The support is available for VB.Net as most of the programmers in the world who develops window systems especially for client/server systems, opt to use this language; (iii) Most of the systems available in the market now days are equipped with .Net Framework which is the most important platform the deploying the VB.Net applications; (iv) The simplicity that VB.Net provides in connection to different database management system is a nice feature; and (v) The provision available for supporting systems to be deployed in the network.

The development of the SES-EMS System adapted the use of modules which implemented single functionality or multiple related functionalities. The login module is aimed at ensuring that the person that has access to the system is the one who is authorized to do so, while the main form and error status view module is for allowing the attendant to select what he/she wants to do in the system. The insert, update and delete known errors modules, in the SES-EMS, is used to register every known error that is already known to the system. Registration of the known errors is required in order to enable the system compare with the current error, so as to distinguish between active existing and active new errors. Delete module is used to delete the details for a selected error and the system and modem communication module automates data between modem and the developed system. In our proposal, auto-notification module develops an auto notification pop messages alerting that there is error occurring some where. Auto generation of data module is built to take part on demonstration of the system on how it will be working once connected to the modem. It is a temporary module which starts to work once the system has been started and wait for the session and it starts generating data to automate the system and stops once the system has been shut down.

Insert, change and delete attendant module is used for registering the attendants that are entitled to monitor the system whereby the insert, change and delete administrator module is used to register or update authorized user details entitled to control all parts of the system. Finally, in the report module, we can view and print reports on the errors or alarms that have occurred in the past.

5. Setup and Results Analysis
Testing is the process of exercising a program with the specific intent of finding errors prior to delivery to the end user. Testing is divided into two - unit testing which is aimed at testing the individual component and system testing which tests the group of components integrated to create the system [6].

In our SES-EMS, unit testing involved the individual module testing to see if every module implemented the intended functionality and provided the conformity to its specifications. This test can be classified into four categories. These are: (i) Modules carrying out insertion into the database where the testing was done by supplying the inputs to every unit and request the functionality implemented by the given unit. These modules tested successfully and entries registered were found in the database; (ii) Modules carrying out data updates where tests were done first by accessing the data that are already in the database. The intended modifications were then done and the update requested where each module tested successfully; (iii) Modules carrying out data deletion which were done by retrieving the information that is to be deleted from the database and after observation and confirmation the information are deleted upon the request successfully; (iv) Modules implementing the user interface was done by supplying the inputs that are not in the right format and, under this case; appropriate responses were displayed in each module to prompt the attention so that the right input was fed. It was also done by supplying the inputs in the right format for which functionalities were successfully implemented.

<table>
<thead>
<tr>
<th>Table 4. Physical Database Design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Administrator</strong></td>
</tr>
<tr>
<td><strong>name</strong></td>
</tr>
<tr>
<td><strong>Password</strong></td>
</tr>
<tr>
<td><strong>ActiveAlarm</strong></td>
</tr>
<tr>
<td><strong>alarmName</strong></td>
</tr>
<tr>
<td><strong>type</strong></td>
</tr>
<tr>
<td><strong>cause</strong></td>
</tr>
</tbody>
</table>

Table 4. Physical Database Design
During the system testing, all the modules that were developed and tested were integrated to form a complete system. After the integration, the system was tested and to find out if it conforms to the specification.

6. SES-EMS General Design

6.1 Design Descriptions
The design phase is concerned with how to classify the system requirements into subsystems, each with different functions, and on how to present them to the user. In our case, it has involved three main parts: the database design part which is the back end; the application design part which facilitates the user to interact with the database of the system; and the interface design which provides the possibility of the user to interact with the system through the Graphical User Interface (GUI). So, the design of this system has involved the use of: MySQL for the back-end, VB.NET for the graphical user interface while the MySQL Server 5.0 has been used as a system server to accommodate the database. The SES-EMS system has been designed using 3-tier architecture, as shown in Fig. 9, which has included the three models - the presentation layer, the business logic layer, and the data access layer.

The presentation layer is the most important layer simply because it is the one that everyone sees and uses. The SES-EMS presentation layer removes as much business logics out of the UI and into the error layer. On the other hand, the business logic layer is vital in the sense that it validates the input conditions before calling a method from the data layer. This ensures that the data inputs are correct before proceeding, and it can often ensure that the outputs are correct as well. It is best to put as much logic as possible in the business layer. This makes this logic reusable across applications.

The data access layer, on its side, is a separate component whose sole purpose is to serve up the data from the database and return it to the caller. In SES-EMS, the data layer serves up data from MySQL database as shown in Fig. 9.

Fig.9. A Software View of a 3-Tier Architecture

In this designed system, the component types within each layer are: Presentation Layer = forms; Business Layer = services and reports; Data Layer = database driver.

6.2 Design of Graphical User Interface (GUI)
The GUI for the SES-EMS is designed under application layer. It is designed putting in mind that the users for this system are mostly those with education below college level, and they are technically beginners in the use of computers. It is designed using the windows application forms available in the .NET. The arrangement and functionalities in each form consider the users in terms of numbers and complexity. The instructions are in simple and understandable phrases for the same to be easy and user friendly to meet the application requirements. Fig. 10 shows different design stages described.

6.3. Physical Database Design
Physical database design involves taking the results from the logical data of the system analysis, fine—tuning them against the performance and storage requirements of some application and then implementing them in the mechanisms of some DBMS. Some of the common DBMSs are MS Access, Sybase, Oracle9i and MySQL. In this designed SES-EMS, MySQL DBMS has been used. MySQL offers the advantages of reliability, performance, ease of use, and ease of deployment. To use MySQL database management system with VB.NET, some connectors have been developed and they have been integrated in the development of the SES-EMS. These connectors include MySQL connector – net - 5.0.9 and MySQL connector – odbc – 3.51.2. These connectors make it possible to drive the MySQL from the VB.NET applications. The
attributes of the physical database design have been summarized in Table 4.

**6.4 Security Design**
Different solutions have been designed to ensure the security in this SES-EMS system. Database security has been the first aspect of consideration. The database itself has provided system authorization which is flexibly allowing some or all the database privileges. For example, it allows the privilege to create, insert, update or delete from the database to specific users or groups of users. On the other side, the filtering of information from user has been considered where all the inputs from the users will be filtered before being stored into the database. The system will check if the information received is of reasonable formats or of vulnerable characters. Finally, the aspect of validation of the user has been considered where the system provides the login services for its users. Hence, users are supposed to have usernames and passwords that are already created in the database for validation.

**7. Conclusions, Recommendations and Future Work**

**7.1. Conclusions**
The developed SES-EMS system has followed the software development cycle which includes system investigation, system elicitation, system analysis, system design, system implementation and lastly system testing. The proposed SES-EMS System can be of help to SESs in managing the stations consistently and reliably as this SES-EMS is able to manage the occurred alarms and errors, and suggest possible solutions which have already been known and being setup within the system. In that case, the system on the same way can be built to know where the problem occurred and can give option to correct it from the system. In addition, after being able to work on that, the system can be extended. Instead of controlling only errors, it can manage all other cases at satellite stations. These include customized options control, back panel options control, Reed-Solomon codec control, drop and insert (D&I) control, 8PSK modulation control, OQPSK modulation control, 16QAM modulation control, sequential decoding control, earth station-to-earth station (ES-ES) communications control, and analog AGC voltage control, to name some.

**7.2. Recommendations**
The developed SES-EMS consists of the front panel control screen menus and the front panel user interface whereby attendant can be set some parameters of the modem. Nevertheless, because of sensitivity issues concerned with the information being carried out at the satellite earth station modems, the part had not been tested with the actual data; therefore, it is recommended that the SES should arrange a clear way of access the actual testing data, so that the part can facilitate field tests.

**7.3. Future Work**
The developed SES-EMS system can be of help to SESs in consistently managing the stations. This is possible since these SES-EMSs with the proposed design are able to manage the occurred alarms and errors, and suggest possible solutions which have already been known and being setup within the system. In that case, the system on the same way can be built to know where the problem occurred and can give option to correct it from the system. In addition, after being able to work on that, the system can be extended. Instead of controlling only errors, it can manage all other cases at satellite stations. These include customized options control, back panel options control, Reed-Solomon codec control, drop and insert (D&I) control, 8PSK modulation control, OQPSK modulation control, 16QAM modulation control, sequential decoding control, earth station-to-earth station (ES-ES) communications control, and analog AGC voltage control, to name some.

Reference:
[5] Software Engineering: A Practitioner’s Approach
[7] UDSM’s CS-332, CS-331, and CS-431 Lecture notes
[12] Mwenge Satellite Earth station

Appendix A: Attendant System Interface

Fig. A0. Login form

Fig. A1. Main Form Module

Fig. A2. Tool bar options

Fig. A3. Front Panel Control Screen Menus

Fig. A4. Front Panel User Interface

Fig. A5. Alarms and errors status module

Fig. A6. Active Alarm View

Fig. A7. Active Errors Exist View

Fig. A8. View possible solution of known errors

Appendix B: Administrator System Interface

Fig. A9. MSES Control option
Fig. B1. Known errors, Attendant & Admin. Setup Module

Fig. B2. Sample Recorded Known Error

Appendix C: System Operations

Fig. C0-1. The codes to connect to the modem

Fig. C0-2: Codes to get data from modem and convert it to hex)

Fig. C1: Auto notification module

Fig. C2. Codes for automating generation of data from modem

Fig. C3. Possible reports