Framework for Data Historian and Logging for RRL smart products.

Submitted By

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16MCEC10

DEPARTMENT OF COMPUTER ENGINEERING

INSTITUTE OF TECHNOLOGY

NIRMA UNIVERSITY

AHMEDABAD-382481

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Framework for Data Historian and Logging for RRL smart products.

Major Project

Submitted in fulfillment of the requirements

for the degree of

Master of Technology in Computer Science and Engineering

Submitted By

Mistry Nirav Rajendrakumar.

(16MCEC10)

Guided By

Prof. Jigna Patel

DEPARTMENT OF COMPUTER ENGINEERING

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May 2018

Certificate

This is to certify that the major project entitled **"Framework for Data Historian and Logging for RRL smart products."** submitted by **Mistry Nirav Rajendrakumar (16MCEC10)**, towards the fulfillment of the requirements for the award of degree of Master of Technology in Computer Science and Engineering of Nirma University, Ahmedabad, is the record of work carried out by him under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this major project part-II, to the best of my knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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Statement of Originality

I, **Mistry Nirav Rajendrakumar**, **16MCEC10**, give undertaking that the Major Project entitled "**Framework for Data Historian and Logging for RRL smart products.**" submitted by me, towards the fulfillment of the requirements for the degree of Master of Technology in **Computer Science & Engineering** of Institute of Technology, Nirma University, Ahmedabad, contains no material that has been awarded for any degree or diploma in any university or school in any territory to the best of my knowledge. It is the original work carried out by me and I give assurance that no attempt of plagiarism has been made.It contains no material that is previously published or written, except where reference has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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Place:

Endorsed by

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(Signature of Guide)

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Abstract

Framework for Data Historian and Logging is the major required software for data acquisition. The objective of this project is to develop framework for monitoring (Data acquisition) over GPRS/GSM/Ethernet, validation and data storage (both real-time and historian). The framework will focus initially to historical Data storage and later extend to Real-time. The framework will also focus in development of human machine interface (HMI) to analyze, trace, report and other graphical interfaces. The framework will be initially used for RRL application like FPI, sTRU and later will be extended to other application like TCM.

Abbreviations

FPI	Fault Passage Indicator.
sTRU	Smart Transformer Rectifier Unit.
RTU	Remote Terminal Unit.
GPRS	General Packer Radio Service.
GSM	Global System for Mobile Communication.
TCP/IP	Transmission Control Protocol / Internet Protocol.
AC	Alternating Current.
DC	Direct Current.
HMI	Human Machine Interface
CSV	Comma-separated values
AOR	Area of Responsibility
GUI	Graphical User Interface
RRL	Raychem RPG Limited.
TCM	Transformer Condition Monitoring.

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Chapter 1

Introduction

1.1 Introduction of Problem

There are many hardware devices are placed on field in which there we have to maintain the data of that hardware devices. For these Hardware devices like Datalogger, FPI, sTRU we are making common framework which monitoring data (Data acquisition over GPRS/GSM/Ethernet), validation and data storage(both real-time and historian). There are events which are triggering at fix interval time which data should be display into the database and by accessing this data, user can identify, which event is occurred and which action has to be performed. Under this framework(software) user can view data and insert data into database. This database is connected with client and server and server is connected with particular hardware devices.

1.2 Problem Statement and Explanation

1.2.1 Problem Statement

For the different hardware devices, there are no data acquisition software which store data and shown it to the user. If they want to check which event is occur they have to go to that field and check manually and then take appropriate actions. Based on this details user have to work on particular problem.

1.2.2 Description

We need better solution for solving this problems, thus we made a desktop application which keep record and store it into database. We are storing different Analog parameters

and different Digital parameters along with Reference cell data. In analog parameter there are values of AC/DC Voltage and AC/DC current. Different type of user have different type of permission of access the data and they can view and add the data according to their need.

Chapter 2

Literature Survey

To develop this framework, first we require to understand the specification of the software as well as hardware which is connected with the software from which data is generated and coming to the software. For this, we use Remote Terminal Unit (RTU) as a hardware unit which is connected with software and makes a complete Supervisory Control and Data Acquisition system.

M. M. Ahmed *et al.* [1] has presented Supervisory Control and Data Acquisition (SCADA) based Remote Terminal Unit (RTU) for distribution automation system. This RTU is operate on low voltage downstream of 415/240V. They use embedded Ethernet controller which act as human machine Interface (HMI). In this system, RTU act as master and digital input and output modules are act as slave.

A.A.E. Shammah *et al.* [2] has published technique to investigate the problem associated with the optimal location of remote terminal units (RTUs) within Distributed Networks. This RTUs enable different locations monitoring which is linked with central database through a communication system. The main objective of this optimize technique is reduce capital cost as well as running cost. For this they used the node-voltage level and load importance to extend optimization function in general form.

Pongsakorn *et al.* [3] has introduce Remote terminal unit that can trip the circuit in case of power failure when work with central control room. In this he use optimal placement of RTUs by using Partial Swarm Optimization (PSO) technique to minimize customer outage, travel cost and improve System Average Interruption Duration Index (SAIDI).

Dan Xu *et al.* [4] Has presented monitoring of water quality parameter such as

DO, pH, Salinity and temperature are necessary for the sea food. For it low energy consumption RTU is developed and applied. In Hardware design of this type of RTU, STM8L152 is selected in the MCU module to accomplish the function of ultralow power consumption.

G.T. Heng *et al.* [5] has describes the design of low cost and versatile microcomputer based remote terminal unit (RTU) that was commission as part of SCADA system for and oil and gas company. The RTU talks to the master or host computer using leased parallel line. The changes in fields inputs are immediately sends by the RTU to the host computer in real time while controlling outputs can be sends immediately by the host computer to the field.

Chapter 3

System Analysis

3.1 Purpose

The purpose of this project is to develop the framework for monitoring(Data acquisition) over GPRS/GSM/Ethernet, Validation and data storage(both real-time and historian). The framework will focus initially historical data storage and later extend it to Real-time. The framework will also focus on the development of human machine interface (HMI) to analyse, trace, report and other graphical interfaces.

3.2 Document Conventions

- Complete document should be justified.
- Font Face: Times New Roman
- Font Size: 12 for Body
- Font Size: 12 Font Style: Bold for Sub title
- Font Size: 14 Font Style: Bold for Title

3.3 Project Scope

This framework is basically developed for monitoring and logging of data for customer. In this framework customer can see the report of data and graph generated from these data. This framework is use full for automatic data logging and controlling from remote location.

3.4 Overall Description

3.4.1 Product Perspective

For logging and historian I made the standalone Server application. This software is used for full Supervisory Control and Data Acquisition(SCADA). As the hardware devices are placed on field, by using this software customer can work remotely. In this software other user can not insert, update or delete the data only authenticate user can insert, update and delete the data, which increases its security.

3.4.2 Product Functions

- For providing security to the system we have added log in page, which authenticates customer.
- To provide better control to the customer only authentic user can log-in and view the data.
- Authentic admin can add numbers of customer and customer can add its related hardware devices.
- Graphs and reports are generate on single click.
- Customer can generate reports in pdf or CSV format.
- Customer can operate software from remote location via IP address.

3.4.3 User Characteristics

- **Education Level:** At least he or she should have basic knowledge of computer. He or she should be familiar with the English language.
- **Experience:** Users must have knowledge that how to operate computer.
- **Technical Expertise:** User should be comfortable in using software in computer. He or she should be well informed about the system so that he or she can do job carefully and easily.

3.4.4 Operating Environment

This framework requires .Net v4.0 and above which is a free and open source Microsoft packages to run software and active internet connection. This software is run only in Microsoft windows based operating systems only.

3.4.5 Design and Implementation Constraints

This framework is basically developed for a specific customer which is Desktop based version. So this framework is work on a single desktop with the single user only. For this, we are using .Net framework which is windows based software framework. So, this framework will work only for windows based operating system only. For usage limitation, we have added license which is string base key provided to a customer which increases the customer security but the problem occurs in generating the key for the specific customer and because this is multiple product framework, we have faced difficulties in maintaining programming standards and it will increase maintenance of software.

3.4.6 Assumptions and Dependencies

Due to limited features of DBMS, system may become slow with increasing number of records being stored.

Assumptions:

- The coding should be error free.
- The software should be user-friendly.
- The information of all companies, parameters and reports should be stored in a database and it is accessible by desktop software.
- The software has more storage capacity and it provide fast access from database.

Dependencies:

- The required hardware and software are used in software for run that software.
- The user should have proper understanding of the product.
- The general report is stored in software.

- The information of all the companies is stored in database that is accessible from software.
- Any update regarding the company from the customer is recorded in database and entered data should be correct.

3.5 System Features

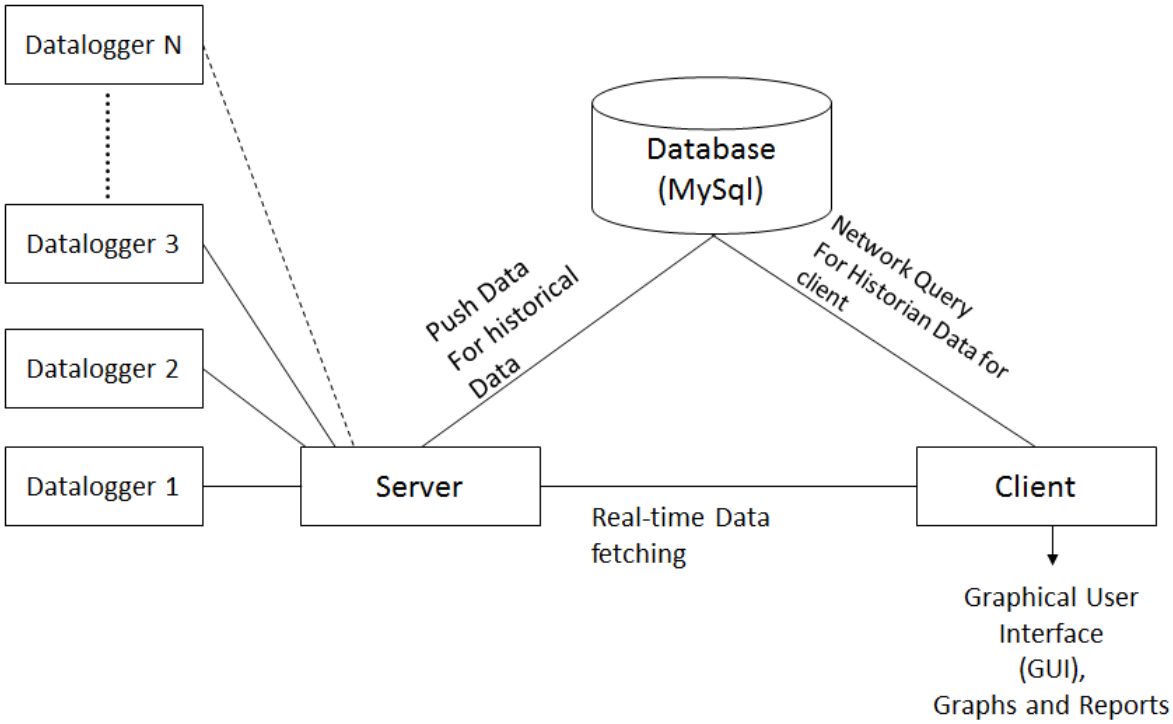

Figure 3.1: Architecture

1 Login

2 Customer registration

3 User registration

4 Device registration

5 Database Controlling

6 Parameter wise and event wise report

7 Parameter Graph

8 Advance Graphical user interface

9 Access Control

10 AOR - Area of Responsibility

3.5.1 Login

User can login to software using their respective user id and password.If user id or password are wrong user cannot use the system. This module is used to provide security to our system

3.5.2 Customer registration

User can add their customer via customer registration page. If there are more then one customer, user can see the list of customer which are registered under particular user.

3.5.3 User registration

The only RaychemRPG Pvt. Ltd. company have authentic access to add user as per customer requirement. There are admin who have full privilege to add and remove the user as per the registered user.

3.5.4 Device Registration

In this, User can add multiple device as the device is registered under that respective user. There should be more then one device on single location ad there should be more then one location respective to user.

3.5.5 Database controlling

Admin as well as User have access to add parameters, events and generate graphs and reports of events and parameter. Database are mainly use for storing and acquisition of data from database. So, Controlling the database over the server is important.

3.5.6 Parameter wise and event wise report

There are different parameters whose values are stored and there are different event which is occurring at no interval if time i.e. randomly. User can see the report of all parameter\Digital parameter\Analog parameter as well as all event reports.

3.5.7 Parameter Graph

There are different parameters whose values are stored in database. User can see the Graph of all parameter\Digital parameter\Analog parameter.

3.5.8 Advance Graphical user interface

User have advance graphical user control so that user view multiple window at same time, user can dock window and change theme of software.

3.5.9 Advance Control

This software is licensed under RaychemRPG Pvt. Ltd. Inc. and it have advance control of all customer, user and devices as they can Add, Modify and Delete any of the details.

3.5.10 AOR - Area of Responsibility

This software is secure and licensed so that no other unregistered user can modify or remove details.

3.6 Other Non-functional Requirements

3.6.1 Performance Requirements

The software is going to develop is used for report and graph generation in for different customer. It is expected that database must be performed all the requirements are specified by the customer.

- The performance of the software is fast and accurate.
- The software can handle expected and non-expected errors in the way of prevent loss in information.
- The software is able to handle large amount of data.
- The load time for the GUI should not be more than four seconds.
- The log in must verified within 7 seconds.
- The search query should be processed within 3 seconds and response must be given.

3.6.2 Safety Requirements

The database may be get crash at any time due to some error, virus and operating system failure. It is required to take the backup of database so the database is not lost.

3.6.3 Security Requirements

- System will use secured database.
- Other user cannot modify and delete the data.
- Proper user authentication should be provided.
- There should be single accounts for admin for no other person can accessing database and only authenticate user has the rights to update the database.
- Only authenticate user can generating graphs and report.

3.6.4 Software Quality Attributes

- There may be authenticate user for maintain the software, authenticate user having permissions for any changes in system. The other users cannot do change.
- The quality of database must be user friendly so any authenticate user can use that software.

Chapter 4

System Design

4.1 System Flow Chart

The Figure 4.1 shows the flow chart of our system. In this system there are server application, client application and Database which are connected with each other. When server starts, it connects with one or more devices and device sends the data to the server. Now, server sends Real-Time data to the client application as well as stores data into database.

System user can login into the client application via given user id and password. Admin can register user according to their location. User can view graphs and reports of parameter and events which is stored by the server into database. Now user request to connect client with server and once client is connected to the server, server sends Real-Time data to the client and user can see it in client application.

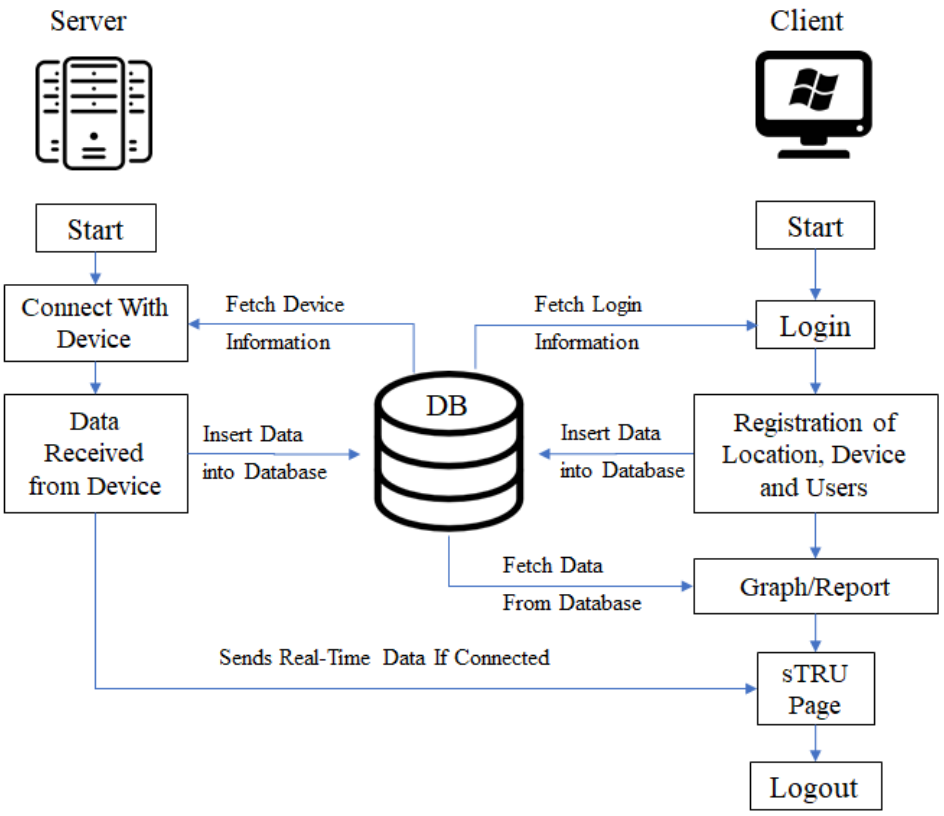

Figure 4.1: Flowchart of Framework for Data Historian and Logging for RRL smart products

4.2 Tools and Technique used

4.2.1 User Interfaces

Screen resolution of at least 800x600 minimum required for proper and complete viewing required for screen. Higher resolution will not be a problem.

4.2.2 Hardware Interfaces

To run this software, the minimum requirement of Hardware(PC) is mentioned below.

- Processor: Intel Pentium
- Hard Disk: 100 GB
- RAM: 2 GB

4.2.3 Software Interfaces

Table 4.1: Open source solutions for development of framework.

Tools and Organization details	**Open source/ licensed**	**Information/Features**	**Limitations**
Tool name: Microsoft Visual Studio Community 2017 Developer: Microsoft	Open Source	Fastest tools for developing the software. Microsoft Visual Studio 2017 is simple, easy and which is run over the .net framework. Microsoft Visual Studio 2017 has many of the language support but we used c# language for development of graphical software. To develop different graphical user interface, we use Krypton framework for better enhancement. This tool is used to develop applications like Stack Overflow Architecture, TakeStock 2, WeatherMate and all Windows platform Application. Source: https://www.visualstudio.com/downloads/?utm_source=mscom&utm_campaign=msdocs	For more functionality, you need to purchase. Developed software with this tool can be run over windows operating systems only.
Microsoft.net Framework v4.5 Developer: Microsoft	Open Source	To operate Microsoft Visual Studio Community 2017, we need to install Microsoft .net framework v4.5 and above version. This to compile and run Microsoft developed software. Source: https://www.microsoft.com/en-in/download/details.aspx?id=30653	NA

MariaDB 10.1 with MySQL 5.6 Developer: GNU GPL	Open Source	For storing the data, we must use a database, for which we have used Maria DB database engine which has inbuild MySQL 5.6 support. Along with this setup, it installs HeidySql which is MySQL database management software. Facebook, Google, LinkedIn, and Twitter all use MySQL for at least some of their data management. Source: https://downloads.mariadb.org/	This tool supports only one database i.e. MySQL.
SQLServer 2014 Developer: Microsoft	Open Source	This tool is another way of storing database i.e. SQL Server which is like this MySQL database. Source: https://www.microsoft.com/en-in/download/details.aspx?id=42299	This tool supports only one database i.e. SQL Server.
SQL Server 2014 Management Studio. Developer: Microsoft	Open Source	This tool is supporting to manage all the data of SQL Server Database which is based on Microsoft coding guideline where you can manually add and delete data as well as create a database and update existing database. Source: https://www.microsoft.com/en-in/download/details.aspx?id=42299	This tool supports only one database i.e. SQL Server.

4.2.4 Communications Interfaces

- TCP/IP protocol is used for communication between local computer and hardware device.
- Modbus TCP/IP protocol is used for communication with RTU.

Chapter 5

Proposed Model

5.1 Client Server Model

Client server model is distributed application structure that partitions between service provider called server and service requester called client. Generally client server architecture used in computer network where client is on one machine and server is on another machine. Here in proposed model, client ans server may be on same machine and may not be on same machine.

The client server architecture is used to provide the relation of co-operative program in an application. The server provide service to one or more clients, which initiates for particular service. There are many type of server like web server, web pages, file server, computer files, Database server, Application server etc. Here we used Application server which is made for communicate with device as well as client.

Here one server can communicate with many of of the client and one server can communicate with more then one devices.

5.2 Modbus TCP/IP

Modbus TCP/ip is a variant of MODBUS family, intended for supervision and control of automation products. Simply, it uses Modbus messaging in an internet using TCP/IP Protocol. The common use of the protocol are for Ethernet, attachment f PLC's, I/O modules to other simple field buses or I/O Networks.

TCP is transmission control protocol and IP is Internet protocol. This protocol used together and are the transport layer protocol. When modbus information is sent using

TCP it has additional information is attached and given to IP. IP then places data into packets and transmit it.

5.2.1 Modbus RTU over TCP

When Modbus RTU message transmitted with a TCP/IP, and sent over a network instead of serial line, it uses Modbus TCP/IP Protocol. The server uses IP addess so it does not have slave Id.

5.2.2 Modbus TCP

Modbus TCP Data transaction is generally stateless, making them highly resistant to disruption from noise and required minimal recovery information to be maintained at either end. Generally Modbus TCP works on 502 Port number.

MODBUS uses a "BIG-ENDEN" representation for address and data items. So that when you send more then one byte, MOST significant byte is sent first.

Below is the Data encoding in Modbus.

Table 5.1: Data encoding in Modbus

16 bits	0x1234	0x12	0x34		
32 bits	0x12345678L	0x12	0x34	0x56	0x78

Chapter 6

Implementation

6.1 Login

In this module authenticate user can login using user id and password. If user id or password are wrong user cannot use the system. This module is used to provide security to our system.

Figure 6.1: Login

6.2 Location Registration

In this module user can add location on which their companies are there and hardware devices are placed.

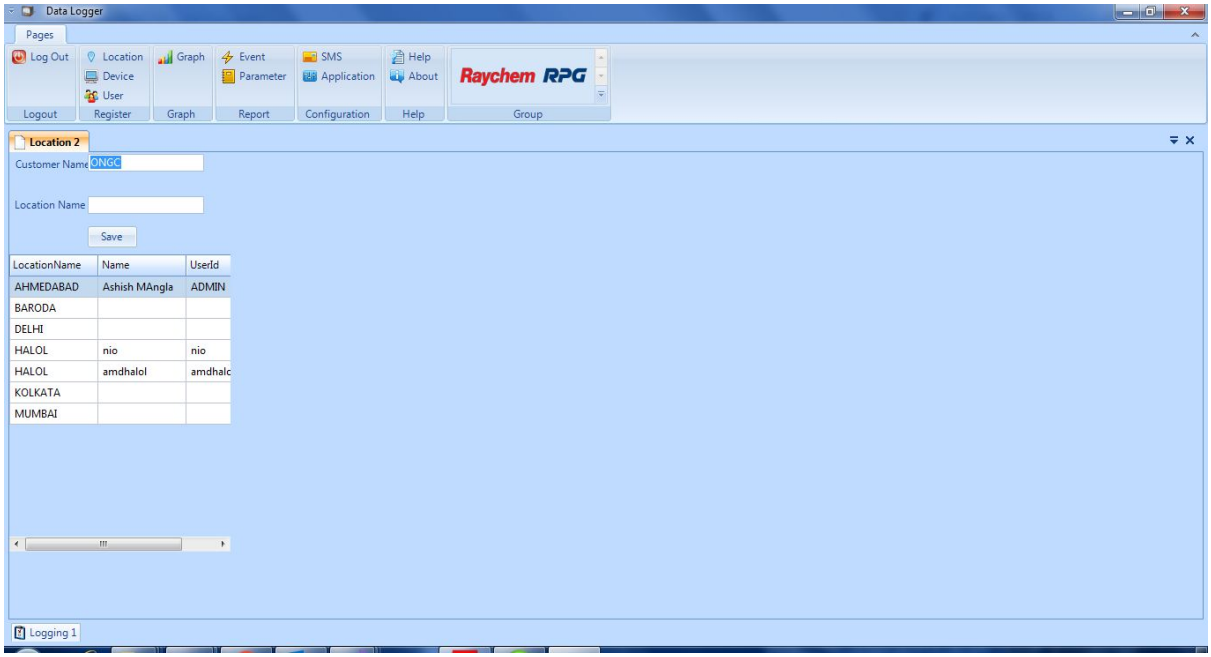

Figure 6.2: Location Registration

6.3 Device registration

In this module, user can register the hardware device as many as they have.

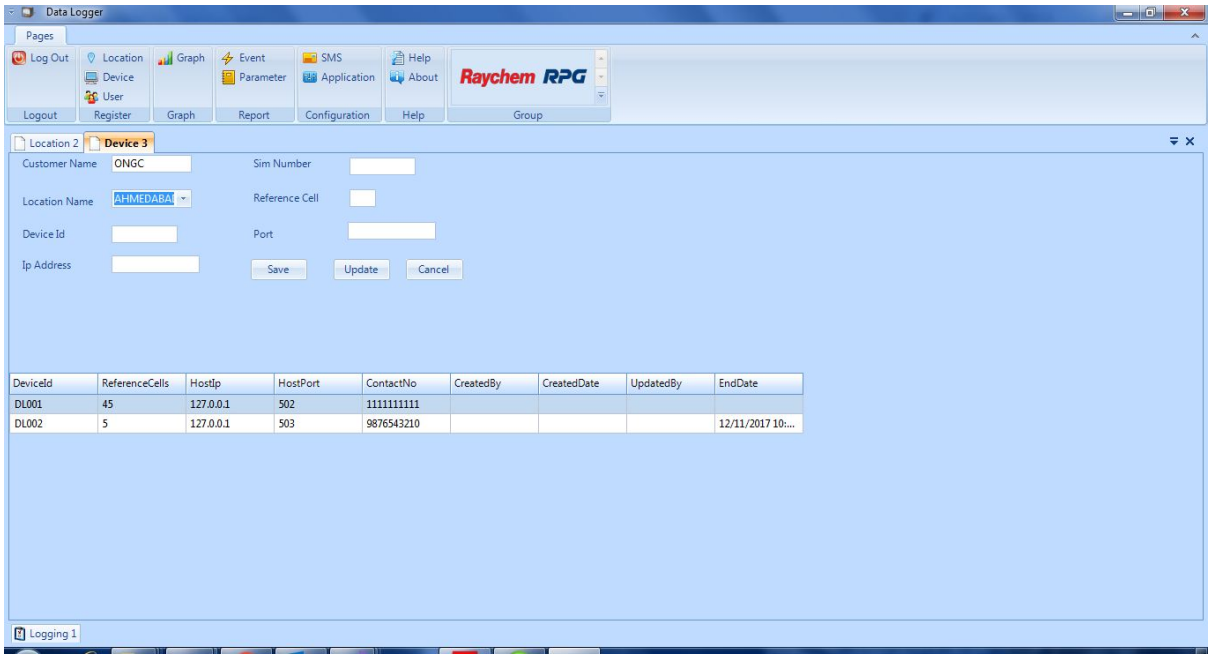

Figure 6.3: Device Registration

6.4 User Registration

In this, Admin can add the user and store user information as per the number of user.

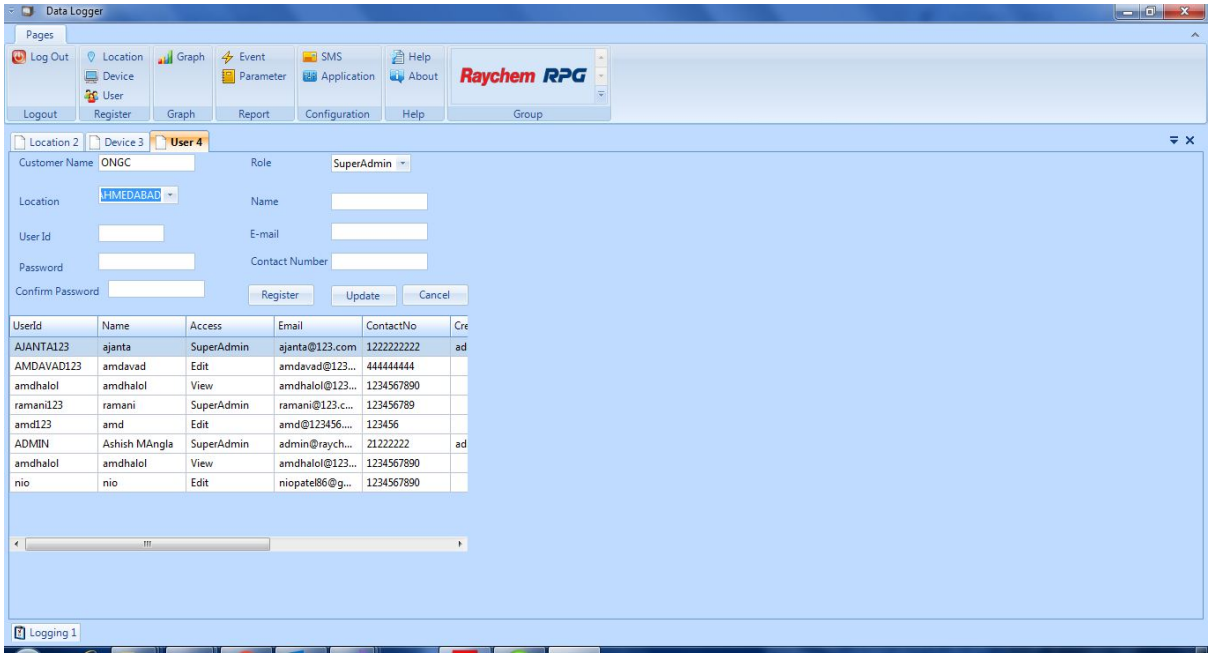

Figure 6.4: User Registration

6.5 Graph

In this, user can see the real time as well as previous years parameter value graph.

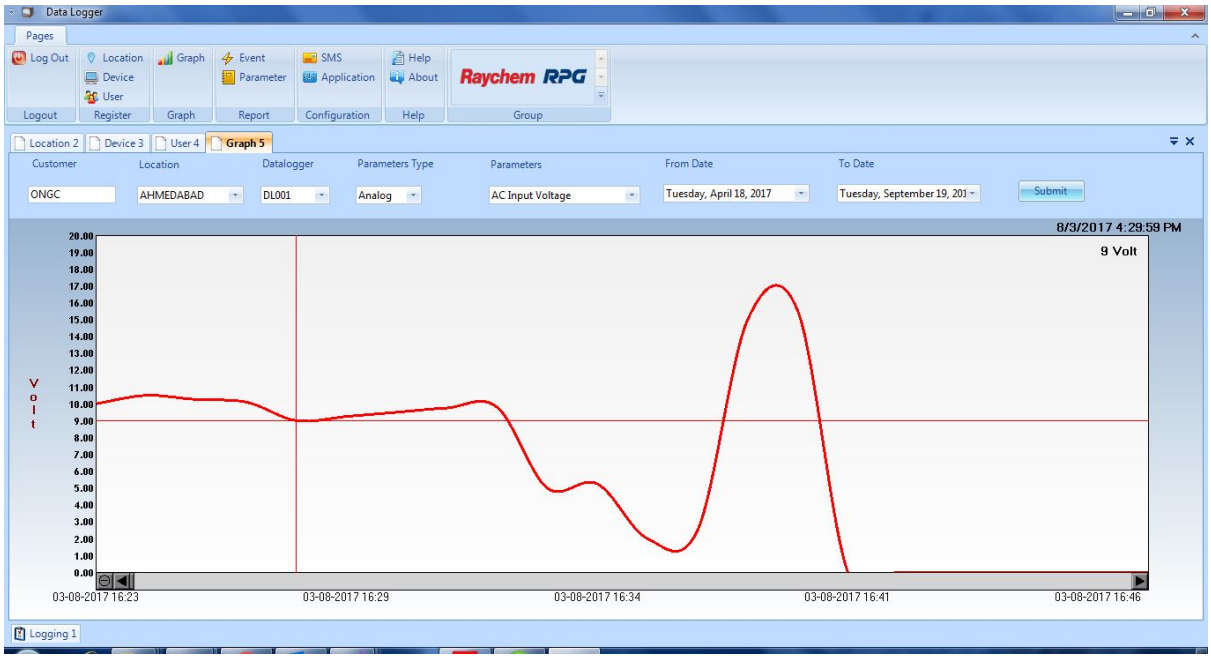

Figure 6.5: Graph

6.6 Parameter Report

In this, user can see the real time as well as previous years parameter value graph.

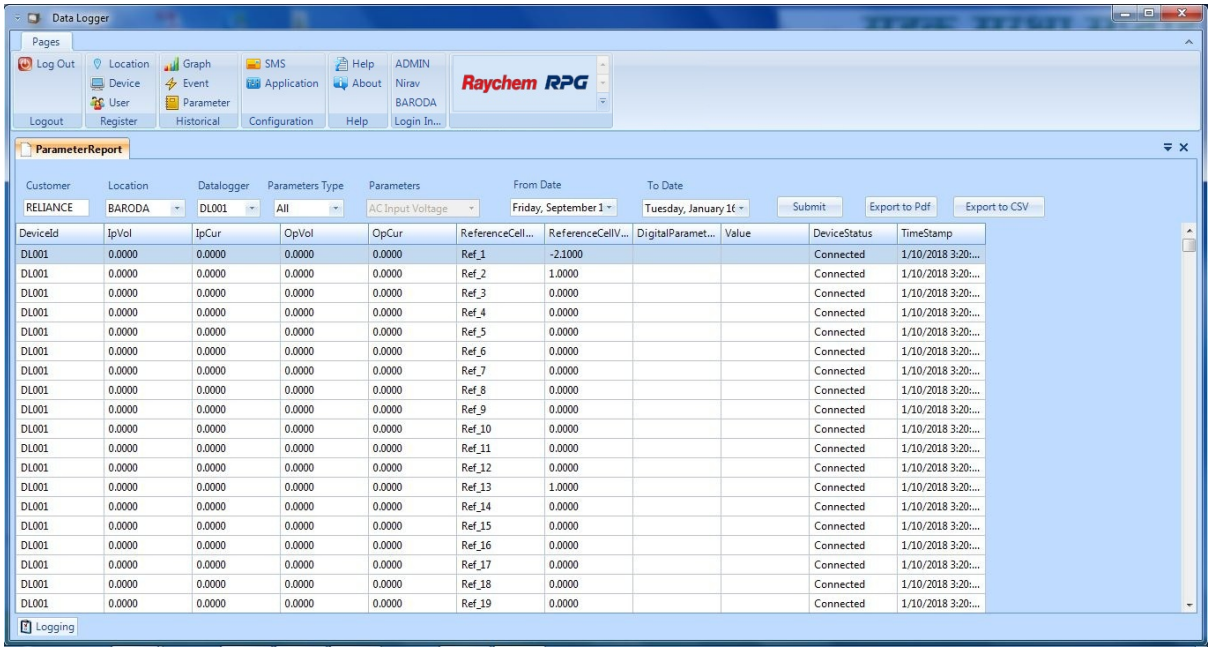

Figure 6.6: Graph

6.7 Event Report

In Event report, first of all the data which is coming from hardware devices are stored into database and from database user can see the event in report form.

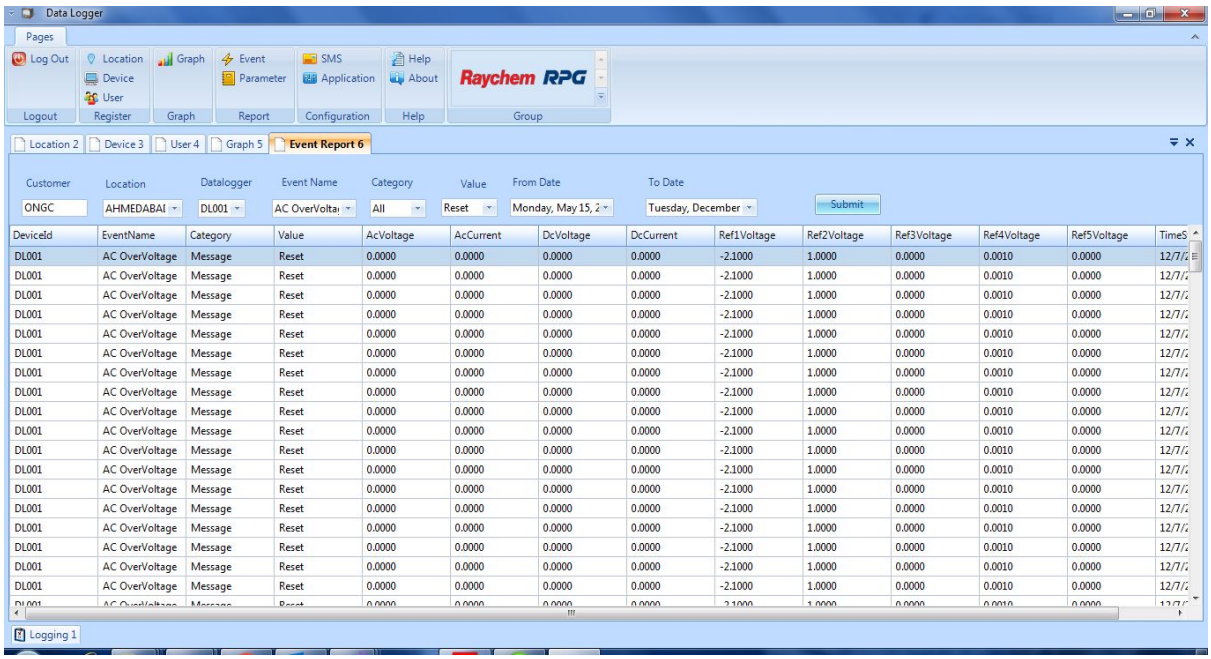

Figure 6.7: Event Report

6.8 TRU Status

In TRU status, status will give you the alert at which particular point the error is occurred.

```
Value = Convert.ToSingle(values[CV_MODE_CURRENT_SETTINGS_HOLDING_REG * 2] * 256 + values[CV_MODE_CURRENT_SETTINGS_HOLDING_REG * 2 + 1]);
Value /= CV_MODE_CURRENT_SCALING;
txtCVModeCurrent.Text = Value.ToString("0.0");

Value = Convert.ToSingle(values[REF_FAIL_PRESET_VALUE_HOLDING_REG * 2] * 256 + values[REF_FAIL_PRESET_VALUE_HOLDING_REG * 2 + 1]);
Value /= REF_FAIL_PRESET_SCALING;
txtRefFailPreset.Text = Value.ToString("0.0");

Value = Convert.ToSingle((Int16)(values[AUTO_MODE_REF_VOLTAGE_HOLDING_REG * 2] * 256 + values[AUTO_MODE_REF_VOLTAGE_HOLDING_REG * 2 + 1]));
txtAutoRefVoltage.Text = Value.ToString();

Value = Convert.ToSingle((Int16)(values[OVER_PROTECTION_THRESHOLD_HOLDING_REG * 2] * 256 + values[OVER_PROTECTION_THRESHOLD_HOLDING_REG * 2 + 1]));
txtOPLimit.Text = Value.ToString();

Value = Convert.ToSingle((Int16)(values[UNDER_PROTECTION_THRESHOLD_HOLDING_REG * 2] * 256 + values[UNDER_PROTECTION_THRESHOLD_HOLDING_REG * 2 + 1]));
txtUPLimit.Text = Value.ToString();

Value = Convert.ToSingle((Int16)(values[REF_FAIL_HIGH_THRESHOLD_HOLDING_REG * 2] * 256 + values[REF_FAIL_HIGH_THRESHOLD_HOLDING_REG * 2 + 1]));
txtRefFailLimit.Text = Value.ToString();

Value = values[REF_CELL_CONNECTED_HOLDING_REG * 2] * 256 + values[REF_CELL_CONNECTED_HOLDING_REG * 2 + 1];
txtRefConnected.Text = Value.ToString();

Value = values[IO_BOARD_CONNECTED_HOLDING_REG * 2] * 256 + values[IO_BOARD_CONNECTED_HOLDING_REG * 2 + 1];
txtIOConnected.Text = Value.ToString();
```

Figure 6.8: TRU Status Calculation

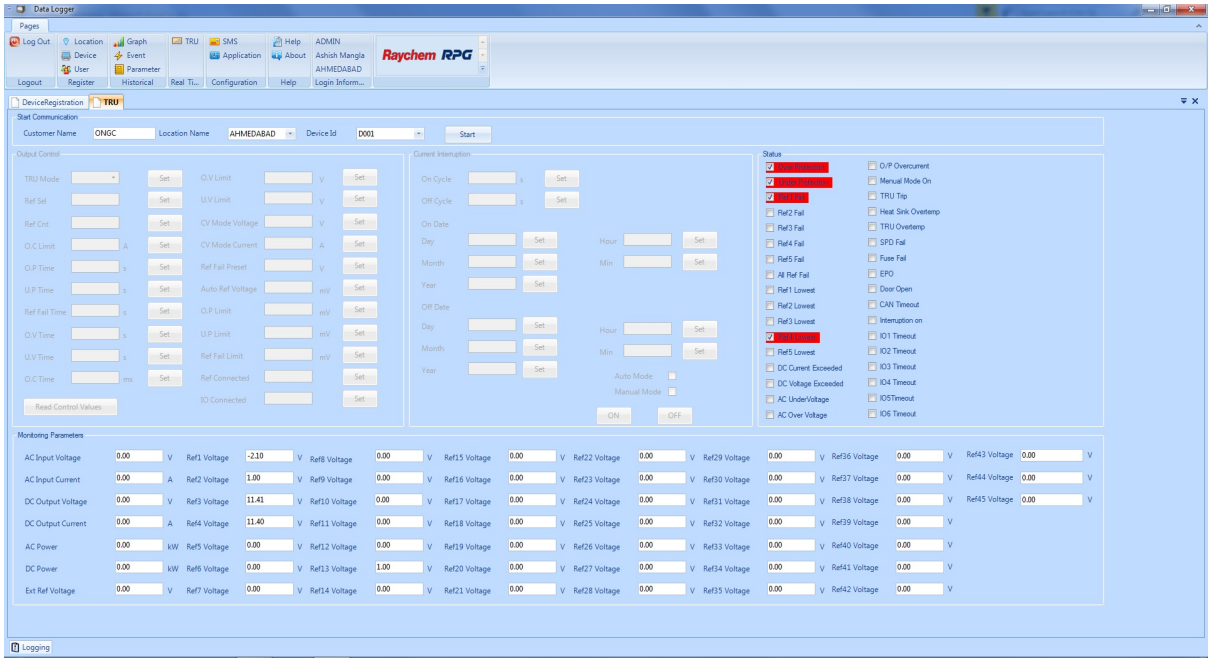

Figure 6.9: TRU Status

6.9 SMS Configuration

In SMS Configuration user can send the SMS to the hardware device to get the connection details of the server with that particular hardware devices for starting communication.

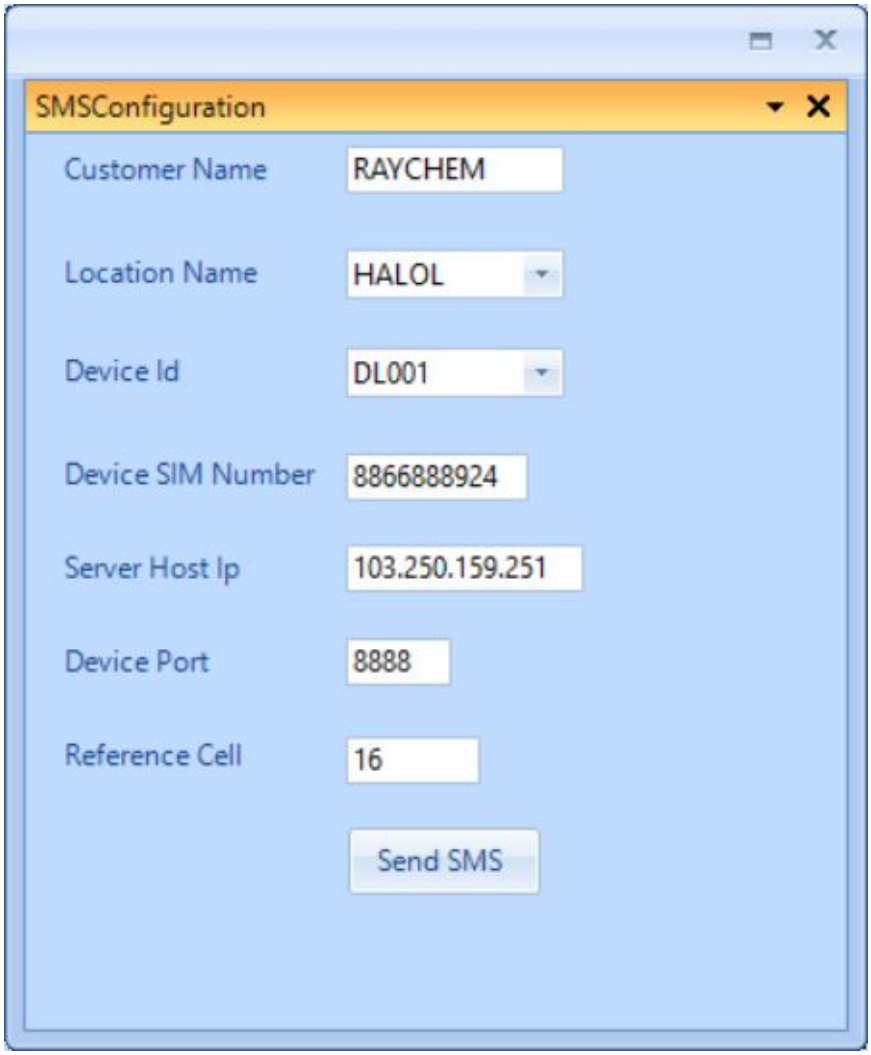

Figure 6.10: SMS Configuration

6.10 Settings

In settings, User can set the connection information such as Ip Address and Port of the server.

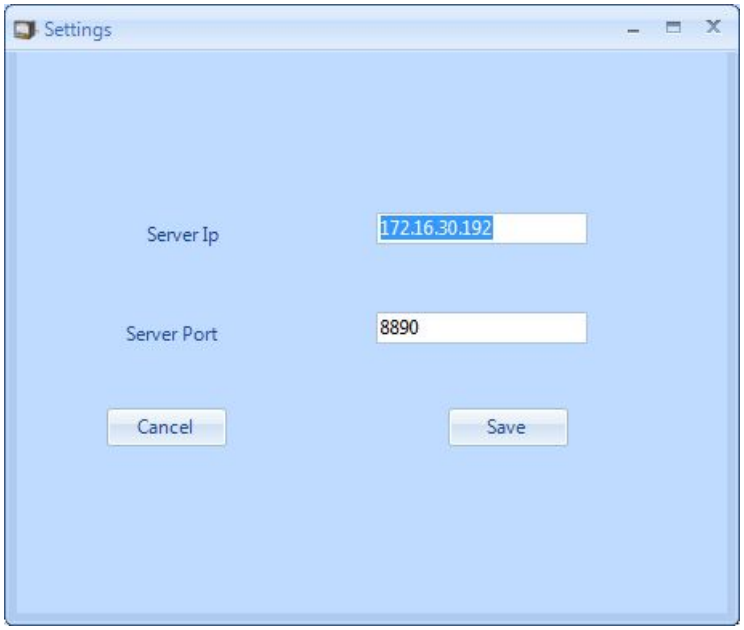

Figure 6.11: Settings

6.11 About

Figure 6.12: About

6.12 Server

Here you can connect one or more devices to server, one or more client to the server and you can send SMS for configuration of Device via SMS Gateway.

Once, Device starts, it will generate events and alarms which is shown in Server application.

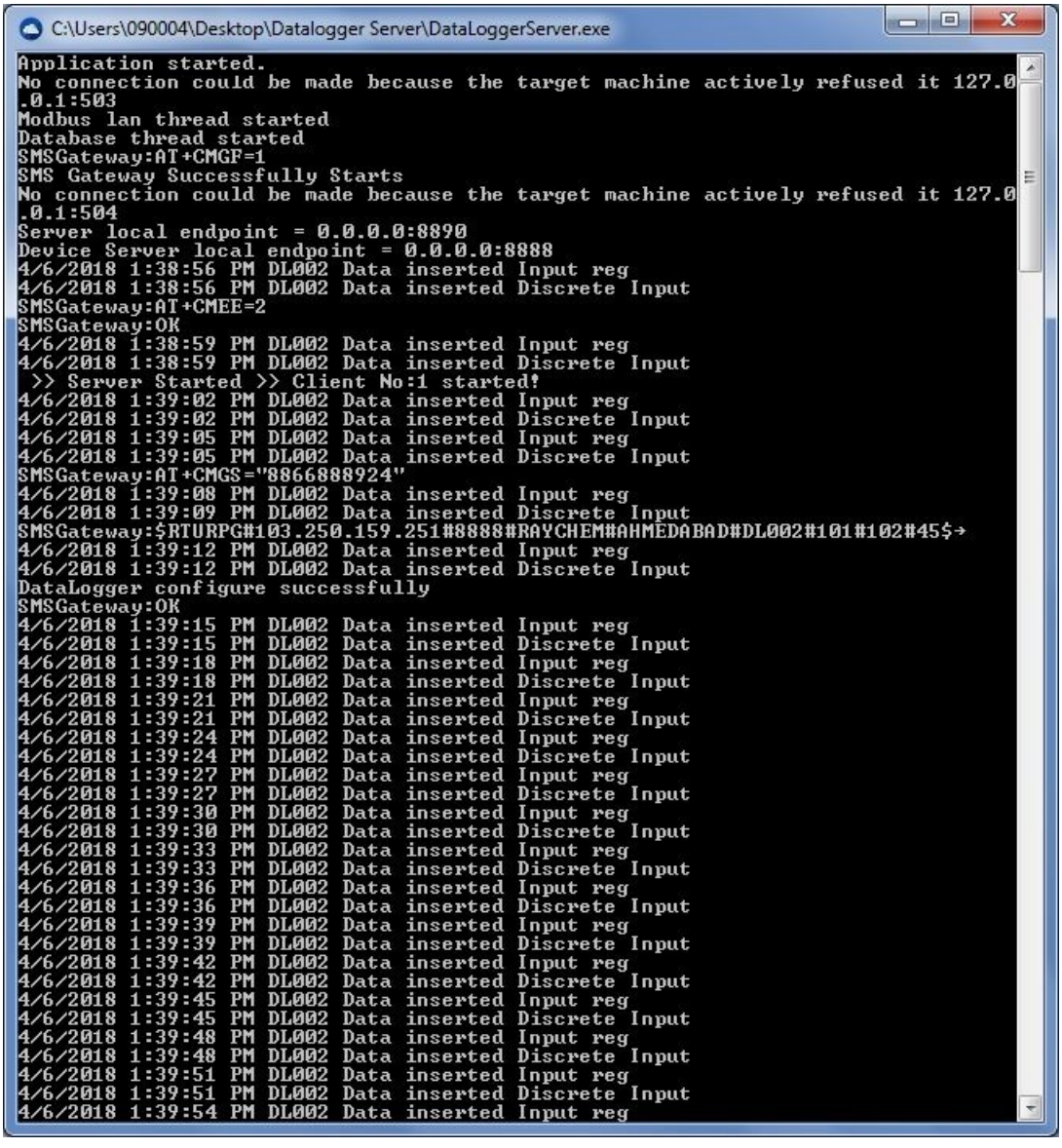

Figure 6.13: Server

Chapter 7

Result Analysis

By understanding customer requirement, we made common framework for data historian and logging where customer should add device and user as per the location and they have to connect this software with device over GPRS. The software stores all the data into database and user can see the real-time data as well Historical data in terms of graphs and report and user can configure connection parameter via SMS also.

Here to fetch data from database it uses Binary search algorithm.

Comparison of Linear Search with Binary Search.

A linear search scans one item at a time, without looking at another one.

1 The worst case complexity of linear search algorithm is O(n).

2 If the number of elements are increase, time taken to search the elements keep increasing.

Binary search cut down search to half as soon as it finds the middle elements of the sorted list.

1 The worst case complexity of binary search algorithm is O(log n).

2 Here, searching is done in half of the given list.

Chapter 8

Conclusion

There were no data acquisition software in which user can Monitor and Control data. This project is useful for development of framework for monitoring (Data acquisition) over GPRS/GSM/Ethernet, validation and data storage (both real-time and historian). The framework is focusing on historical Data storage and later as well as Real-time. The framework is also focusing on development of human machine interface (HMI) to analyze, trace, report and other graphical interfaces. The framework is initially used for RRL application like FPI, sTRU and later will be extended to other applications.

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