國立交通大學

網路工程研究所

碩士論文

TDR 感測平台資訊監測系統

A monitoring information system with TDR sensing capability platform

研 究 生：戴子強

指導教授：謝筱齡、蔡文能　教授

中 華 民 國 九 十 九 年 六 月

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TDR 感測平台資訊監測系統

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摘要

傳統監測系統多仰賴人工觀測方式，若遇到颱風期間因為氣候、交通、安全等因素，耗時的人力成本過高且分析資料很困難。本論文採用時域反射法(TDR ,Time Domain Reflectometry)做為自動化監測系統核心。，而且利用可同時量測水位、降雨量、沖刷、位移、錯動變形及含砂濃度之整合型遠端自動監測資訊系統，讓多項監測技術可同時在單一平台的監測資訊系統上運作。TDR 使用同軸纜線做傳輸資料並連接多工器，而多工器主要的功能在於擴充同時監測的感測器數量。

我們希望發展一套資訊化監測系統讓監測人員只需要透過網頁即可及時觀看各個監測站點最新資料,遠端控制各個監測站點和便利的方式取得歷史資料做分析。監測人員只需要透過網頁即可及時觀看各地最新資料並可以遠端控制監測站點，並且此系統可以讓監測人員根據歷史資料做分析，並取得報表。

關鍵字:時域反射法(TDR)、服務導向架構、含沙濃度、嵌入式系統

A monitoring information system with TDR sensing capability platform

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Abstract

The traditional monitoring systems rely on manual observation. During the typhoon seasons, there is traffic, safety and other factors cannot reach the monitoring sites. Furthermore, it takes high labor cost and time-consuming to analyze data. The study applies Time Domain Reflectometry (TDR) sensing technique to build monitoring system. The system can measure water levels, rainfall amounts, scours, displacements, dislocation deformations and suspended sediment concentrations. It is a unique approach of pulsing several long coaxial probes, multiplexing (8 channels) and analyzing the reflected voltage signatures. This study establishes an automatic and integrated monitoring system. It provides a convenient method to control each monitoring site and obtain real-time data, historical information queries, and analyses via browsers.

Keywords: Time Domain Reflectometry (TDR)、Service-Oriented Architecture (SOA)、Suspended Sediment Concentration (SSC)、Embedded system

致謝

這篇論文的完成，首先特別感謝我的指導教授謝筱齡老師，在這兩年期間給予課業上的指導以及生活上支持與關心，讓我在交大的求學生涯中不僅學到了許多學業上的知識，還有更多做人做事的道理與堅持，也讓我對於未來的自我定位有了新的想法，謝謝老師的關懷和指導。也要感謝我的共同指導教授蔡文能老師，在這兩年交大研究生涯中給予我的幫助；以及土木系教授林志平老師在合作計畫進行中給予我許多的指導。口試期間良受陳延禎教授、林正中教授、蔡文能教授、謝筱齡教授給予本論文許多寶貴的建議與指正，使論文得以更加完善，在此表示由衷的感謝。

研究期間，幸蒙鐘志忠與翁永卿學長等在研究過程中給予我許多寶貴的建議與指導，遇到困難時給予我研究的方向；還有合作計畫中一起努力的土木所同學岳勳、智棟、永政，以及實驗室所有共同奮鬥的伙伴群：怡欣、家銘、佩慈和所有學弟們，謝謝你們在學業上以及生活上的協助，有你們讓實驗室整個溫馨了起來，謝謝大家的互相鼓勵和扶持，度過這非常豐富的兩年碩士生涯。 還有曾經幫忙過我的人，謹以此謝文獻上致意。

最後，謝謝我最愛的家人。謝謝你們對我的關心和鼓勵，讓我在一次又一次的挫折中，學習面對困境，讓我更有勇氣去面對接下來的挑戰。謹以此篇論文獻給每一個曾在這人生道路上給予我鼓勵的你們。

Content

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Chapter 1 Introduction

The main motivation of this study is establish a Data Center to integrate monitoring system. The traditional monitoring system use artificial measure data. It is very inconvenient for data analysis and presentation. Therefore, we wish to be able to develop a web-base Data Center system to overcome this issue. This study presents integrated monitoring system and establishes a Data Center. The system base on client-server architecture transmits ASCII formatted text data via Wireless GPRS to Data Center. In order to implement the system, we separate the system into two parts: one is web-base provides user interface; another is windows-base retrieve text files and control station parameter. The Data Center system provides a convenient way to control every monitoring system, display real-time monitoring data, history information queries and export monitor data to analysis via browsers. The further illustrations of the individual entities are elaborated in the following sections.

Chapter 2 Background

2.1 Background

2.1.1 Monitoring System

To develop an effectively and efficiently monitoring system, this study use Time Domain Reflectometry (TDR) sensing technique. The system can measurable water level, rainfall amount, scour, displacement, dislocation deformation and suspended sediment concentration.

2.1.2 Time Domain Reflectometry (TDR) Overview

Time Domain Reflectometry (TDR) is based on electromagnetic wave detection method. It is basic principles similar to radar. It transmits down a short rise time pulse of energy to a cable. When that pulse reaches the end of the cable, or a fault along the cable, part or all of the pulse energy is reflected back towards the source. TDR remote sensing electrical measurement technique has been used for many years to determine the spatial location and nature of various objects [1, 2, 3, 8].

2.1.3 Data Acquisition (DAQ) Overview

Data acquisition [9] (DAQ) is the process of measuring an electrical or physical conditions and convert the result into measurable digital numeric values, e.g., temperature, pressure, or fluid flow. The components of data acquisition systems include: (1) Transducers/Sensors, convert a physical property into a corresponding electrical signal; (2) Signal Conditioning, filter the physical property guarantees the system safety; (3) Data Acquisition Hardware, an interface between the signal and the computer; (4) Data Acquisition Software, DAQ hardware work with the computer.

2.1.4 LabVIEW Overview

LabVIEW [5, 6, 7, 10] is a graphical programming environment to develop sophisticated measurement, test, and control systems using intuitive graphical icons, wires that resemble into an integrated system.

LabVIEW programs and subroutines are called virtual instruments (VIs). Each VI has three components: a front panel in figure 1.a, a block diagram in figure 2.b, and a connector panel in figure 3.c.a.

The front panel can serve as a programmatic interface. The block diagram is the source code behind the front panel. The connector is used to represent the sub-VI in the block diagrams for other VI calls in figure 3.c.b. The connector defines the inputs and outputs VI just like subroutine in figure 3.c.c. Thus a VI can either run as a program use the front panel be user interface or be a node put into other block diagram. Therefore, each VI can be easily tested and debugged before combined to a larger program.

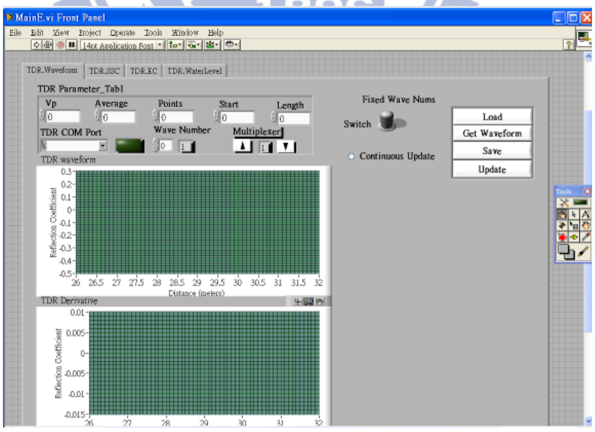


Figure 1.a: LabVIEW front panel

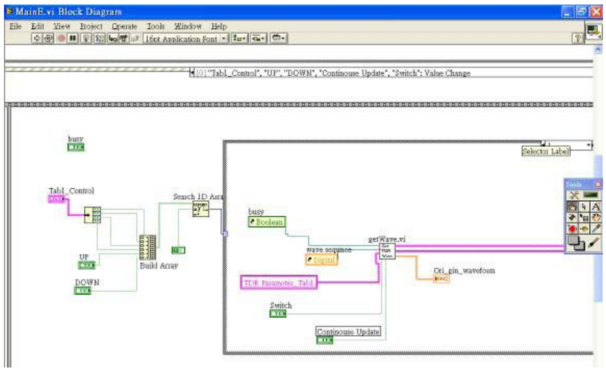
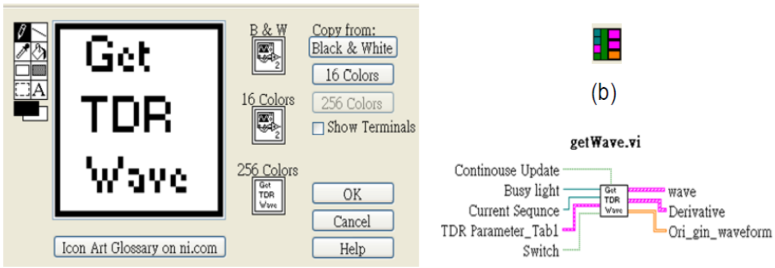


Figure 2.b: LabVIEW Block Diagram



(a) (c)

Figure 3.c.a: LabVIEW Connector diagram

;Figure 3.c.b: LabVIEW Connector in Block Diagram

Figure 3.c.c: LabVIEW Connector VI inputs and outputs

Chapter 3 Design Objectives & Requirements

The objective of this work is developing a scalable system which is called Data Center that collects and analyzes monitoring system transmitted data.

The three objectives of the system: (1) build a web-based Data Center system that provided real-time monitoring data and history information queries, analysis; (2) establish an automatic mechanism integrate monitoring system information to Data Center; (3) provide a convenient way to control every monitoring system.

Chapter 4 Design and Implementation

4.1 Overall architecture

The overall architecture of the Geo-nerve monitoring system is depicted in Figure 4. In the diagram, it encompasses three major components, i.e., the front-end module (Clients), the monitoring system, and the back-end services (Data Center) including database servers. The front-end module handles user interfaces via browsers. It establishes user sessions to provide services via Internet. The monitoring system has the aim to investigate the behavior of water content, detect its levels and temperatures, etc. In addition, it can interpret and analyze TDR (Time Domain Reflectometry) signals that associated with water quantitative, qualitative characteristics, e.g., suspended sediment concentration. The back-end module facilitates services and databases management. The architecture supports communication and connectivity via Internet as well as GPRS (General Packet Radio Service) mechanism. The data exchanged between the Monitoring System and the Data Center are ASCII formatted text files.

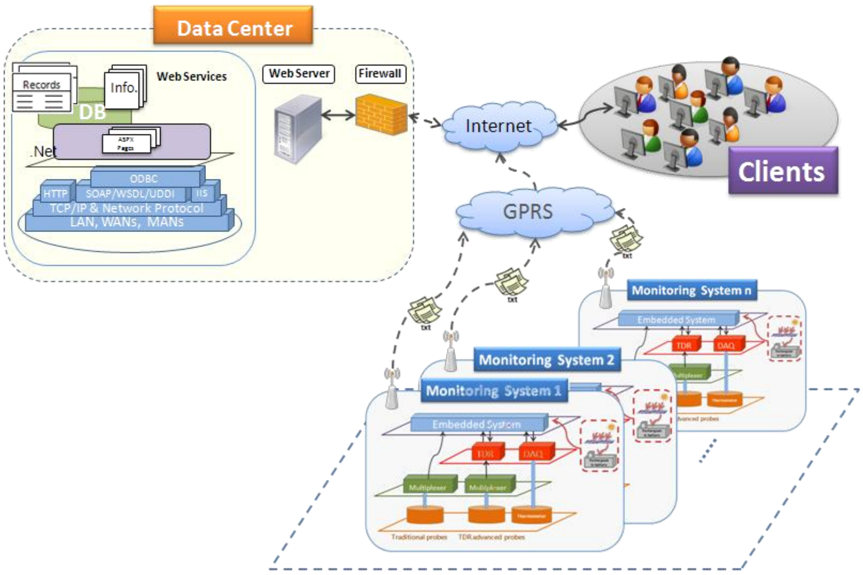


Figure 4: Geo-nerve Monitoring System overall architecture

In the architecture, for user friendly browsing interfaces, we adopt web based services. Further illustrations of the individual entities are elaborated in the following sections.

4.2 Preliminary research

4.2.1 Monitoring System overall architecture

The Monitoring System components and their decomposition relationships are depicted in Figure 5. It consists of Time Domain Reflectometry (TDR) and Data acquisition (DAQ) sensing instruments for automatic retrieving, transmitting water content, water characteristics, or electrical conductivity measurements via serial communication ports. The communication protocols implemented between the Monitoring System and the Data Center are wireless GPRS, Internet for data and alters delivery. In the Monitoring System, the Embedded System interconnects, controls the instruments for data probing, retrieving and telecommunication.

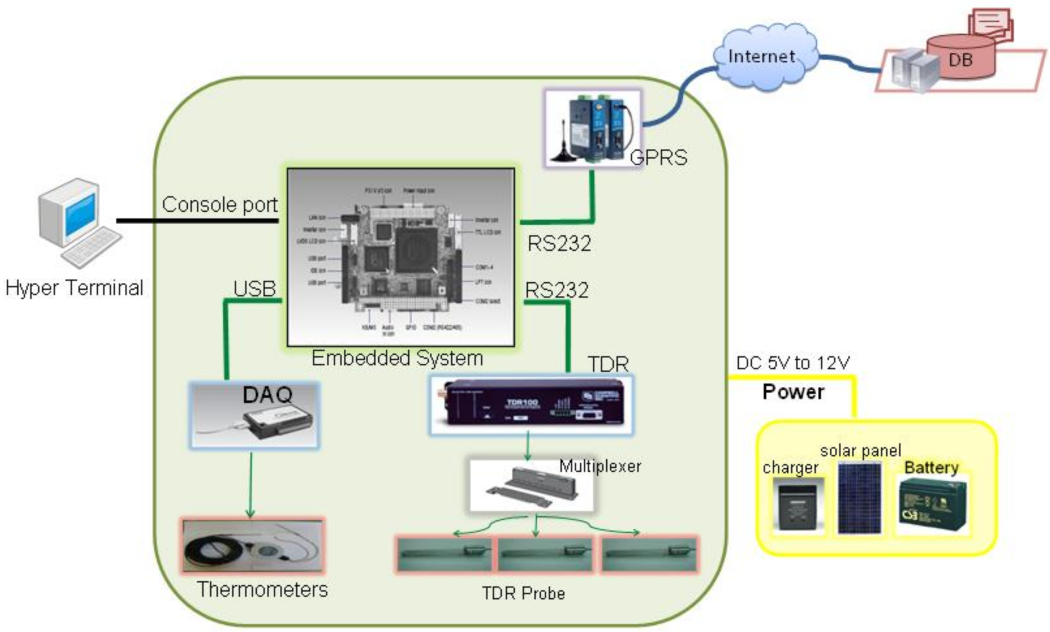


Figure 5: Monitoring System components

Moreover, the system is operated via the console port for functional parameter settings as well as configurations.

4.2.2 TDR component

The Monitoring System applies the TDR technique. It is a unique approach of pulsing several long coaxial probes, multiplexing (8 channels) and analyzing the reflected voltage signatures. In addition, it is capable of remotely acceding, controlling and electronically retrieving, transmitting data to the Embedded System via a RS232 connector (a serial communication port). Thus, the Embedded System controls the TDR operation, measurement sequence as well as waveform transformation and data results storage.

4.2.3 DAQ component

The Embedded System interfaces with the DAQ device, via a USB port, to monitor or sense the physical phenomena. Currently, the measurement is focused on "temperature" solely.

4.2.4 TDR LabVIEW components

The major segments of the TDR LabVIEW graphical programming are represented in Figure 6. In the diagram, the left hand side displays the Hyper Terminal console port parameter settings. They include baud rate, data bits, parity, stop bits, flow control, etc. The Writing Command inputs TDR parameters into VISA Write. The parameters will be entered into the write buffer which controls or interfaces to the TDR device. The outputs from the TDR device read from the interfaces specified by VISA Read and store in the Received buffer. The VISA Close will terminate the TDR device. The errors or status pass into the error out entity.

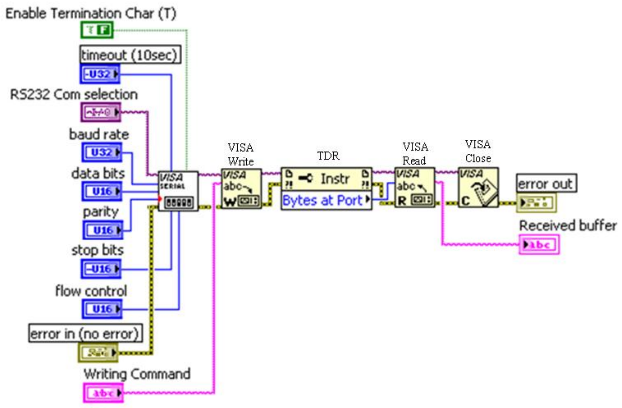


Figure 6 TDR LabVIEW representations

4.2.5 DAQ LabVIEW components

The major segments of the DAQ LabVIEW graphical programming are represented in Figure 7. The descriptions of the diagram can be illustrated similarly as in the previous section, e.g., Writing Command, VISA Write, VISA Read, VISA Close, Received buffer, etc.

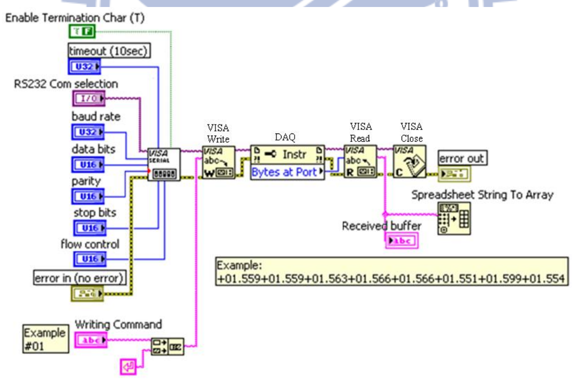


Figure 7 DAQ LabVIEW representations

4.2.6 Embedded component

The Embedded System provides user friendly graphical interfaces. Users can configure, access, and schedule probing devices, i.e., TDR & DAQ components, effectively and efficiently through customized manual selections implemented in Windows applications. Furthermore, the system retrieves, logs, and calculates input signal sequences from TDR and DAQ devices respectively. Afterwards, the system stores and transforms the signal measurements into digitized data. The system is controlled by a console port via HyperTerminal interfaces.

In general, the TDR device contains the pulse generator for the signal applied to a TDR probe. The Embedded System digitizes the reflections and applies numerical algorithms for measuring volumetric water content or electrical conductivity. The system displays, presents the digitized elements into reflection waveform values as well. The waveforms can be collected, converted by the Embedded System into ASCII formatted text files, later transmitted them via Wireless GPRS to the Data Center.

Similarly, the DAQ device is controlled, configured, and accessed by the Embedded System as well.

4.2.7 Monitoring System Data Schemes

The suspended sediment concentration and water level output data schemes generated by the Embedded System are comprehended explicitly in the following sections.

4.2.7.1 Suspended Sediment Concentration (SSC)

After transformed the collected waveforms calibrated by the associated local temperatures, the analyzed SSC sensing results, per line basis in ASCII formats, are obtained and presented clearly in Figure 8a. In the diagram, each line indicates the following parameter settings: 1) measurement collecting time & date, e.g.,1/1/2008 at 1:00 am; 2) TDR multiplexer number, configuring multiplexer switching, e.g., 100 as defined; 3) TDR function, e.g., TDR SSC; 4) User Defined Functionalities, e.g., SSC No1; 5) Waveform Start value, e.g., a Waveform Start value of 10 m will provide the complete data needed by the probe length; 6) Waveform Length, the algorithm will use the length of the waveform set by the Waveform Length, e.g., 20 m; Start and Length parameters to display relevant portion of reflected signals; 7) Temperature, average temperature TDR waveform measurements, e.g., 21.1 ℃; 8) Temperature Standard Deviation, e.g., σ = 0.08 ℃; 9) Suspended Sediment Concentration, e.g.,1000 mg/L; 10) SSC Standard Deviation, e.g., σ = 500 mg/L.

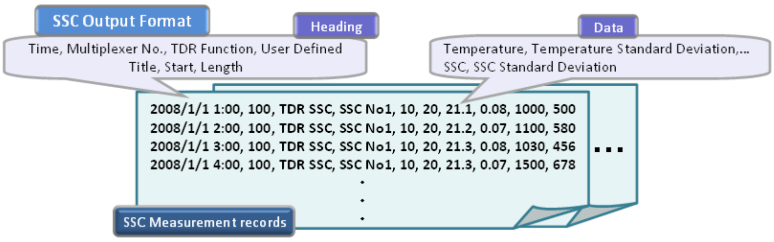


Figure 8a SSC output receipt

4.2.7.2 Water Level

Similarly, the analyzed Water Level sensing results, per line basis in ASCII formats, are obtained and presented clearly in Figure 8b. In the diagram, each line indicates the following parameter settings: 1) measurement recording time & date, e.g.,1/1/2008 at 1:00 am; 2) TDR multiplexer number, configuring multiplexer switching, e.g., 100 as defined; 3) TDR function, e.g., TDR Water level; 4) User Defined Title, e.g., WL No1; 5) Waveform Start value, e.g., a Waveform Start value of 10 m will provide the complete data needed by the probe length; 6) Waveform Length, the algorithm will utilize the length of the waveform set by the Waveform Length, e.g., 20 m; Start and Length parameters to display relevant portion of reflected signals; 7) Water Level, e.g., 0.11 m; 8) Water Level (by elevation), Water Level fluctuation indicated as 7) pluses the absolute height of Water elevation, e.g., 121.0 m as defined.

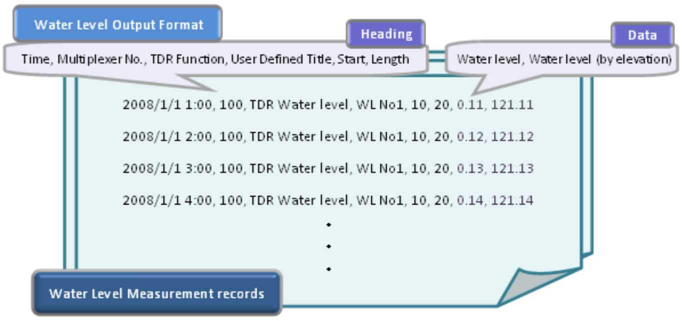


Figure 8b water level output receipt

4.3 Data Center Overall architecture

The overall architecture of Data Center System is illustrated in Figure 9. There are eleven main modules in the architecture: Station Management Module, Period Management Module, Text Files Path Module, Parsing Text Files Module, Backup Module, Display Real-time Data Module, Monitoring Data Query Module, Monitoring Data Export Module, Drawing Line Chart Module, Manual Input Data Module and Remote Control Monitor System Module.

In the diagram, the embedded system transmitted ASCII formatted text files via Wireless GPRS to the Data Center. The monitoring system classifies and appends text files data by each station. Users use Station Management Module add station, Period Management Module setting station period time, Text Files Path Module setting destination path and backup path. After setting station information, the multi-thread program (running in background) automate use Parsing Text Files Module parsing station text files and store data to database during each station period time. After saving parsing data, the program use Backup Module to backup text files to backup path. Next, the user can obtain real-time monitoring data, query and export history information, illustrate line chart diagram, manual input monitoring data and remote control monitor system via browsers. Here, Display Real-time Data Module shows every station real-time data after retrieving monitoring system, Monitoring Data

Query Module executes query operation, Monitoring Data Export Module export history monitoring data, Drawing Line Chart Module translates monitoring data into line chart diagram, Manual Input Data Module implements input monitoring data by hand and Remote Control Monitor System Module setting monitoring system parameter that can influence TDR & DAQ parameters, threshold parameters, scheduling parameters and backup text files path. They will be discussed in detail in the following.

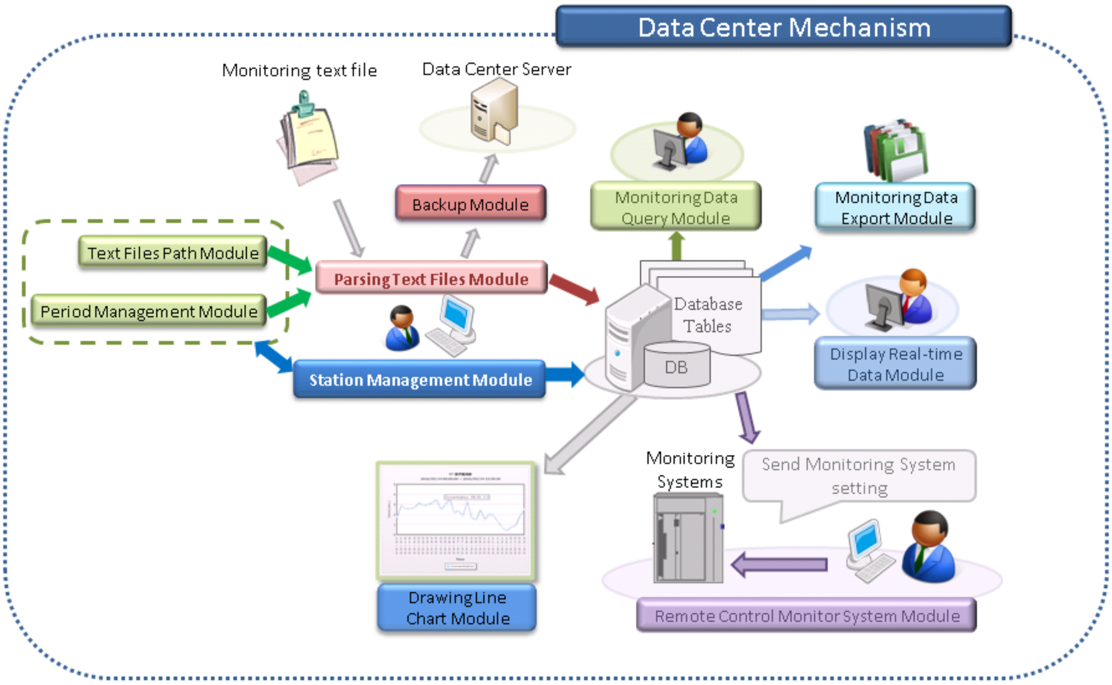


Figure 9: Data Center System Overall Architecture.

4.3.1 Station Management Module

The module is the main program user interface. The interface can be separated into three blocks. The upper block provide user station operation, it has new, edit and delete station operations. The middle block display station information including station name, period time, destination path and backup path. The lower one provides user editing station information area.

When users want to add station, they need first click “New” button and the station information editing area change un-editable field to editable field. After user fill station information, user able to press “Save” button to save station information. When user saved station information, the module will connect to Period Management Module setting station period time, Text Files Path Module save destination and backup path to database, it depends on period time periodical trigger Parsing Text Files Module parsing text files and Backup Module backup text files. Figure 10 displays the concept diagram of the module.

Similarly, the users want to edit station information, they press “Edit” button to change editing area to editable filed. After users change station information, users press “Save” button to save changed data to database. If users change station period time, the module is able to trigger Period Management Module change the station period time and update the regular time trigger Parsing Text Files Module parsing text files. The detail of the Period Management Module, Text Files Path Module and Parsing Text Files Module will be discussed in next several sections. Figure 11 shows the implementation result of the module.

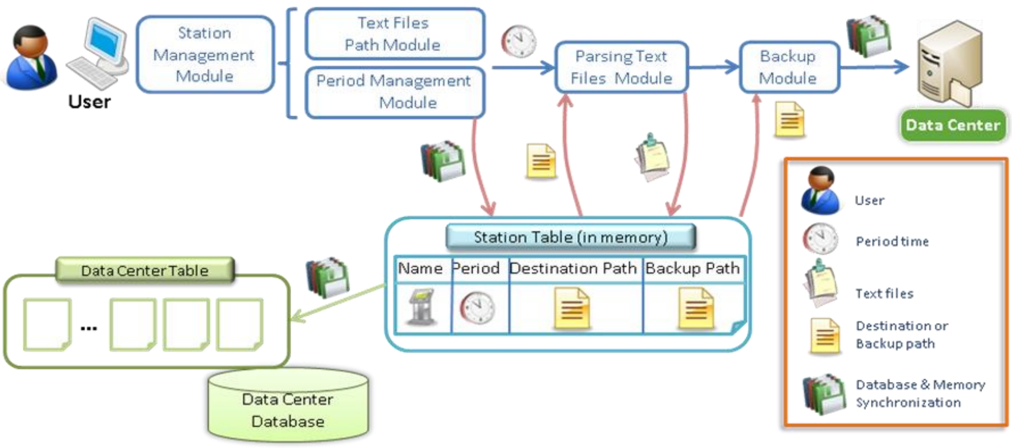


Figure 10: the concept of the module

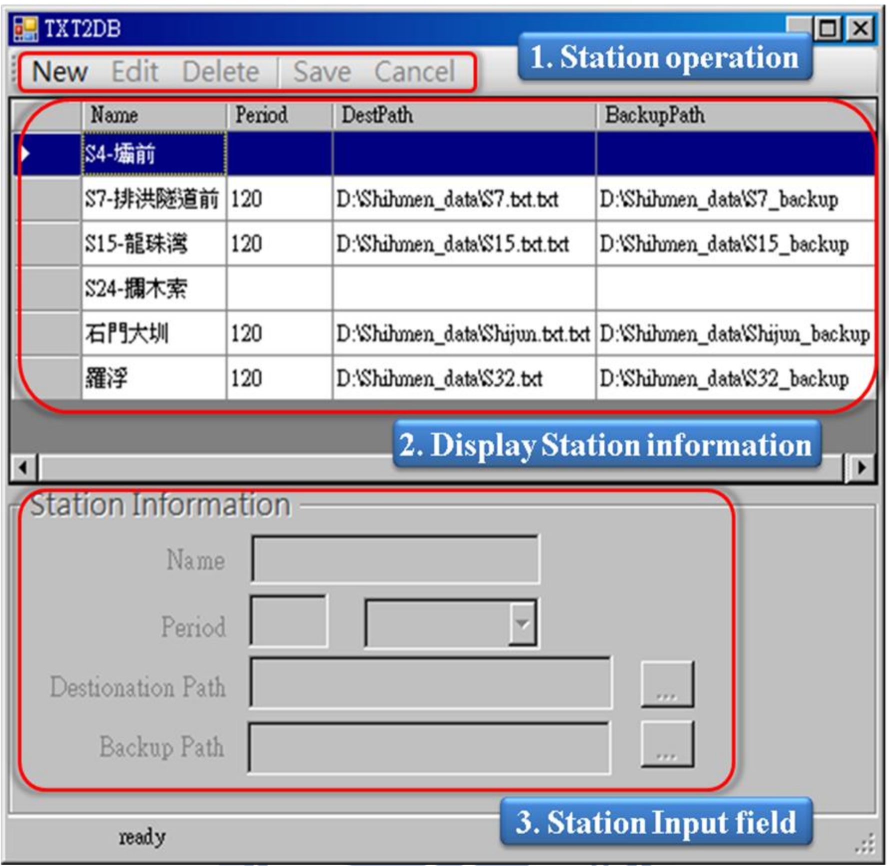


Figure 11: Station Management Module.

4.3.2 Period Management Module

The main purpose of the module provides timers to set every station period time. Because every monitor system has different scheduling time collect monitoring data, the module provide timers for every station. The user interface has two parts: one is an input column provide user typing numeric values, another one is a dropdown menu, it displays four types: Seconds, Minutes, Hours and Days. When user enters period value and select period type, the module auto translates value into milliseconds. Next, the module according to period time multi-thread trigger Parsing Text Files Module parsing text file. Figure 12 shows the implementation result of the module.

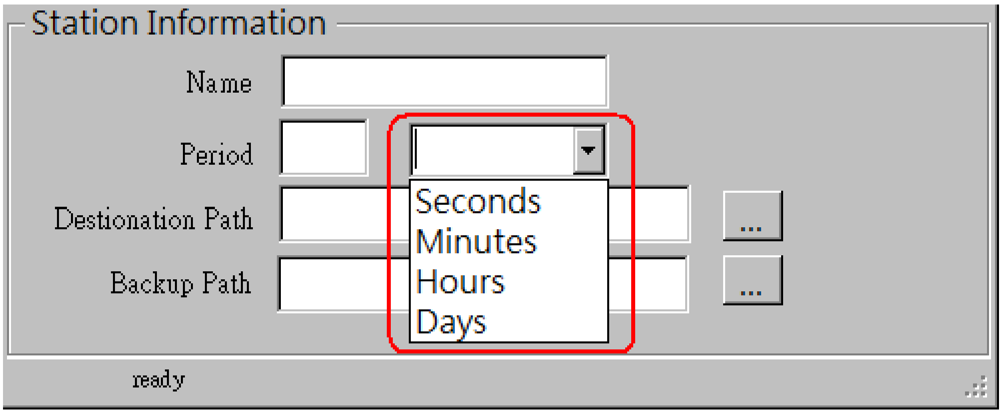


Figure 12: Period Management Module user interface

4.3.3 Text Files Path Module

The main purpose of the module is save destination and backup path. User can select destination file name, the module check the file exists or not. The module provides fault tolerance methods if windows system hides extension file type, the module append extension file type and check again. User can select backup folder and the module provide create new folder. After user select destination and backup path, it will be saved in database. It provides Parsing Text Files Module the source of the text files and Backup Module the backup folder. When the program uses destination and backup path, it checks the file or the folder existence every time. If the text file does not exist the program will skip this station parsing text files and backup text files. Figure 13 shows the destination path user interface. Figure 14 shows the backup path user interface.

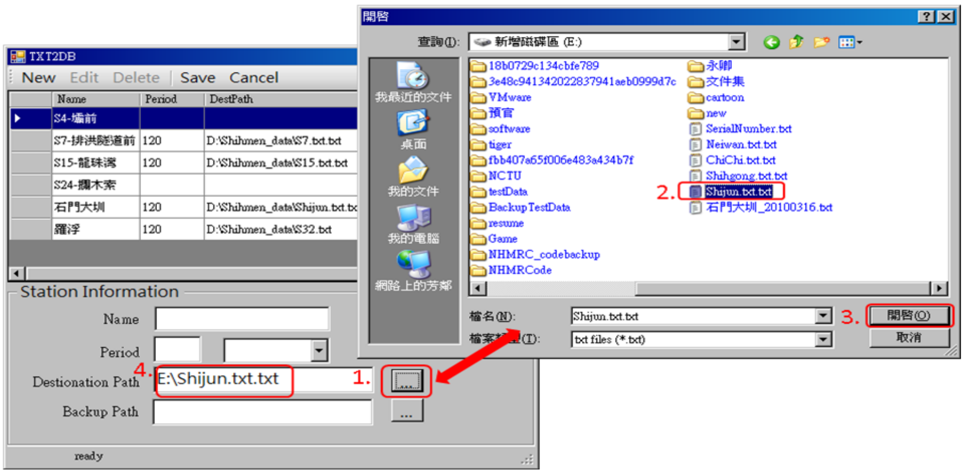


Figure 13: Destination Path user interface

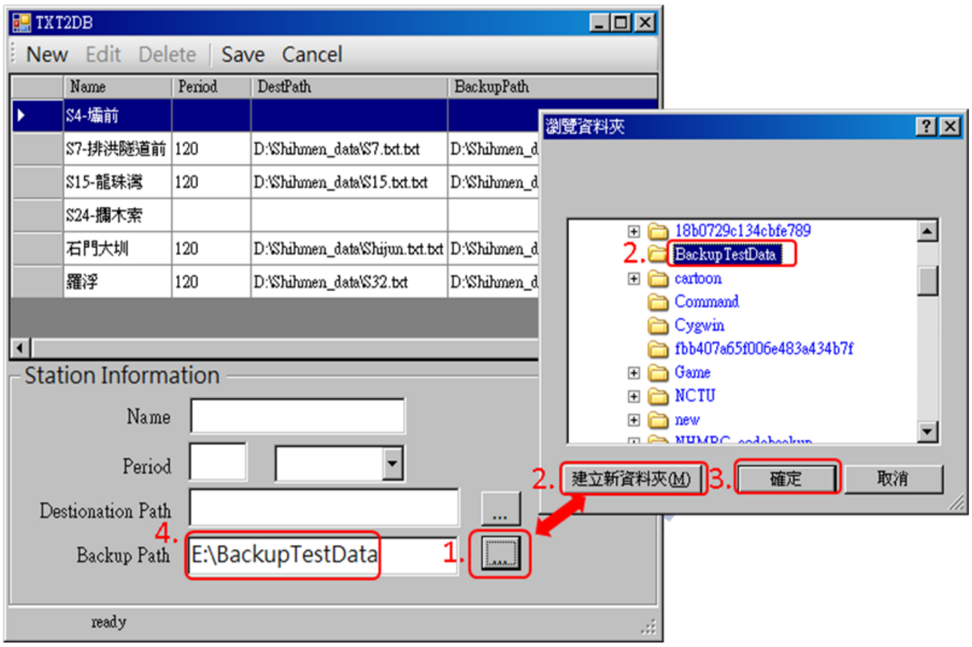


Figure 14: Backup Path user interface

4.3.4 Parsing Text Files Module

The main purpose of the module is parsing text files and save text data to database. After user saving station information data, the Period Management Module periodical trigger the module parsing text files. The text files format is describe in 4.2.7.1 and 4.2.7.2 sections. The module parses the text file and stores data to database line by line. It gets the fourth parameter “User Defined Title”, it means the probe name, and check the name column in the database probe table. If the probe table cannot find the name, the module inserts a new probe. Next, the module checks the third parameter “TDR function”. The concept is depicted in Figure 15. Because the monitor system provides many functions, every function has its parameter and its database table. After the module finds TDR function, it will insert the data to the function table. In addition to parsing the text file, the module also saves the data in memory line by line. The detail diagram of the database concept is depicted in Figure 16. When the module finished parsing text file, the module invokes Backup Module saving data to backup path.

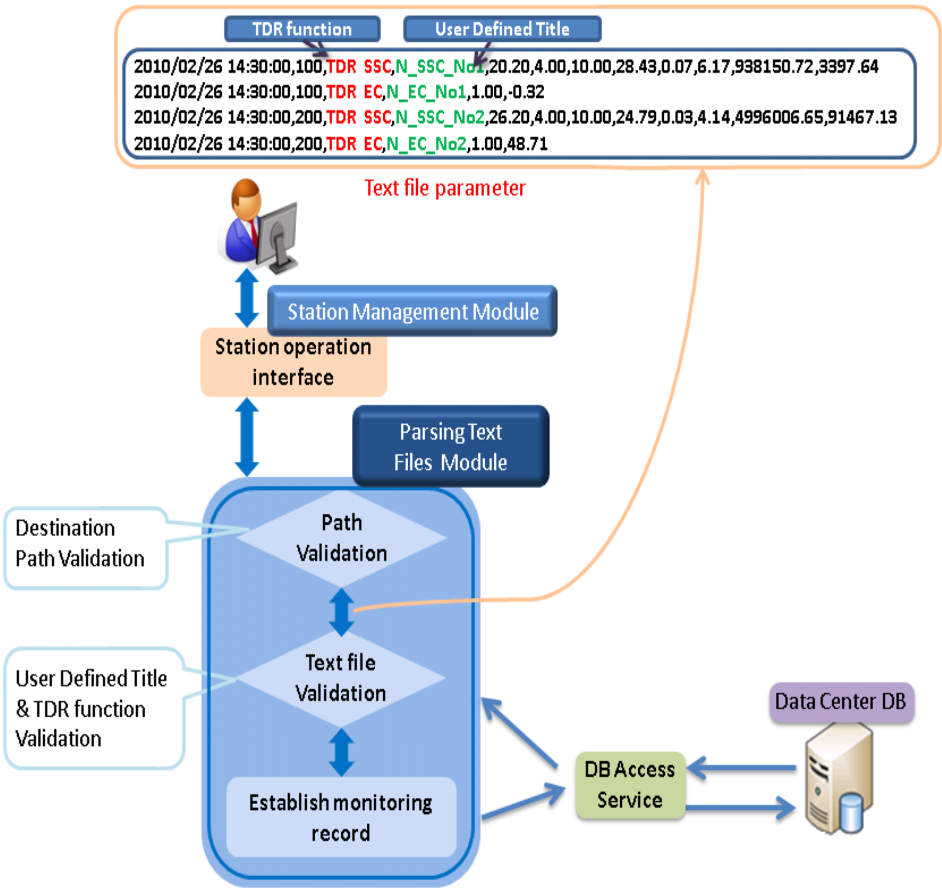


Figure 15: The concept of Parsing Text Files Module

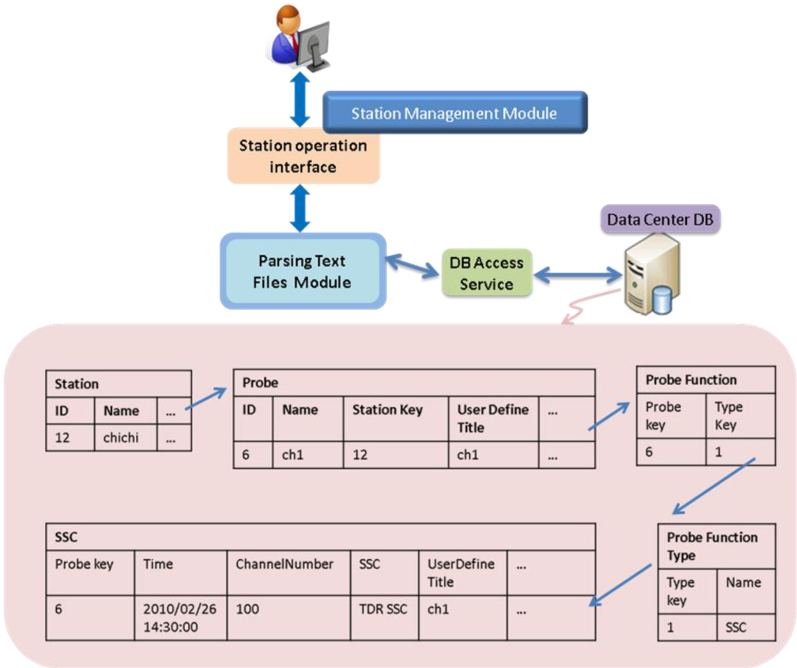


Figure 16: the database concept of Parsing Text Files Module

4.3.5 Backup Module

The main purpose of the module is backup text file after parsing text file. User use Text Files Path Module save backup folder to the database. The module gets the backup folder from database and verifies the backup folder. If the module doesn't find the folder, it creates the folder to save backup file. Figure 17 is the concept of the module. When the module backup file, it appends to pervious save text file and separate by days. In order to distinguish different date and station of the backup file, the module provides a mechanism to save backup file. In this module the backup file name distinguish different station name and date. The backup file name for example, chichi_20100520.txt and chichi_20100521.txt. The backup files show in Figure 18.

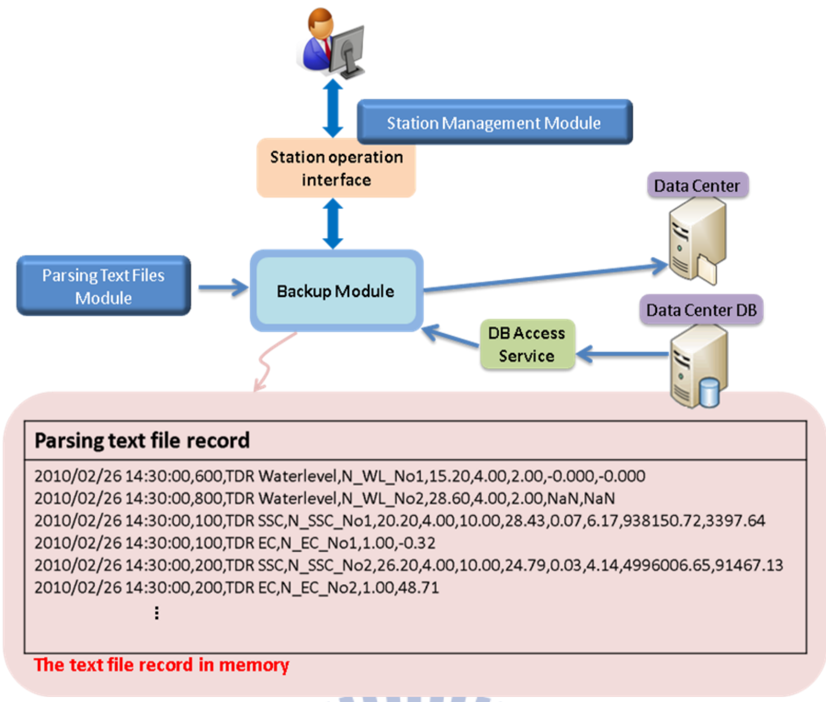


Figure 17: the concept of Backup Module

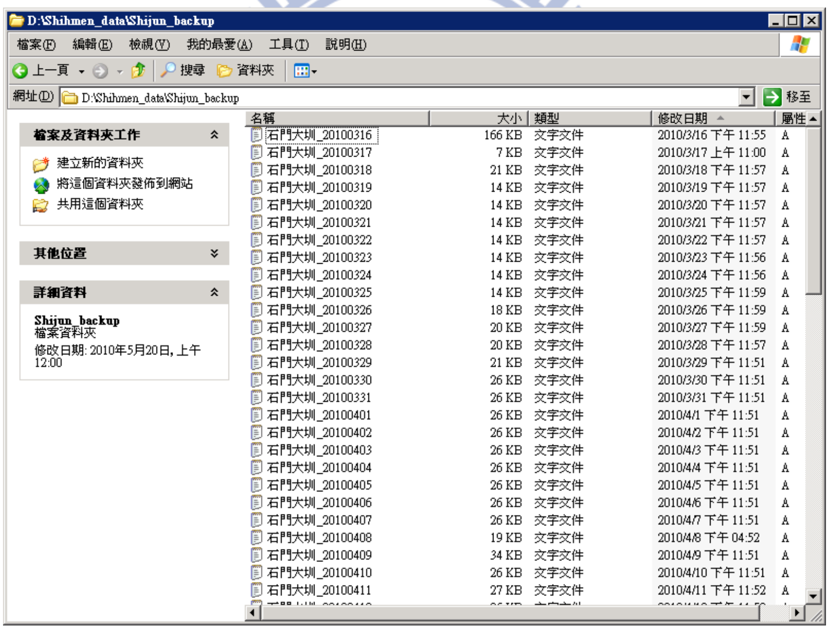


Figure 18: the backup files diagram

4.3.6 Display Real-time Data Module

The main purpose of the module provides interface to display real-time data via browsers. The interface has two parts. One part shows every stations and probes real-time monitor information the figure is depicted in Figure 19. In Figure 19, it divided three blocks. The upper block shows the latest update time. When the Parsing Text Files Module parsing the text files and store to database. The Display Real-time

Data Module get the latest time. The middle block shows real-time monitor data. The website establishes the user sessions as well as provides services to validate users' authentications, authorizations. Therefore, guest can only see following parameter: 1) Temperature, average temperature TDR waveform measurements, e.g., 21.1 ℃; 2) Suspended Sediment Concentration, e.g.,1000 mg/L; 3) Conductivity, e.g., 319.17 us/cm; user and admin show in Figure x can see more than guest monitor system parameter : 1)Voltage, monitor system battery voltage,e.g.,12v; 2) Temperature, average temperature TDR waveform measurements, e.g., 21.1 ℃; 3) Temperature Standard Deviation, e.g., σ = 0.08 ℃; 4) Suspended Sediment Concentration, e.g.,1000 mg/L; 5) Suspended Sediment Concentration Standard Deviation, e.g., σ = 500 mg/L; 6) Conductivity, e.g., 319.17 us/cm; 7) T2, the electromagnetic waves generate wave change range in TDR Sensing Waveguide, e.g., 7.5 ns. The lower one provides latest update time every five minutes.

Another part provides user select specific station and shows the station all probes real-time monitor information the figure is depicted in Figure 20. In Figure 20, user can initiate select the station and following shows the station real-time information. In Figure 21, it divided three blocks. The upper block shows the latest update time. The middle block shows real-time monitor data as well as previous description. The lower one provides latest update time every five minutes.

In order to obtain real-time data effectively and efficiently, the database establish an automatic mechanism and the concept is indicated in Figure 22. The database create hot table to save every station the latest monitor station data. In Parsing Text Files Module parses the text file and save to database. After the Parsing Text Files Module insert the data to database, the database automate trigger a procedure that is called "Trigger" to save the latest data to hot table. When Display Real-time Data Module wants to display the newest data to user, the module selects the hot table to show the latest data.

Figure 19: the user interface of Display Real-time Data Module

Figure 20: the authentication user display user interface

Figure 21: specific station user interface

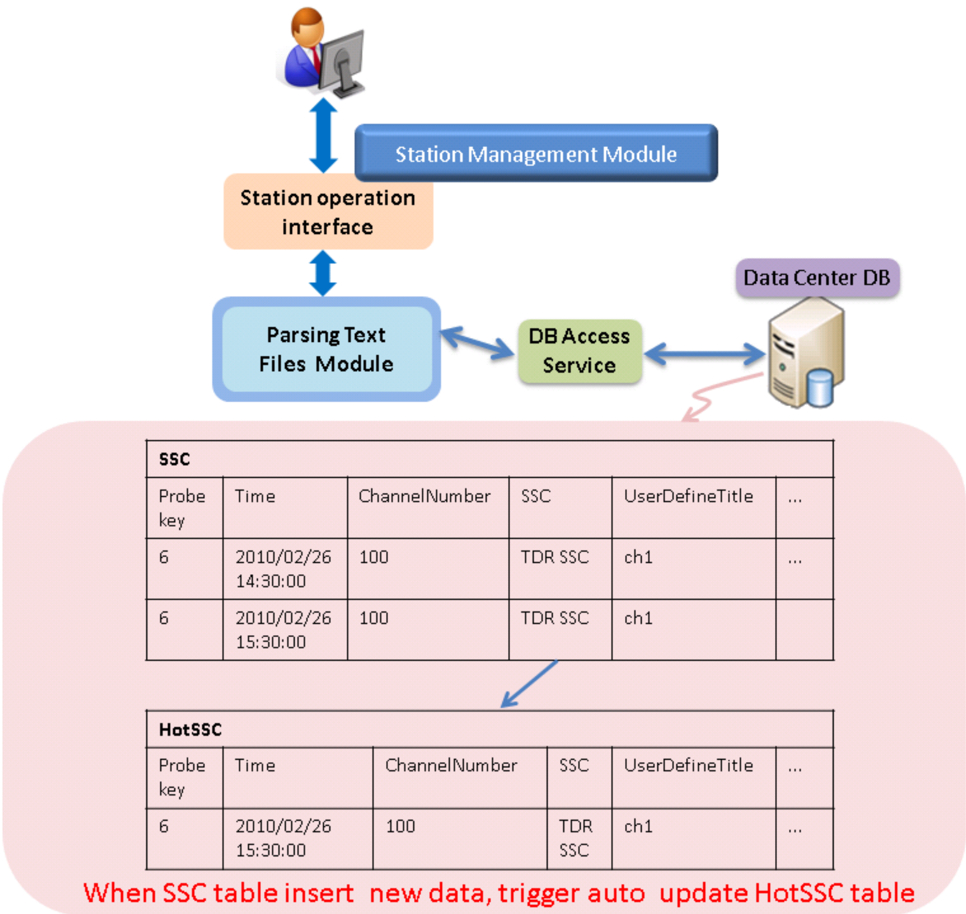


Figure 22: the trigger concept of the database table

4.3.7 Monitoring Data Query Module

The main purpose of the module provides user interface to query history monitor information. The interface can be separated into two blocks. The function of upper block provides user select query parameter and date, and lower one display the query data.

When user click the "@" button form Display Real-time Data Module the parameter can be delivered direct by the standard HTML GET method, i.e., ASP.NET QueryString scheme to Monitoring Data Query Module. The operation procedure is illustrated in Figure 23. In Figure 23, the diagram divide two parts, one part is setting station parameter, such as: station name, e.g., S7, probe name, e.g., ch1, function name, e.g., SSC, factor name, e.g., Concentration, the start date and the end date. Another part is show Time and factor value. If user clicks "@" from Display Real-time Data Module the start date and the end date are set today by default. If any dropdown menu didn't select, the module will alert warning message. After user press the query button, the module query database and output Time and factor value. Next, the module triggers Drawing Line Chart Module drawing line chart, the module will be discussed in next section. When user clicks "@" from Manual Input Data Module, the module will query data from different database table and display different user interface as shown in Figure 24.

Figure 23: the operation procedure of Monitoring Data Query Module from Display Real-time Data Module

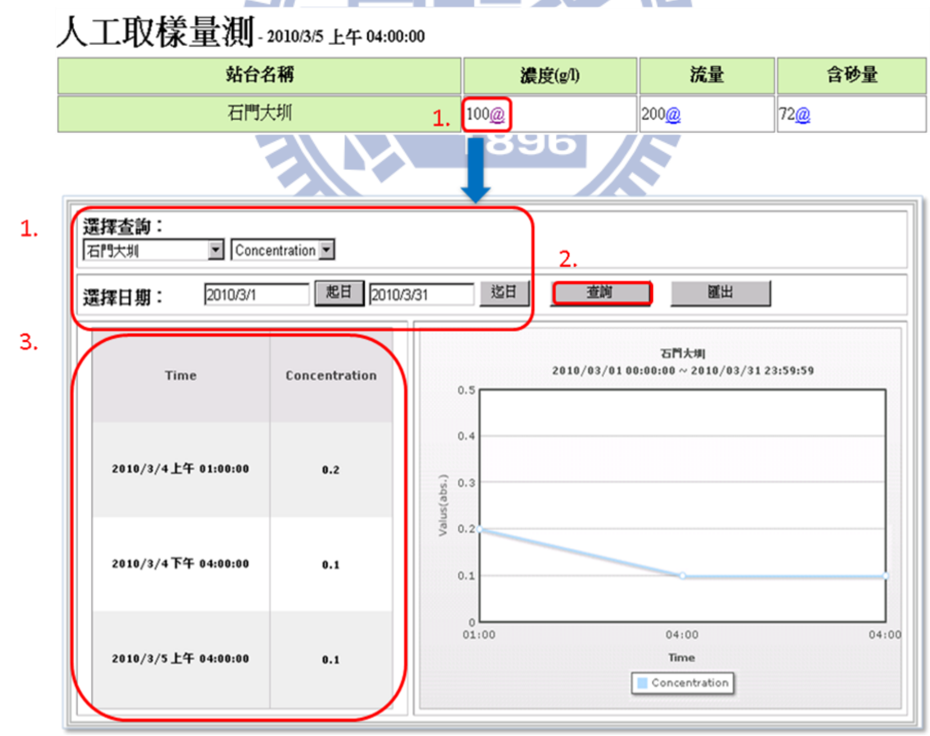


Figure 24: the operation procedure of Monitoring Data Query Module from Manual Input Data Module

4.3.8 Drawing Line Chart Module

The main purpose of the module provides user visualize tool to display query history monitor information. After user query the history monitor data form Monitoring Data Query Module, the Monitoring Data Query Module will integrate query data to XML and transmit to Drawing Line Chart Module. Next, the module retrieve the XML data and draw line chart as shown in Figure x. In the figure 25, the diagram divided three parts, the upper part shows the station name, the start time and the end time. The middle part shows the line chart. In the line chart, the x-axis displays time and the y-axis displays the factor values. When user move mouse to every point above the diagram, it shows detail information, the factor name, time and the factor value, for examples, Concentration, 08:00, 3.3. The lower one shows the factor name, such as: Concentration.

Figure 25: the user interface of Drawing Line Chart Module

4.3.9 Monitoring Data Export Module

The main purpose of the module provides user output monitor data to excel. The module has two kinds of export mode. One is for user export specific factor value, another one is for admin export the file more information. It can export the station every probe, function and factor data. In the user export user use Monitoring Data Query Module select station parameter, start date and end date, and press “export” button, the module use Monitoring Data Query Module query data and export excel file as indicated in Figure 26. The export file format has two parameters: 1) Time, e.g., 2010/5/29 12:00; 2) user select factor parameter, e.g., Concentration, 1.9 mg/L. The admin export user only need select station name parameter, other dropdown menus are not necessary to be selected. Later, user select start date and end date, the module provides more dynamic export monitoring system data. The export excel file is depicted in Figure 27. In Figure 27, user can export more information such as, every probe, function and factor values.

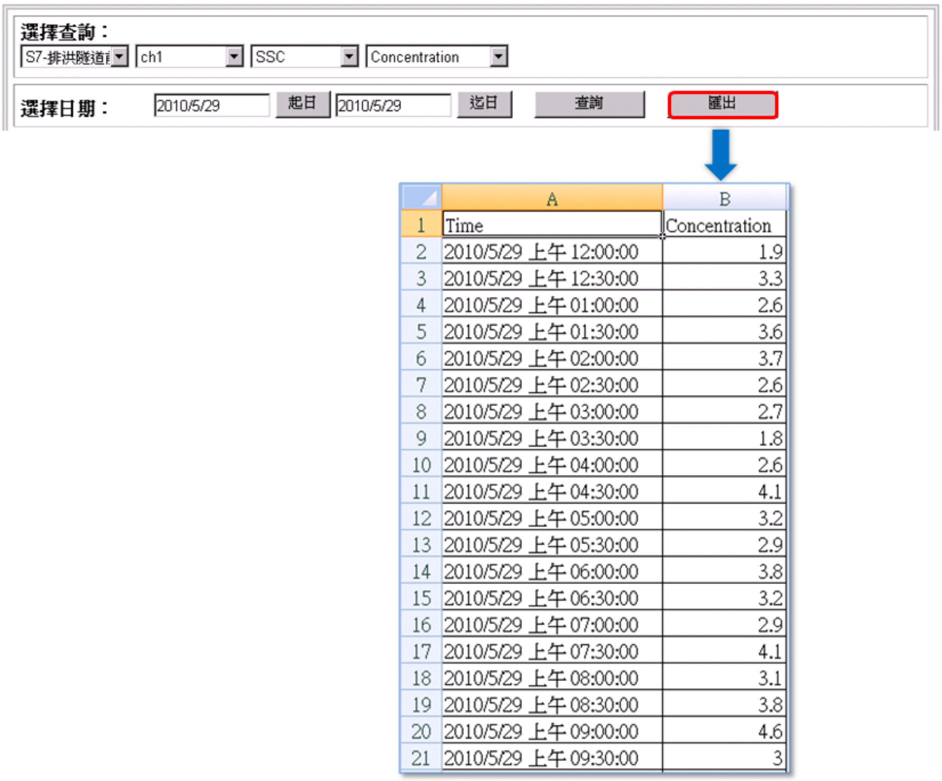
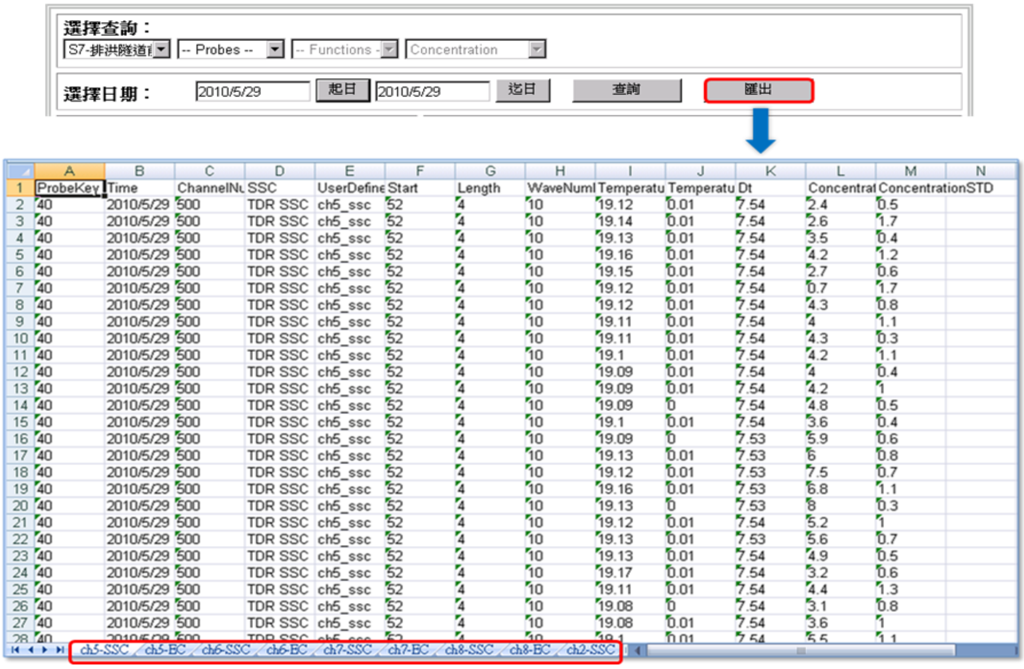


Figure 26: the user export user interface



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	ProbeKey	Time	ChannelNu	SSC	UserDefine	Start	Length	WaveNuml	Temperatu	Temperatu	Dt	Concentrat	ConcentrationSTD	
2	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.12	0.01	7.54	2.4	0.5	
3	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.14	0.01	7.54	2.6	1.7	
4	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.13	0.01	7.54	3.5	0.4	
5	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.16	0.01	7.54	4.2	1.2	
6	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.15	0.01	7.54	2.7	0.6	
7	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.12	0.01	7.54	0.7	1.7	
8	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.12	0.01	7.54	4.3	0.8	
9	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.11	0.01	7.54	4	1.1	
10	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.11	0.01	7.54	4.3	0.3	
11	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.1	0.01	7.54	4.2	1.1	
12	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.09	0.01	7.54	4	0.4	
13	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.09	0.01	7.54	4.2	1	
14	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.09	0	7.54	4.8	0.5	
15	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.1	0.01	7.54	3.6	0.4	
16	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.09	0	7.53	5.9	0.6	
17	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.13	0.01	7.53	6	0.8	
18	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.12	0.01	7.53	7.5	0.7	
19	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.16	0.01	7.53	6.8	1.1	
20	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.13	0	7.53	8	0.3	
21	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.12	0.01	7.54	5.2	1	
22	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.13	0.01	7.53	5.6	0.7	
23	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.13	0.01	7.54	4.9	0.5	
24	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.17	0.01	7.54	3.2	0.6	
25	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.11	0.01	7.54	4.4	1.3	
26	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.08	0	7.54	3.1	0.8	
27	40	2010/5/29	500	TDR SSC	ch5_ssc	52	4	10	19.08	0.01	7.54	3.6	1	

Figure 27: the admin export user interface

4.3.10 Manual Input Data Module

The main purpose of the module provides user input monitor data by manual. There are two parts of the modules; one provide user manual input user interface; another is display user input.

When user wants to manual input monitor data as shown in figure x, they need first authentication. After user authentication, user can select station location. Then, user can setting monitor date and time, user press “select” it will pop out AJAX (Asynchronous JavaScript and XML) calendar. When user selects a date, the calendar will automate close and setting the date without refresh the page. Next, user can select time and input concentration or flow. If user only input concentration or flow, the module allows user input only one value and press “Summit”. After the module inserts user input data to database, the database automate trigger a procedure to save the latest data to hot table. When the module displays user input as shown in Figure 28, the module will select the hot table to display the latest data. The concept is depicted in Figure 29.

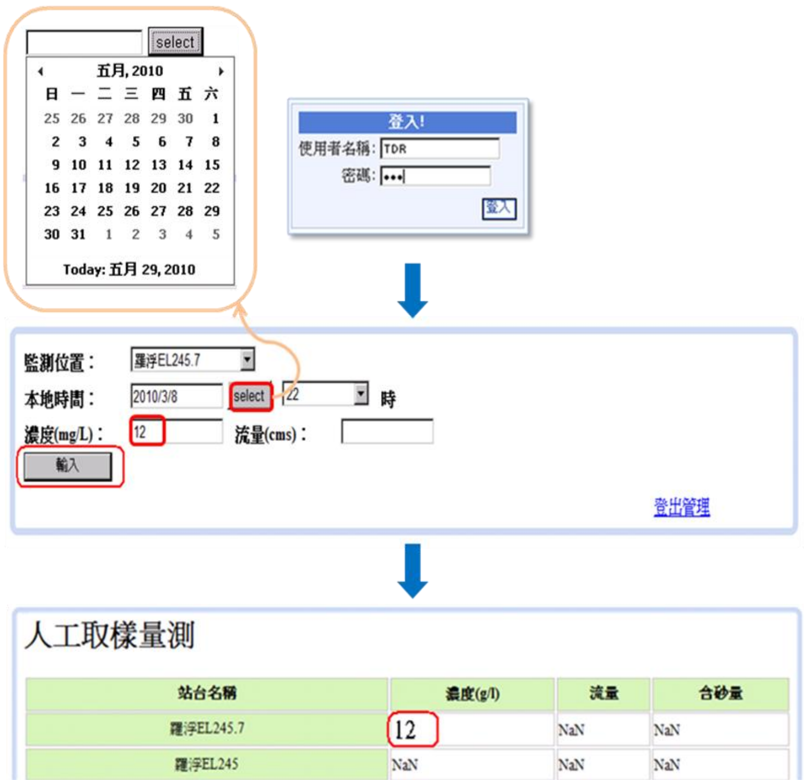


Figure 28: the operation procedure of Manual Input Data Module

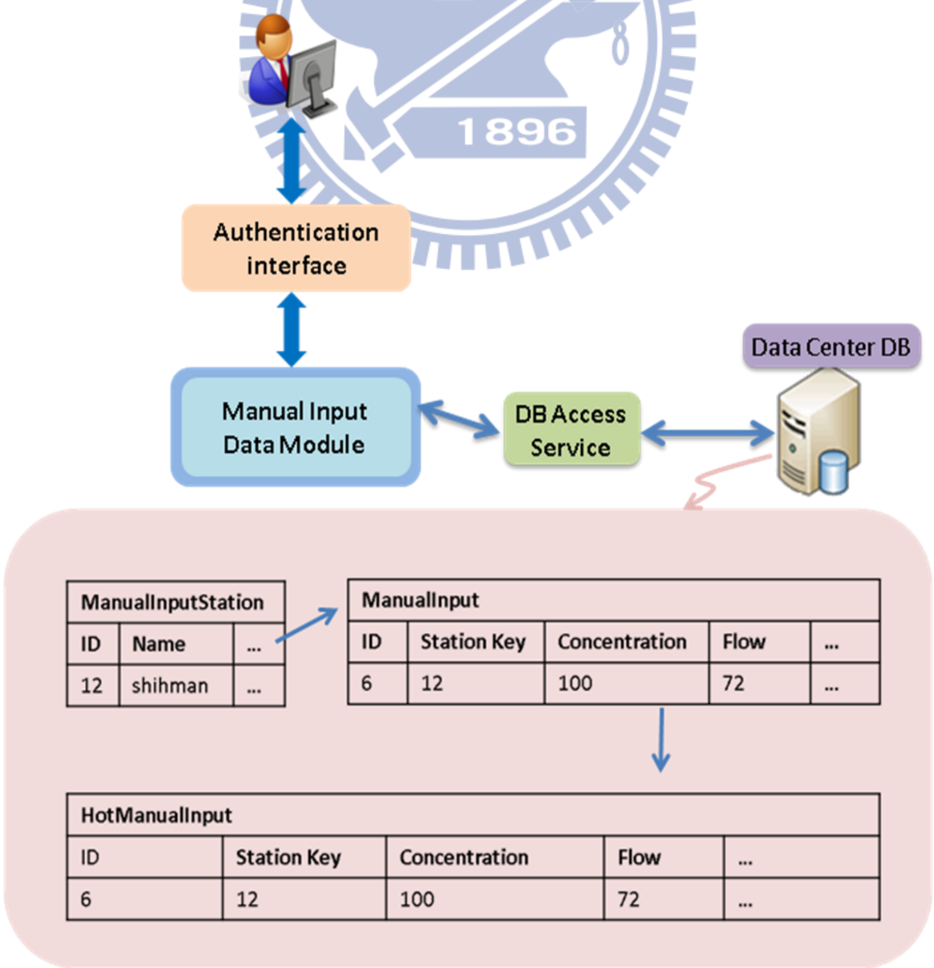


Figure 29: the concept of Manual Input Data Module

4.3.11 Remote Control Monitor System Module

The main purpose of the module provides user remote control monitoring system. There are two approaches to measure and collect monitor data, i.e., interactively or automatically. In this section we discuss SSC parameter, the other parameter is the same as SSC parameter. The interactive one, as indicated in Figure 30.a, initially we need to either setup temperature parameters manually or obtain the values from DAQ automatically. The temperature values will be utilized while measuring SSC and TDR waveforms calibration. After enter additional parameters in the diagram, as illustrated in section 4.2.7.1, the waveforms can be obtained via the TDR device. Later, the Embedded System calculates and transforms the waveforms into SSC displayed in the diagram. Similarly, the automate interface is depicted in Figure 30.b. Users can initiate the TDR server application remotely by selecting "Open Station Setting" and following the instructions as indicated at the top of the diagram. After entering acquisition, processing, threshold, as well as scheduling parameters, the SSC outputs can be generated in an ASCII formatted text file as described in Figure x.

The sequence diagram of the scenario is clearly depicted in Figure 30.c. In the diagram, at beginning, the TDR and probe acquisition parameters entered at console via Embedded System. The scheduling, threshold and backup settings are inputted as well. After configured the TDR device, the device acquires the probe to collect data according to the scheduling. If any threshold reaches, the SMS (Short Message Service) will be generated and delivered the alerts to a cell phone by GPRS. The Embedded System retrieves and transforms TDR waveform outputs into ASCII formatted data and delivers them to Clients by Internet.

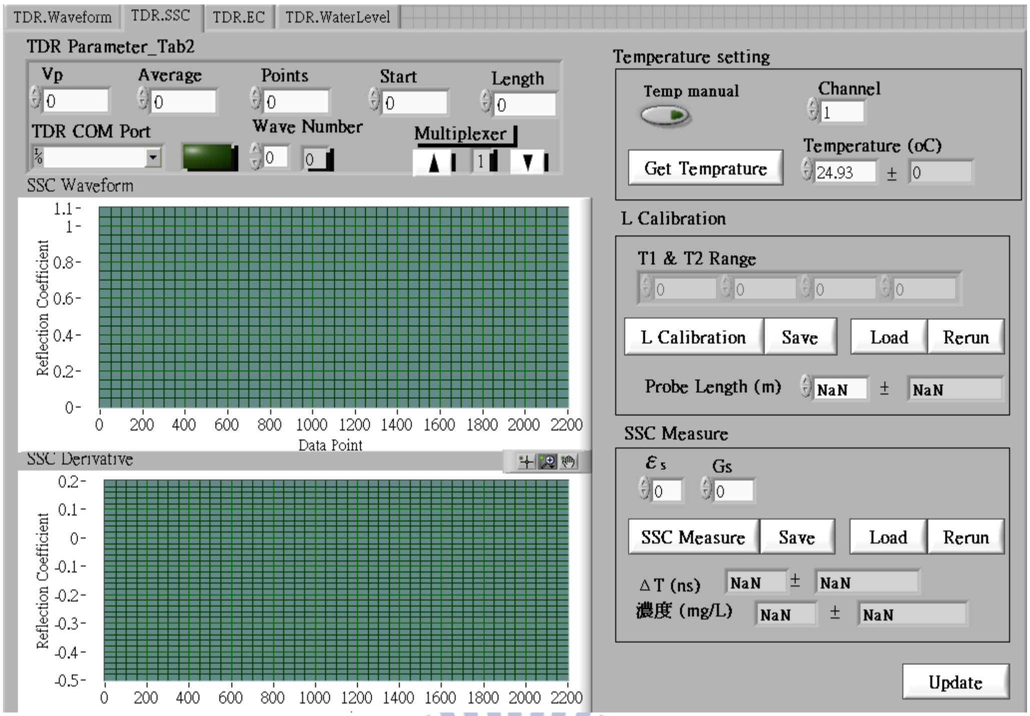


Figure 30.a SSC scenarios interactive approach

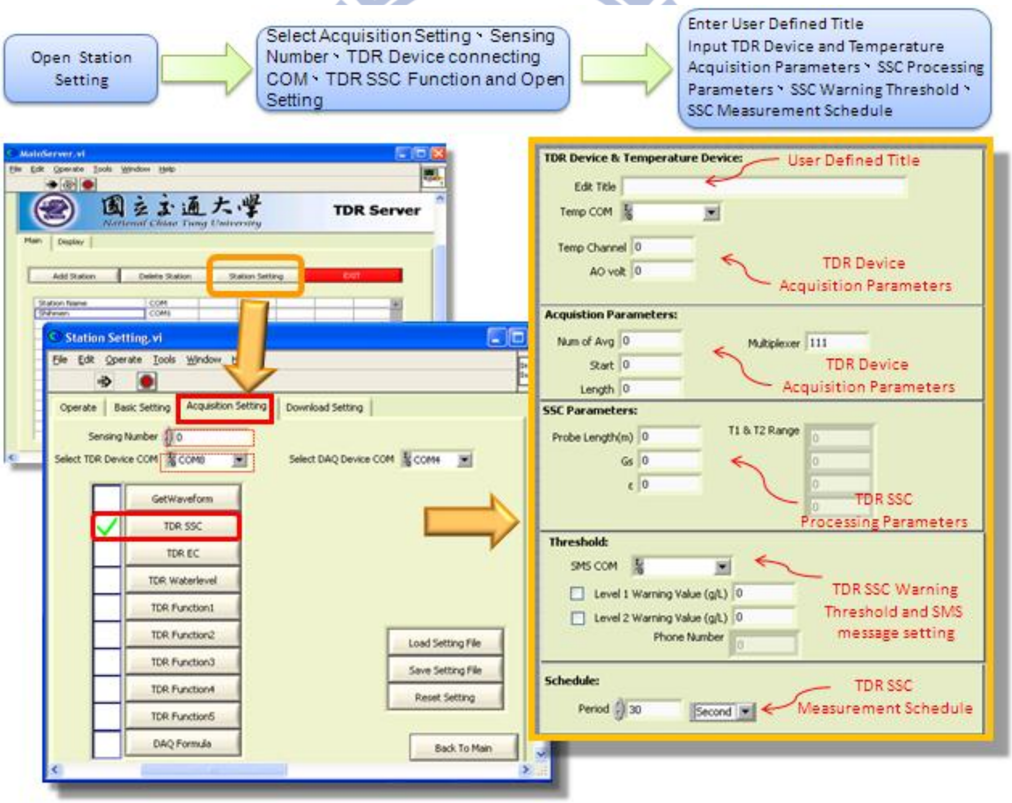


Figure 30.b SSC scenarios automatic approach

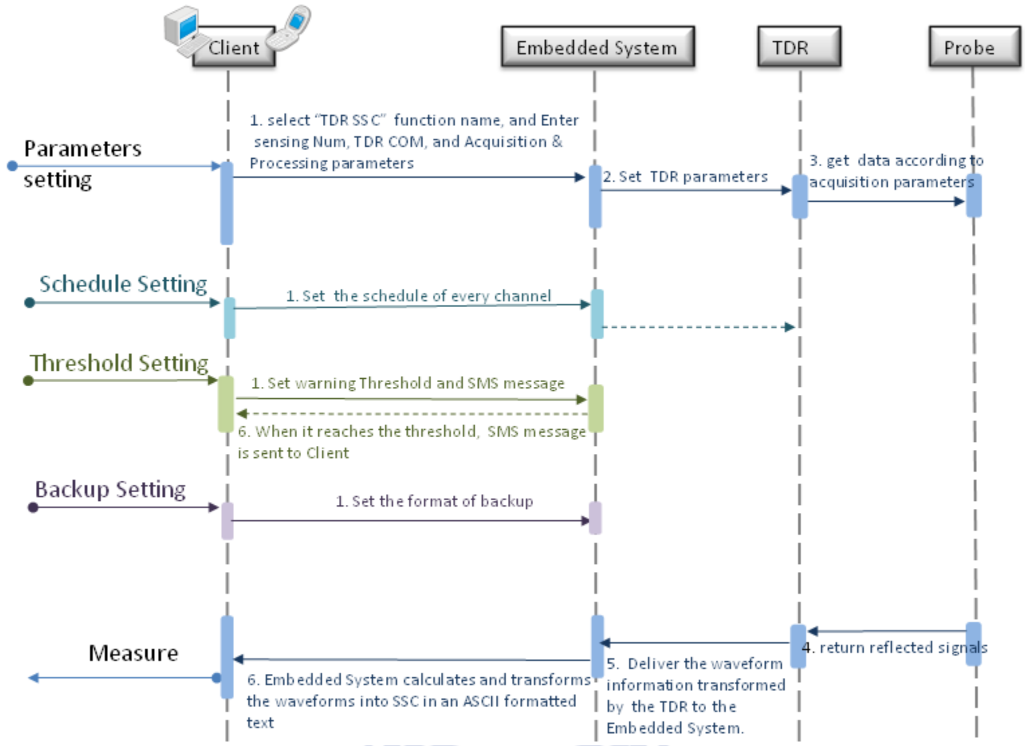


Figure 30.c SSC scenarios sequence diagram

Chapter 5 Conclusions and Future Work

The Data Center integrates every location monitor system and it separates web-base user interface and windows-base retrieve text file user interface. Therefore, the supervisor can adjust monitor systems setting and it can not affect user interface. In particular, the system provides user easy way to observe real-time data, draw line chart, and export history monitor data. If field doesn't have automated monitoring system, the Data Center also provides manual input to insert data by manual. When engineers setting monitor system, user only use windows-base retrieve text file user interface setting destination path and backup path. The system can auto retrieve text file and backup text file. The web-base user interface can update real-time data regularly. The database schema considers more flexible when the monitor system function expand. Overall we establish the Data Center provides quick, easy start up, no IT involvement, and no hardware and software to install. We believe this study could serve as a basis for further integrate embedded systems and data centers.

This work needs more user provides many opinion to improve Data Center. No matter the user interface or the retrieve text file user interface. It can help the system more user friendly and easy to use.

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