

RETIME SOFTWARE FOR REAL TIME DATA ACQUISITION USING LEICA TCA SERIES

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Abstract

Industrial survey is a discipline of engineering surveys that requires the utmost in achievable accuracies and real time data processing. The instrumentation used in conventional industrial survey requires long painstaking procedures with very skilled craftsmen to obtain the required results. Revolution of technology with the introduction of new instruments (such as total station, computer and software) has revolutionized industrial survey. The development of three dimensional (3D) coordinating system and total station interfaced to a microcomputer provides the capabilities for on line data gathering with simultaneous processing in 3D. This research concentrates on the development of software to acquire data from robotic total station (RTS) TCA2003 in real time. This software called RETIME is a short form of REal TIME. RETIME software consisted of the three core module i.e. (i) Data communication with RTS TCA2003, (ii) Calculate the raw data to produce 3D coordinates, and (iii) Convert the data from RETIME format into STAR*NET format. STAR*NET software (third party software) has been used in this research to provide an adjusted data. For verification purpose, RETIME software has been evaluated and the resulted are acceptable for industrial survey environment.

1.0 Introduction

Nowadays, three dimensional (3D) coordinating systems are required to achieve a high-level of accuracy and at a high data rate in purpose to detect any moving object or for monitoring purpose. Typical applications include studies of dam monitoring, bridges and building under load, monitoring cranes in operation for deflections and aligning large machinery during construction.

In recent years, total station have been upgraded from instrument which can used for measure bearing, distance and also have a microcomputer to perform a simple calculation. Now, attached with servo-driven, automatic tracking and specialized software (to perform more calculation), total station is changed to robotic total station (RTS). RTS have been developed which can track a moving target and make automatic measurements of angles and distances to the target in motion (Radovanic & Teskey, 2001). These instruments can make measurements at data rates up to 1 Hz and can operate autonomously once lock to the target has been manually set by an operator (automatic target recognition).

Industrial survey is a field of engineering surveys that requires the utmost in achievable accuracies and almost invariably depends on the results being in real time (Wilkins, 1989). Capability of RTS to give 3D coordinates made real time data processing is possible. Normally, data processing

is done by computer because the needed of a big memory. For this reason, software for connected between computer and RTS for data communication must be developed. Appropriate with this purpose, this research has developed software to capture data from RTS (Leica TCA series) in real time.

2.0 Data Communication

Communication is the process of transferring messages from one place to another. Data communications is the transfer of information from one location to another by means of communication channel. Communication involves three basic elements: A sending unit, transmission channel and receiving unit.

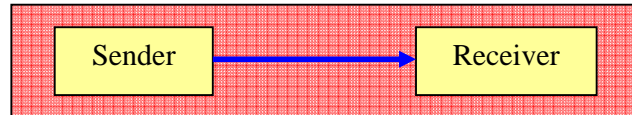


Figure 1. Communication process

In order to understand basic functioning of data communications we need to know more about how a message is sent over a communication link: modes of transmission, types of transmission and protocol.

2.1 Modes of Transmission

The mode of transmission refers to the manner in which the characters of a message are transmitted. Data transmission is carried out in three different modes: synchronous, asynchronous and isochronous transmission.

Synchronous transmission sends character in groups or blocks. A block of data may contain hundreds of characters. Each block is framed by header and trailer information. The header consists of synchronizing information which is used by the receiving unit to set its clock to in synchronism with the sending unit clock. The header also contains information to identify sender and receiver. Following the header is a block of characters that contains the actual message to be transmitted. The message characters are terminated by trailer. Thus the trailer contains an end of message character.

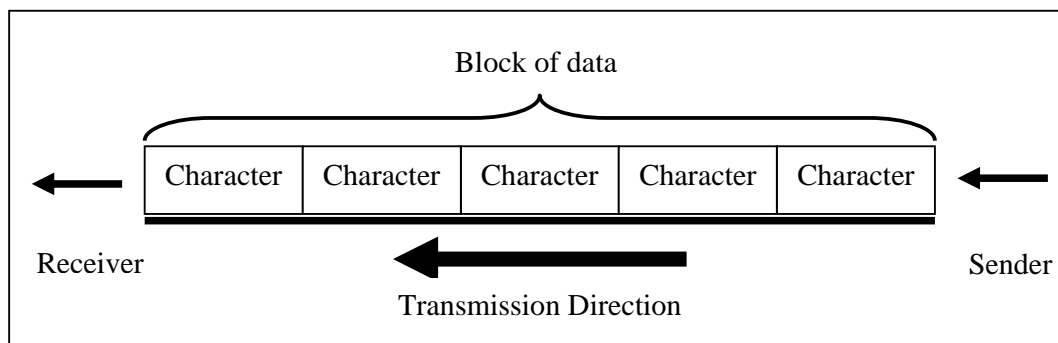


Figure 2. Synchronous transmission

Asynchronous transmission sends characters one at a time. Each character is identified by a start bit and a stop bit. Preceding the character is a start bit and following the character is one or two (depending upon the system) stop bits. This type of transmission is said to be asynchronous because the receiver can identify a character by its start and stop bits regardless of when it arrives. Thus, characters can be sent at irregular intervals.

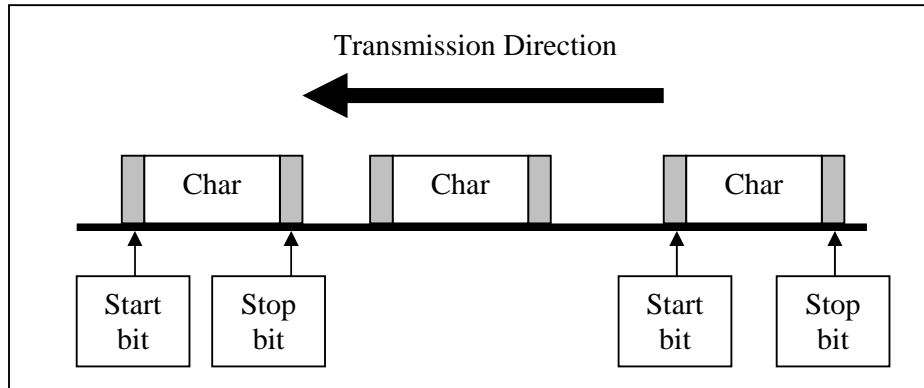


Figure 3. Asynchronous transmission

Isochronous transmission combines features of synchronous and asynchronous transmissions. In this type of transmission characters have identifying start and stop bits and the sender and receiver are synchronized.

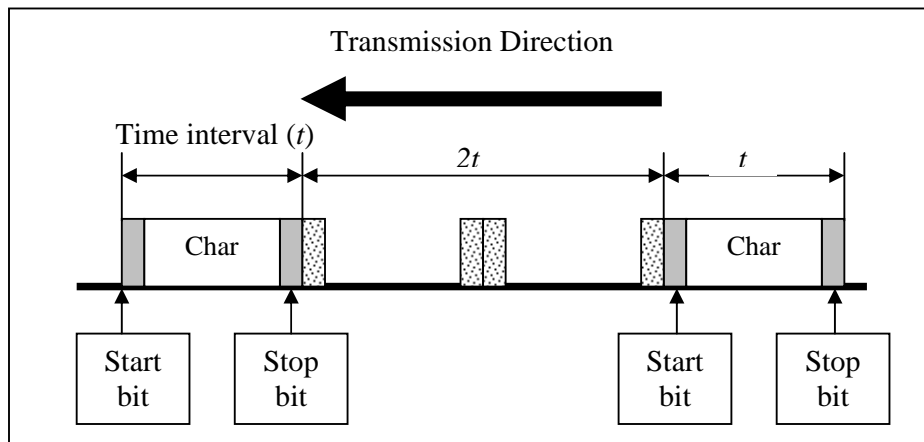


Figure 4. Isochronous transmission

2.2 Types of Transmission

There are three ways for transmitting data from one place to another. These are simplex, half duplex and full duplex transmissions. Simplex transmission is one way. The communication can take place in only one direction. Devices connect to such a circuit is either a send-only or receive-only devices. The sending unit always sends and the receiving unit always receives. For example, a printer connected to a computer is restricted to receive information to be printed. It cannot be used to transmit message to the computer.

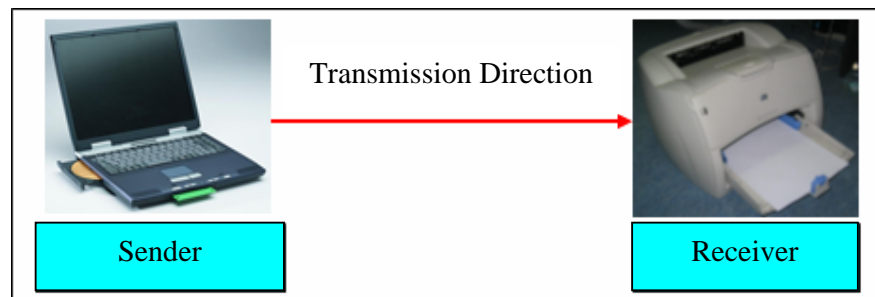


Figure 5. Simplex transmission

Half-duplex transmission permits transmission in both directions, but in only one direction at a time. That is, one unit can send a message to another, but receiving unit must wait until the reception is completed before transmitting message of its own.

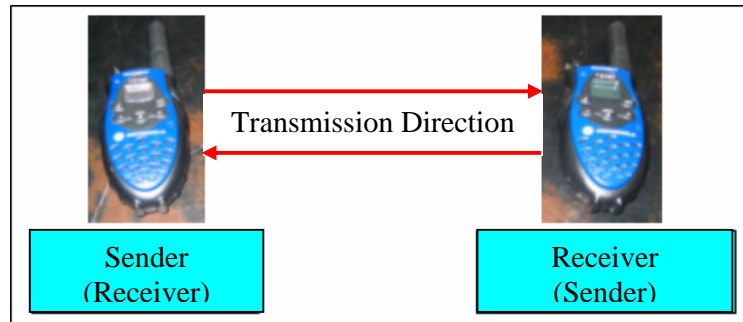


Figure 6. Half-duplex transmission

Full-duplex transmission permits information to flow simultaneously in both directions on transmission line. Thus, full duplex transmission allows a unit to send and receive messages simultaneously.

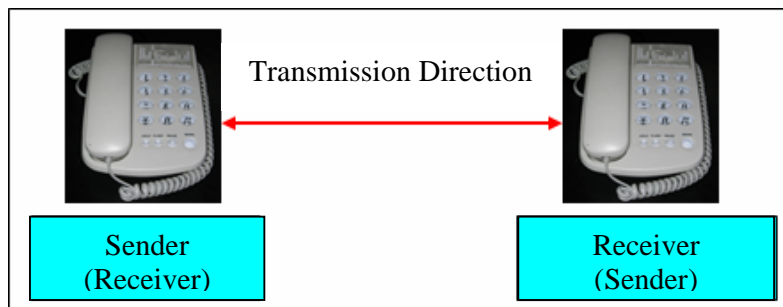


Figure 7. Full-duplex transmission

3.0 Methods of Communication

There are many methods to perform data communication such as serial, parallel, universal serial bus, infra red and the latest is Bluetooth. For this research, serial communication method has been used to perform data communication. Serial method was selected because it is common communication protocol that is used by many total stations.

The concept of serial communication is simple. The serial port sends and receives bytes of information one bit at a time. Typically, serial is used to transmit ASCII data. Communication is completed using 3 transmission lines: (1) Ground, (2) Transmit, and (3) Receive. The important serial characteristics are baud rate, data bits, stop bits and parity. For two communication port, these 4 parameters must match.

1. Baud rate: a speed measurement for communication. It indicates the number of bits transfers per second.
2. Data bits: a measurement of the actual data bits in transmission. When the computer sends a packet of information, the amount of actual data may not be a full 8 bits. Standard values for the data packets are 5, 7 and 8 bits. Setting these values is depends on information that are transferred.
3. Stop bits: used to signal the end of communication for a single packet.
4. Parity: a simple form of error checking that is used in serial communication.

4.0 Protocol Communication

Leica provides two different languages to control the instruments via RS232 interface (serial communication): Geo Serial Interface (GSI) and GeoCOM. GSI is a simple and easy understandable language which operates mainly four commands: SET, CONF, PUT, GET with which the main functionality of the instrument can be controlled. But GSI is mainly used to get data from the instrument and there is only a small number of commands available that actually steer the instrument.

Second protocol is GeoCOM (used for this research), might be seen as the successor of the GSI protocol and allows to commands the instrument with the full set of commands. GeoCOM itself handles all necessary communication with no intervention of the programmer in respect to the communication. GeoCOM is implemented as a point to point communication system. The two communication participants are known as the client (external device) and the server (TPS1000 instrument). One communication unit consists of request of a request and a corresponding reply. Hence, one communication takes place when the client sends a request to the server and the server sends a reply back to the client. GeoCOM is implemented as synchronous communication. A request/reply pair may not be interrupted by another request/reply (half duplex transmission). Instead, a communication must be completed successfully before a new communication unit may be initiated. Although the ASCII protocol allows sending the next request before the corresponding reply has been received, it is not recommended to do that because subsequent request will be buffered when the previous request has not been finished so far. But if the buffer content reaches its limit in size then data may be lost. Below is a sample for data request using GeoCOM protocol (Table 1):

GeoCOM protocol (request)

```
[ <LF> ]%R1Q,<RPC>[ ,<TrId>:[ <P0> ] [ ,<P1> ,... ]<Term>
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Table 1. GeoCOM Protocol (Leica, 1999)

Parameter	Description
<LF>	An initial line feed clears the receiver buffer.
%R1Q	GeoCOM request type 1.
<RPC>	Remote Procedure Call identification number in between 0 to 65535.
<TrId>	Optional transaction ID: normally incremented from 1 to 7. Same value in reply.
:	Separator between protocol header and following parameters.
<P0> , <P1> , ...	Parameter 0, Parameter 1, ...
<Term>	Terminator string.

5.0 Software Development

For this research Microsoft Visual Basic V6.0 is used for software development and GeoCOM is selected protocol because of the ability to capture and steer the instrument with full set of commands. Programming with VB is based on the Dynamic Link Library (DLL) concept. To enable access to GeoCOM the special module stubs_p .bas has to be included in the project. This stubs_p .bas module includes all constants, data types and function prototypes, which are available in GeoCOM.

To develop this software, there are 3 core modules. Module 1 for communication between RTS TCA2003 and computer, module 2 to provide three dimensional coordinates and module 3 for convert data format from RETIME into Starnet (LSE software) format (refer Figure 8).

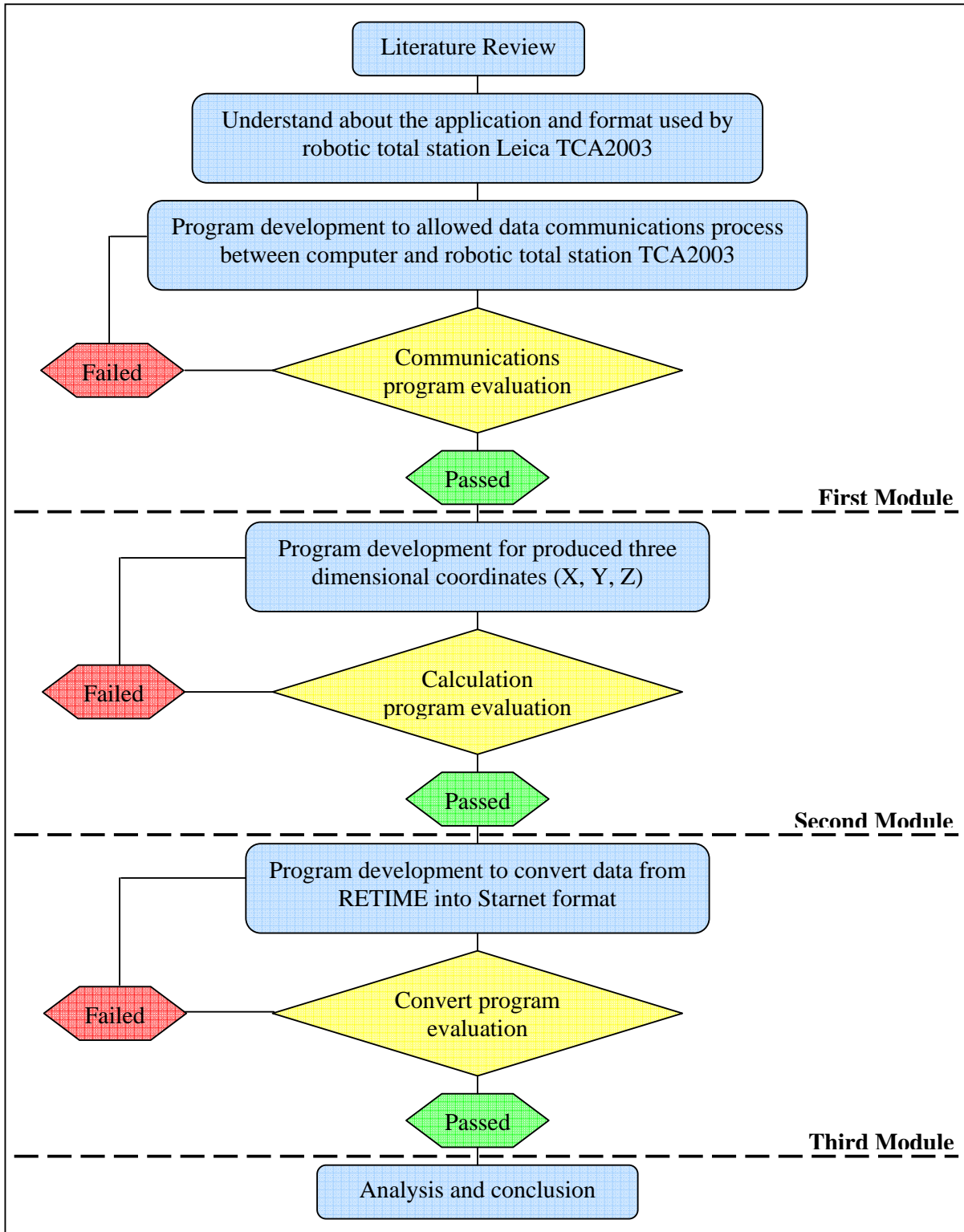


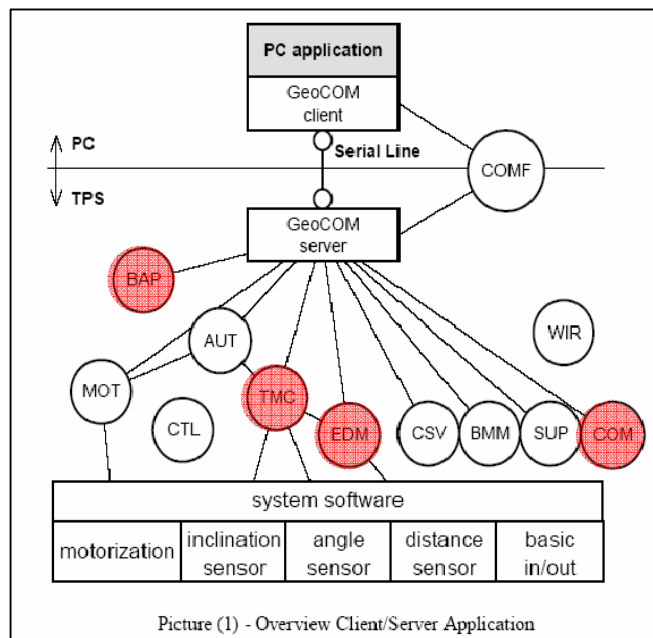
Figure 8. Methodology of software development

Module 1 is important module because it involved about data communication, which data observation from RTS can be receive by computer using this module. This module was developed using GeoCOM protocol and serial communication have been used. Using serial communication, programmer need to setting this for 4 parameters (baud rate, data bits, stop bits and parity) to allow communication between two devices. Hence, it is programmer responsibility to synchronize the values between computer and instrument.

Table 2. Serial Communicatin Parameter for RTS TCA2003

Serial communication parameter (robotic total station TCA2003)	Value
Baud Rate	9600
Data Bits	8
Stop Bits	1
Parity	None

In GeoCOM protocol, there are several functions such as automatisation (AUT), basic applications (BAP), basic man machine (BMM), communicatin (COM), central services (CSV), control task (CTL), electronic distance meter (EDM), motorization (MOT), supervisor (SUP), theodolite measurement and calculation (TMC), and word index registration (WIR). Figure 9 below can describe about GeoCOM functions.



Picture (1) - Overview Client/Server Application

Figure 9. GeoCOM Functions (Leica, 1999)

For this research, only basic applications (BAP), theodolite measurement and calculation (TMC), electronic distance meter (EDM) and communicatin (COM) is used. BAP is a functions which can easily be used to get measuring data, TMC is the core module for getting measuring data, EDM is the module which measures distances and COM is a functions to do a communication between RTS and computer. Using those four functions, module 1 can acquired raw data such as slope distance, vertical and horizontal angle.

Module 2 is a calculation module, which used to provide three dimensional (3D) coordinates. Raw data from module 1 will be calculated to produced 3D coordinates.

In industrial or deformation survey, before further analysis can perform, the data must be adjusted. In purpose to provide an adjusted data, this research have collaborate with Starnet software. Starnet software is a commercial software which used to perform Least Square Adjustment analysis. Before Starnet software can be used, the data from RETIME format must be compiled into Starnet format (Figure 10). For this reason, module 3 have been developed.

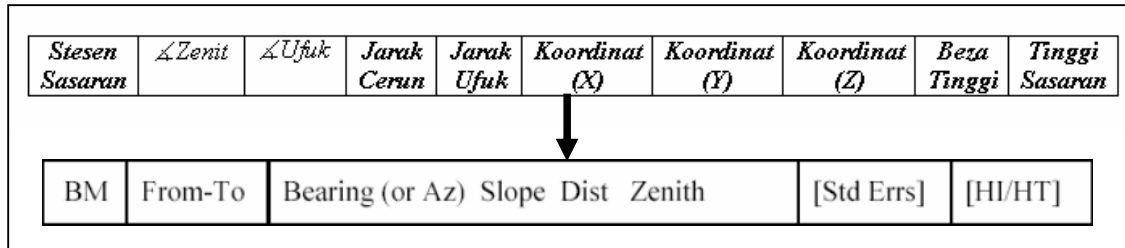


Figure 10. Conversion process from RETIME into Starnet format

6.0 Analysis

In purpose to verify the reliability of the data received by RETIME software, comparison analysis for observation data has been done. This analysis required data observations from others establish software. For this research, data observations from onboard software (TPS1000) and APSWin V1.42 have been compared to data observations using RETIME software. Table 3, Table 4 and Table 5 showed the statistical analysis for data observations different between those three observations.

Table 3. Statistical analysis for data observations different between onboard software (TPS1000) and RETIME

	Hz. Angle (second)	Zenith (second)	Hz. Distance (m)
Minimum diff.	0.000	0.000	0.000
Maximum diff.	2.000	2.000	0.000
Average	1.167	1.333	0.000
Varians	0.566	0.667	0.000
Standard deviation	0.753	0.816	0.000

Table 4. Statistical analysis for data observations different between APSWin V1.42 and RETIME

	Hz. Angle (second)	Zenith (second)	Hz. Distance (m)
Minimum diff.	0.000	1.000	0.000
Maximum diff.	3.000	5.000	1.000
Average	1.333	3.000	0.000
Varians	1.067	2.400	0.000
Standard deviation	1.033	1.549	0.000

Table 5. Statistical analysis for data observations different between onboard software (TPS1000) and APSWin V1.42

	Hz. Angle (second)	Zenith (second)	Hz. Distance (m)
Minimum diff.	0.000	0.000	0.000
Maximum diff.	4.000	6.000	1.000
Average	2.000	2.667	0.000
Varians	3.600	9.067	0.000
Standard deviation	1.897	3.011	0.000

Consider the data showed in onboard software (TPS1000) give a true value then the evaluation have done refer to the onboard software data. Therefore, values of standard deviation showed that the data receive by RETIME software (Table 3) is rather than data receive by APSWin V1.42 (Table 5).

7.0 Conclusion

RETIME software have three core module which is data communication, calculation and convert module. Each module have their own function, for example module 1 used to received the data from robotic total station TCA2003, module 2 to provide 3D coordinates and module 3 was develop to allowed adjustment analysis using Starnet software. To ensure the data received by RETIME software is valid, thus comparison analysis for observation data has been done and the result showed RETIME software is able to receive the true data from robotic total station TCA2003.

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