

# The Research And Development Of Measurement Robot Automatic Monitoring Systems

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## **ABSTRACT:**

*This paper describes the hardware components and principles of measuring of the measurement robot and introduces its secondary developmental principles. For the purposes of this study serial control between the computer and the measuring robot was studied. Through the analysis and coordination of software requirements, engineering automation observations, Microsoft Visual C#2008 programming language, and Leica Geosystems GeoCOM robot programming interface, developers can achieve the engineering standards of automatic monitoring data acquisition software. Experiments show a high degree of automation software improves work efficiency in significant ways.*

**KEYWORDS:** *Measuring robot; automatic monitoring; serial control*

## **I. THE BASIC COMPONENTS AND MEASURING PRINCIPLES OF THE MEASUREMENT ROBOT**

The measurement robot, also known as the total station, is a comprehensive surveying system, which includes the basic functions of auto target recognition (ATR), autocollimation, auto target tracking (ATT), auto angle and distance measurement and automatic recording. It minimizes labor intensity, greatly improves work efficiency and achieves a more accurate result. The major subsystem of the measurement robot contains eight parts, namely a coordinate system, manipulator, transducer, calculator & controller, closed-circuit control sensor, decision maker, target acquisition and integrated sensor. First of all, by using a spherical coordinates system, the coordinate system can find targets in the range of 360° horizontally and 180° vertically; the manipulator is mainly used to adjust rotation; the transducer transforms electrical energy into mechanical energy that activates the stepper motor; the calculator & controller boots up and shuts down the operating system(OS) and stores data while creating conditions for other systems related to dock; the closed-circuit control sensor transmits collected data to the manipulator and controller in order to fix positions accurately and measure; the decision making is used to find targets; target acquisition, including setting thresholds, region-segmentation method and heliography, is mainly for precisely collimating targets and the integrated sensor is used to collect data. The basic measuring principles are: processing images collected by the image sensor to achieve automatic tracking and precise collimation under the control of the calculator & controller. In general, surveyors plan a measuring strategy based on information acquired from a measuring task. They obtain data using sensory recognition analyzing the surroundings and targets via the available instruments. While measuring the robot can identify, judge, analyze, automatically control, collimate and indicate. It can be connected to a computer and or softwares for data analysis and program design and has high automation, remote control, fast response and high precision features. The measurement robot has passed three stages of development. Currently, it can use image-processing to automatically recognize, match and autocollimate targets according to their counters and textures, and can realize 3D imaging.

## **II. THE PRINCIPLES OF MEASURING ROBOT'S DEVELOPMENT AND THE REALIZATION OF AUTOMATIC MONITORING SYSTEMS PREPARE YOUR PAPER BEFORE STYLING**

### **The principles**

Internationally famous measurement solution providers have launched their own products. The robot produced by Leica Geosystems in Switzerland has always been leader in the development of this industry because of its high precision, stability and ease of secondary development. The high-performance Leica TCRA1201 intelligent measuring robot with its high precision is widely employed for construction use. This paper studies the way its hardware device and Microsoft Visual C#2008 as the programming language are used to develop software. The secondary development can be carried out with a uniform serial interface GeoCOM instruction set. GeoCOM, a COM component in the form of DLL (Dynamic Link Library), specially developed by Leica Geosystems for secondary development, can provide users with a more personalized UI (User Interface) or allow users to develop more advanced client applications on the basis of the Leica measuring devices. It has two interface modes: the advanced function mode and ASCII. The former uses VB (Visual Basic) or C++ and can directly invoke the request, response and analytic function packaged in the COM component; the latter, constructed to demand, uses serial line to send request to the robot and immediately receiving response decoding. During each process of the latter there is a corresponding specific identification code related to given parameters. Although the advanced function mode is highly integrated and easy to invoke,

its functions are all too often called, which greatly consumes memory, drags response rate and limits the programming language. Therefore this study is based on the ASCII interface mode to realize the software's development. The ASCII command character strings format of the Leica TCRA1201 measurement robot is as follows:

Transmission serial: [`<LF>`]`%R1Q`, `<RPC>`, [`<TrId>`]: [`<P0>`], [`<P1>`,...] `<Term>`, meaning of each symbol is presented in Table 1.

Table 1. Symbol Meaning of Transmission Serial

<code>&lt;LF&gt;</code>	Initialize the new line character to empty the buffer
<code>%R1Q</code>	First category request mark of GeoCOM
<code>&lt;RPC&gt;</code>	Remote procedure call mark, from 0 to 65535
<code>&lt;TrId&gt;</code>	Optional transaction ID, generally from 1 to 7, the same as the transaction ID of reception serial
:	Head of character string and decollator of the parameter
<code>&lt;P0&gt;</code> , <code>&lt;P1&gt;</code> ...	Parameter 1, parameter 2...
<code>&lt;Term&gt;</code>	character string terminator (default: CR/LF) can be set by COM_SetTerminator

Reception serial: `%R1P`, `<GRC>`, [`<TrId>`]: `<RC>`, [`<P0>`, `<P1>`...] `<Term>`, meaning of each symbol is presented in Table 2.

Table 2. Symbol Meaning of Reception Serial

<code>%R1P</code>	First category response code of GeoCOM
<code>&lt;GRC&gt;</code>	GeoCOM return code. If it's 0, succeed; if not, fail.
<code>&lt;TrId&gt;</code>	Optional transaction ID, generally from 1 to 7
:	Head of character string and decollator of the parameter
<code>&lt;RC&gt;</code>	Remote procedure call return code. If it's 0, succeed; if not, fail.
<code>&lt;P0&gt;</code> , <code>&lt;P1&gt;</code> ...	Parameter 1, parameter 2...
<code>&lt;Term&gt;</code>	Character string terminator (default: CR/LF) can be set by COM_SetTerminator

### The Realization of Automatic Monitoring

Because the location and numbers of the observation spot are relatively fixed, in order to realize unattended, real-time, consecutive, effective and dynamic automatic measurement, the software used can automatically search, collimate and indicate in a certain field range to finish tasks like timing measurement, calculation, analysis and output. The objective Automation. The automatic monitoring software strictly implements auto detection and processes and analyzes data feedback according to given observation set numbers and observation intervals. Intelligence. When blocked and not meeting tolerance requirements, the software should command the robot to measure again, and if necessary, give an alarm. Mass storage. After measuring there is a large amount of data. The DLL can store and manage data effectively and provides data query and analysis. Friendly and easy user interface. For the convenience of users, the software should have an easy-to-use interface and simple operation. The main functional modules of the automatic monitoring software This software mainly consists of project management, system preferences, survey station settings, measurement learning, automatic measurement, data processing and output. Project management. Each engineering project has a corresponding database file that stores data including system preferences, original values and a range of calculated analysis.

System preferences. Set the computer's serial communication parameters to conform to the robot's baud rate, calibration stop bit, 2c mutual error, index error. Misclosure of the round will be set as well.

Survey station settings. These include settings of the name of the station, the height of the instrument and prism constants.

Measurement learning. Firstly, users supply rough information about the target spot. After auto search, precise collimating and surveying, location data is recorded.

Automatic measurement. The software will, if running over time, automatically remeasure part or all of the target according to the numbers configured.

Data processing. Based on the original data, the software will calculate and analyze.

Output. It provides enquiry and output of the original observation data, calculation and analytic results and generate forms and charts.

Friendly and easy user interface. For the convenience of users, the software should have an easy-to-use interface and simple operation.

1.3 The realization

According to the analysis and study above, the automatic monitoring software’s major structure plan of measurement robot is presented in Figure 1, and the major interface is presented in Figure 2.

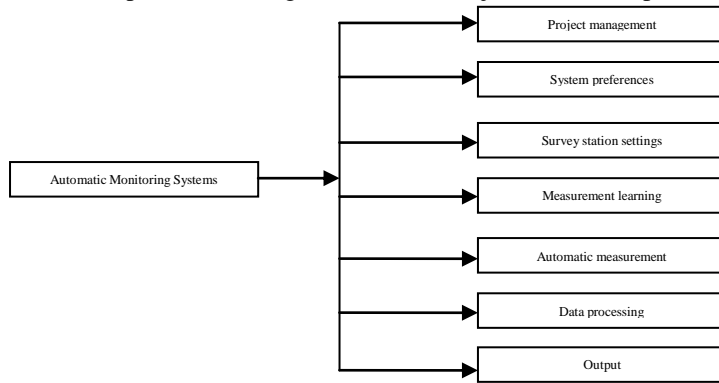


Figure 1

III. THE PRACTICAL USE OF THE AUTOMATIC MONITORING SOFTWARE

In order to analytically verify this software, a project is hence selected and its datum point & the arrangement of the observation spot is presented in Figure 3.

In Figure 3, BM1~BM4 is the datum point, J1~J2 is the observation spot.

The process of the experience is as follows:

- 1) Tolerance observation and communications parameters edition, input. Tolerance observation is presented in Table 3.

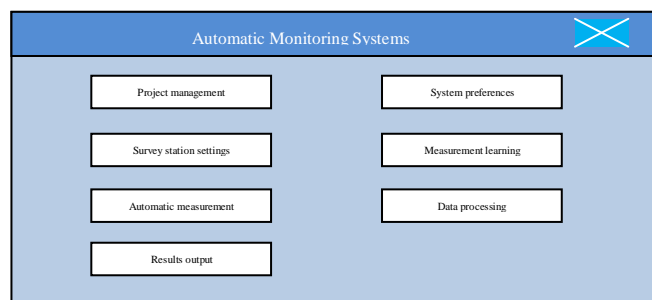


Figure 2

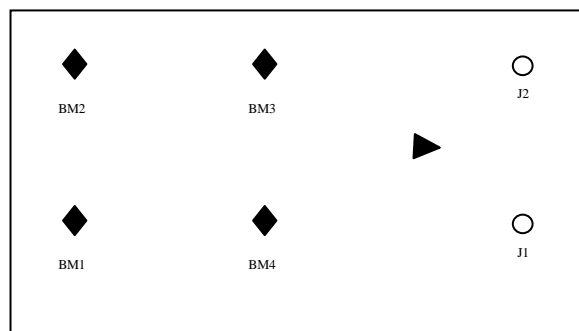


Figure 3

Table 3. Tolerance Observation

Numbers of observation set	Semiobservation of misclosure of round	Different observation set of 2c mutual error in the same direction	The same direction zero direction value is poor	2C value
3	6"	9"	6"	≤±15"

- 2) Measurement learning and storage of the Datum point BM1~BM4 and the observation spot J1~J2.
- 3) Collect data 3 times of observation set according to the parameters in Table 3. If the results do not meet the requirements in Table 3, the tester is warned and the robot will remeasure part of target or the whole.
- 4) After auto measurement, make coordinate calculations and store the results. The observation spot’s eight-period coordinate transformation is presented in Figure 4 and Figure 5. And this system based on measurement robot is proved to be capable of the surveying requirements and increasing work efficiency.

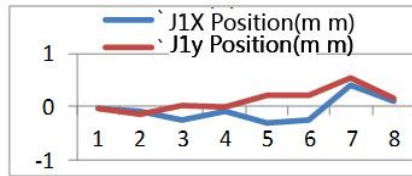


Figure 4

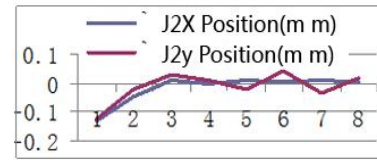


Figure 5

#### IV. CONCLUSION

This paper studies the development of automatic monitoring systems of the measuring robot. By connecting computer equipment and the robot, after serial steps (program delivery, command acceptance) of data collecting, the problems of huge workload and highly-required precision can be solved, which increases the efficiency and quality of the field survey.

#### V. ACKNOWLEDGMENT

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