An Automation Positioning Measurement System Based on Multi-measurement Equipment

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Abstract: According to the requirement of flight test, The high precision Automation positioning measurement system is designed and implemented for obtaining three-dimensional points, lines or polygons of measured object. The system can be satisfied with the needs of future weapons development. The system functions include simulation, online measurement, fast processing, real-time monitoring etc. The system structures, framework and composition are given. The key technical problems are analyzed in order to know of the system feasibility. A feasible platform are set up by total station instrument, light pen, image measuring system equipment in the laboratory. The interface performance, real time guide, coordinate transforming, adjustment of observation are verified. The algorithm accuracy is verified. The system construction thought is overall being planned. The system will effectively boost the development in flight test, It is very important to improve testing precision, speed or saving manpower and material resources.

1 INTRODUCTION

Space positioning measurement for Flight test is surveying the aviation aircraft position and other parameters of the target in the real test environment, which mainly is used for the establishment of Spatial reference Information and the value transfer, installation and calibration for weapons, the plane deformation test and three-dimensional model[1,2].The improving of the aviation weapon performance put forward higher requirements for measurement. Measurement object is becoming more and more complex, it is not only to measure the position of aircraft and weapons, but also to measure the relationship between weapons and aircraft. The accuracy requirements for attitude angle arc seconds, positioning requirements are millimeter. The measurement tests get more and more. The measurement items are more than one type measured with high frequency which measure hundreds of sorties every year; the original static measurement is converted for static and dynamic binding; The automation technology research must be conducted in order to improve the accuracy and reliability and the test efficiency[3].

At present, digitalization and detection technology are becoming more and more mature. Model-based detection technology has become the main detection method for engineering，and Model-based detection technology effectively improve the detection capability and efficiency[4].

Model-Based Systems Engineering is regarded as the "revolution" of system engineering, "the future of system engineering ","transformation of system engineering" and so on. China Aviation Industry Group has also carried out related research and application[5,6].

According to the requirement of flight test, the high precision automation engineering positioning measurement system for flight test is designed and implemented for obtaining 3D points, lines or polygons integration of measured object in greater scope. The system should be satisfied with the needs of future weapons development. The system functions include simulation ,online measurement, fast processing, real-time monitoring etc. The system can realize the plane model building, installation process online test for weapon system on the aircraft ,the complex body positioning monitoring, monitoring of the test site ,which can provide the basis for on-the-spot decisions.

This subject provides new methods and new ideas for online monitoring ,provides technical support for the research of distributed large-scale measurement, and also provides online error correction of industrial robots, online space positioning and reverse engineering, which is widely used for flight test.

2 THE SYSTEM FRAMEWORK

2.1 Basic Framework

According to the requirement of flight test, using the advanced digital measurement equipment such as total station instrument, light pen, image measuring system equipment ,3D scanners, GPS, laser tracker, etc. based on 3D digital-analog measuring system composed of a set of automation measurement system, through the computer and automatic control technology to achieve integration measurement[7]. Through offline programming device layout and mission planning system after the completion of online testing in the field of data processing, shortening the processing cycle, improves the effectiveness and accuracy of the measured data .In the measurement platform building process, we should fully consider the system's advanced nature that system construction should not only have data processing and control functions, but to be able to optimize the layout of measurement equipment, In the measurement task trace route planning, ensure the accuracy of automated measurement. The framework of the system is shown in figure 1.

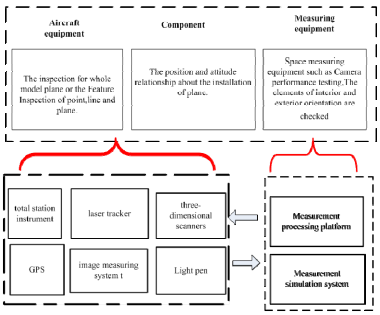

Figure 1: System frame of multi-measurement equipment diagram.

2.2 System Components

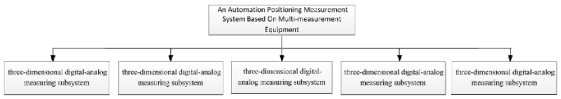

Figure 2: An Automation Positioning Measurement System composition.

According to the characteristics of flight test, automation high-precision measurement system are set up, which can achieve fast automated collection for feature point, line, polygon data, recording, computing and other functions. Automation measurement system is mainly composed of the following parts: accurate point measurement subsystem, image measurement subsystem, three-dimensional digital-analog measuring subsystem, measurement and control center subsystem, measurement simulation subsystem. The system composition is shown in figure 2.System equipment composition is shown in figure 3.In which precise point measurement subsystems, 3D modeling subsystems, image measurement subsystem achieve information collection and access. measurement and control system is the core of the whole system that is responsible for data processing, control, guidance, analysis, display function; measurement simulation mainly completes the measurement equipment layout, composition and measuring path planning, which is key to optimize the allocation of system, but also automatic measurement of foundation. The specific composition is as follows:

1) Accurate point measurement subsystem: which is made up of the total station, light pen, Laser tracker and other equipment, which can obtain 3d measurement information about the main point features.

2) Image measurement subsystem: which is composed of camera, lens, analytical software, The key point coordinates were obtained using digital close-range photogram metry principle, The static or dynamic measuring process target point coordinates can be given through calculating.

3) Three-dimensional digital-analog measuring subsystem: including 3D scanner, hand held scanner, model building tools, etc., is mainly used for model construction or the measurement about Surface target and the attitude datas of the object.

4) Measurement and control center subsystem: mainly achieve the system camera, 3D laser scanner and total station and other equipment background operation control and real time information collection, guide transmitted, the processing,

evaluation, display, with image processing, data processing, and analytical parameters adjustment calculation and other functions.

5) Measurement simulation subsystem: the simulation model is established according to the measurement task requirements and site environmental knowledge, through simulation and calculation on measurement characteristics, through the simulation is given a specific task in measuring device configuration, layout and measurement task planning is key to optimal allocation of system. The main task is to prepare for the simulation of the field, the equipment layout, equipment interference, measurement of the trajectory of the simulation, the test quantity schemes and plans to confirm.

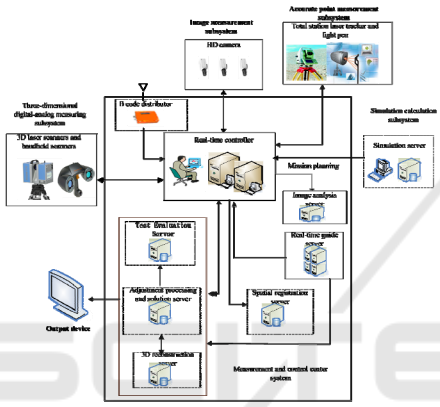

Figure 3: System equipment composition.

2.3 Second Section

For a test, it is necessary to carry out automation measurement, first of all, according to the requirements of the task We measure the field simulation environment and get the measurement plan. This subsystem transfers the measurements related to the planning, equipment status information to the control center, which is based on the original digital to analog information into the coordinate conversion, converts data into the value of the respective equipment coordinate measuring system and controls the equipment in accordance with the requirements for automatic measurement. Other precise measuring system, image measuring system, 3D modeling system are based on the control center issued the control instructions ,then take the respective measurement data back (transfer) to the monitoring and control center for the integrated treatment, carrying out after the process is completed testing and evaluation, and save all the measured data, the data results in accordance with the statements of the model output; model formation through the model viewer access. All measurements according to the measurement plan under control of Control Center automatic completion of the measurement. According to the above planning, the information exchange between the system and the measurement system is given as shown in figure4.

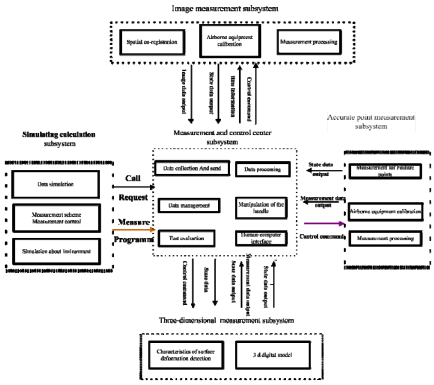

Figure 4: Information exchange.

2.4 Software Framework

The system software is based on operating software, supporting software.

Different kinds of measuring instruments often use different communication interface standards, which makes data communication and integration difficult. For point, line and polygons Object, different measuring devices are adopted, Unified standard interface is designed to control all data in the same control center , Three dimensional CAD software (such as CATIA and UG) has been developed. Based on the unified measurement kernel, information such as geometric information, dimensional tolerance, inspection plan, simulation and measurement results are shared seamlessly between the same or different platforms. All data are managed to achieve information integration and closed loop feedback[4,8]. Application software is the key to intelligent measurement of the system. Its composition and functions are as follows.

The application software contains the following functions:

1) The collected data is mainly from the total station ,laser tracker and three-dimensional scanning instrument, some data is from the manual input parameter information or the model data information. The data and images of all the measuring devices can be unified into the network interface for data transmission, which is in order to

send data efficiently . the hardware interface must be extensible.

2) Mage data, model construction can be processed in the data processing center and the data of multi - measuring equipment can be combined adjustment. many kinds of data from various measurement devices can be processed, including original measured data, the data generated to show on the device and the data to guide.

3) It is mainly used for the preparation of the measurement task, Simulated measurement site, The purpose of simulation is to plan the layout of equipment, to know interact with each other and gain the planed path.

4) The software are decomposed and analyzed to the task. The software can be automatically measured according to the data of the model database, and the various instructions can be manipulated.

5) The Man-machine interface is mainly convenient for information interaction. It is responsible for the display of plane and table information on the display console the software receives various intervention commands and manual input data, and can read the three-dimensional model.

3 KEY TECHNOLOGIES

3.1 The Reasonable Design, Arrangement and Measurement of the Control Standard

A comprehensive measurement system composed of multi measurement equipment to obtain high accuracy of the measurement results, firstly we must determine the structure of observation and how to layout, according to the measurement conditions and the characteristics. In design process, a variety of measurement equipment is needed to identify a common characteristics of the measurement symbols, we must think of the size scale of the measurement object, the structure characteristics of the mark points. According to the task of designing a common identity, public signs are shown in Figure 5. Each different mark represents a different point, and different measuring equipment must identify the center of each mark, Only in this way the data from multi - measurement can be spliced or be fused.

Figure 5: Public sign.

To improve the measurement accuracy, it is necessary to obtain diversity of observation data in the layout process. Diversity observation data will be the basis for an accurate adjustment model. We need to consider measurement datas of blind distribution, spatial distribution of the optical unit can be used, The space of light coverage and the light source arrangement of Optical measurement system should be considered. when above all problem are solved Enter the actual measurement.

3.2 Based on the Model of Automation Measurement Process Design

Automation measurement process model is designed based on digital three-dimensional simulation model[9,10], The task demand is analyzed and simulated. measurement instruction is generated ,according to the relevant test requirements, The selection, combination and layout of the measurement equipment are carried out by simulation measurement, according to the site environment; Based on the integrated control and automatic measurement of the measured plan generated by the simulation, All measurement data are collected and calculated in the measurement and control center, Building a unified coordinate system for data solver to complete the on-line analysis. Finally, the result of measurement is given. Automated measurement procedures are as follows.

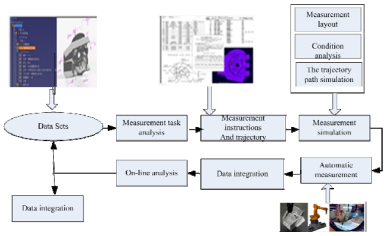

Figure 6: Based on the model of automation measurement process design.

3.3 Measurement Simulation

Measurement simulation is the most important condition to realize Automation measurement, and establishing a reasonable measuring field model is

the base and key of the measurement planning and system optimization in the field of complex aviation experiment[11,12]. Overall, the field measurement model should establish in accordance with the measurement task requirements and site environment model, which should include work space, spare parts, obstacles, measurement, measuring instruments, environmental factors of measuring space etc. measurement system combined with a different layout or configuration scheme, the simulation will form different field measurement results, the performance parameters of the measurement system can be obtained before the implementation of the actual measurement through simulation. which can be in the evaluation of the performance parameters of the measurement system and the optimization of structural parameters to verify the measurement field model and testing requirements match, in the simulation process focus on visibility and accuracy characteristics. The simulation process is shown in figure 7.

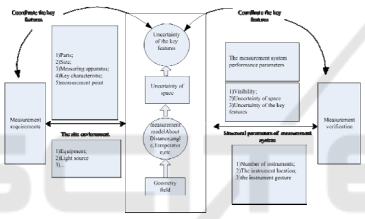

Figure 7: Measurement simulation processn.

3.4 Automatic Measurement Process Sample

The equipment used for automatic measurement includes the tracking devices (tracker, total station), and automatic aiming measurement is realized by adopting the mode of coordinate value conversion - equipment automatic driving - automatic point finding -- Data collection. First , the theoretical position of each measuring points under the design coordinate system is obtained based on based on 3D model, the conversion relationship between the design coordinate system and the measurement coordinate system is calculated, the theoretical coordinate values of each measuring point under the measurement coordinate system under the current actual state are obtained, the measuring equipment is automatically positioned near the measuring point to be acquired through a program control, so that the tracker automatically and accurately find a target bull's-eye ball, complete the measurement. then enter the next desired point of the search and measurement. The process is shown in figure8.

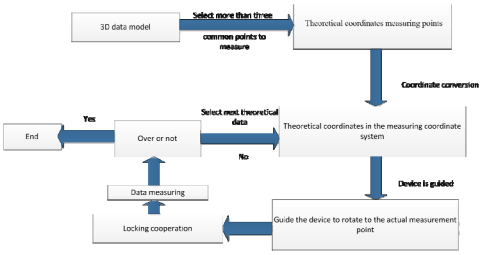

Figure 8: Automatic measurement sample.

4 APPLICATION VERIFICATION

Using a combination of total station instrument, lightpen, image measuring system equipment into an integrated measurement platform. Through measurement platform, Interface interoperability, real-time guidance, coordinate transformation and adjustment function can be verified. we can use the software to develop stable controling equipment for measuring, integrate precision accuracy is better than a separate device; measurement range is expanded,1+1>2 function can be realized. At the same time, in the process of testing a number of models, we test the combination of automated measurement mode, achieve an online measurement; improve the efficiency and reliability of measurement.

5 CONCLUSIONS

Using total station instrument, light pen, image measuring system can be composed of Automation engineering measurement system; after the completion of the Automation measurement system can achieve routine tasks online measurement and improve measurement speed and work efficiency. To achieve the Automation test target requires overall planning, the gradual implementation of the construction line up at the facets, we are building Automation test work progresses follow this idea. The system will give a strong boost to the development of flight test of Automation testing technology, improving test accuracy and measurement speed, saving manpower, material resources.

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