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Design of 3D Data Acquisition System on Handicrafts

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Abstract

The 3D data acquisition system is a very effective means to protect handicrafts. This paper analyzed the advantage of 3D laser scanning technology and designed a 3D data acquisition system on handicrafts base on it. The hardware of this system includes 6 parts: laser range finder, computer, servo system, interface board, distance data instrument, angle data instrument. The software of this system have 4 functions: parameter setting, automatic scanning control, scanning data processing, fault diagnosis. This paper discussed the operation of the software platform and development tools, modular design of software, design of software system framework and information fusion of 3D data acquisition. This paper completed the fusion and matching of point cloud data.

Keywords: *3D data acquisition, system, design, handicrafts*

1. Introduction

Today, there are bout 220 countries and regions in the world, and there are more than 100000 races at the same time. This means that the vast majority of countries are multicultural, multi-ethnic, multi-ethnic. The all contain a large number of cultural and sub cultural groups inside. All the people should respect any group of cultural identity of their own and the right of developing its unique culture life in the domestic and international background. All human culture can obtain equal opportunities in the aspects of cognition, continuity and development. As the carrier of minority nationality culture, handicrafts should be protected better with the protection of minority cultural rights. The protection of handicrafts is a very important aspect in the protection of the cultural rights of minority nationality. The 3D data acquisition system is a very effective means of protection [1-2].

2. Contrast of Sevral Kinds of 3D data Acquisition Techniques

The traditional 3D data acquisition techniques mainly include:

a. Method of discrete single point acquisition of 3D coordinates, such as the total of three coordinate measuring machine, three axis tracker, instrument *etc.*

b. Method of image data acquisition based on 2D optical photography theory, and then the image data was intends to obtain three-dimensional model for software entity.

Short comings of these techniques. The first method to obtain the data takes a long time. The efficiency is low. The modeling process is very tedious, and the operation is very difficult. The second method exists the problems of inherent distortion error of optical devices, lack of depth of field, the real surface pretreatment, reference point setting, two angle plane dislocation, image data conversion and indirect data expression uncertainty [3-6].

In TPH, Conventional image processing workflows is resulting in orthorectified images and accompanying 3D envelope models are considered to be very useful for the reconstruction of all kinds of vertical constructions, because of their

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relatively high geometric quality [7-8]. However, conventional TPH techniquesare timeconsuming, especially when the used workflows are only compatible with single stereo couples. In contrast, structure from motion (Sf M) enables the fast construction of image based 3D models by processing large images sequences at once in one workspace. This procedure has already proven its advantages in archaeology and cultural heritage [9-11]. Despite of these differences, both conventional TPH and Sf M-based TPH have the ability to register high resolution radiometric information of the measured object, which is a big advantage in relation with TLS. TLS is more recent than TPH, but is nevertheless very useful for the fast acquisition of a huge amount of accurate detail points of an object of interest. This acquisition technique is not only used in archaeology, but is well known in civil engineering, *e.g.*, in the detection of changes in constructions [12-15].

3D laser scanning technology is the product of digital photogrammetry technology, computer technology and modern laser technology. It can quickly obtain each surface sampling location coordinates, get a set of said entity, which we called "point clouds". With the help of computer software, the point clouds data describes the three-dimensional model by using point, line, polygon, curve, surface and other forms [16-18]. We can reconstruct the surface model entity. It can collect the 3D data and reconstruct model from substantiality rapidly.

3. Hardware Design of the System

The hardware of this system includes 6 parts, as shown in Figure 1, laser range finder, computer, servo system, interface board, distance data instrument, angle data instrument.

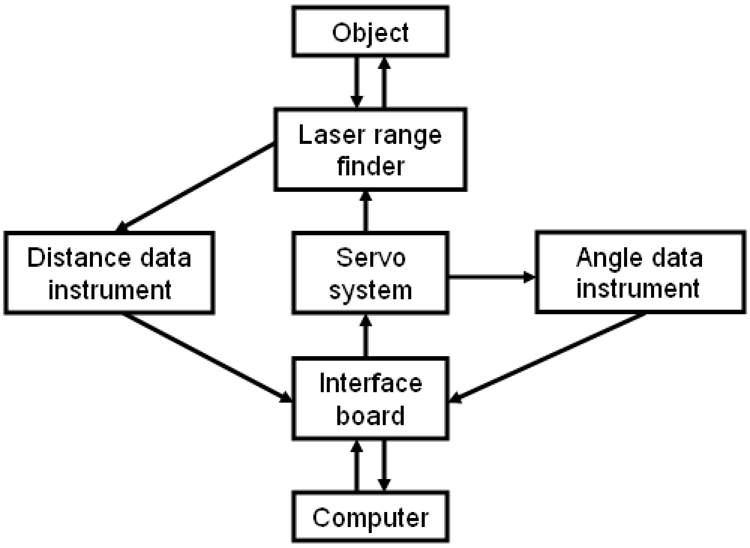

Figure 1. Hardware of this System

Brief introduction of the function of each part are as follows:

The main function of computer are: scanning parameter setting, data display, and the control of laser source, servo system, waveform processing system in the scanning process. The servo system controls pitching, horizontal motor and subdivision circuit. Pitching motor drives the mirror rotation to change the laser beam emitting angle, finish line scanning [19-21]. The horizontal motor is responsible for driving the pitching motor, laser source move to the next frame.

4.Software Design of the System

4.1. Analysis of Software Function Requirement

Software mainly includes these functions: scanning control of 3D laser scanner, scanning data transmission, and the scan data processing in a certain format for 3D modeling software. The control software of data acquisition is mainly through the serial port to send data to the computer to provide data for 3D modeling of follow-up [22-23]. On one hand, the software needs to have the basic function of the software control system of numerical control, such as servo drive unit position control, I/O control and PLC control (limit switch, reset switch operation panel, *etc.*). On the other hand, the software needs to increase the new function according to the requirements of measurement, such as laser measuring head control, measurement path planning, automatic tracking control algorithm, data pre-processing and 3D graphic display. The scanning software, as shown in Figure 2, must have 4 functions, parameter setting, automatic scanning control, scanning data processing, fault diagnosis.

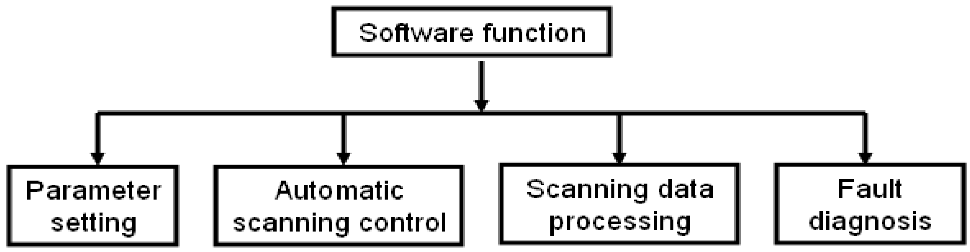

Figure 2. Software Function

a. Parameter setting: according to the requirement of scanning size and precision to determine the basic parameters of the scanning process, such as scanning mode, scanning path, scanning speed, security plane and the sampling frequency.

b. Automatic scanning control: according to the control of scanning parameter to complete the scanning process, including scanning trajectory control implementation, read preservation of 3D data and real-time display. When the measurement range is rectangular or circular area, it can be along the X direction or along the Y scan to scan. For the irregular region, it can be establish a special scanning way according to the specific characteristics of the surface, such as adaptive and tracking scanning.

c. Scanning data processing: can realize different kinds of processing the raw scan data, such as eliminating noise, scaling and rotation.

d. Fault diagnosis: can achieve a variety of state examination of 3D laser scanner, such as the I/O port status and servo system.

4.2. The Operation of the Software Platform and Development Tools

Operation platform is Windows. Windows provides a powerful function and friendly man-machine interface (GUI). This makes it not only is widely used as a management type work platform, has also been applied to the engineering field. Windows provides the internal interface function rich to application development (API) [24-25]. It can easily achieve the pop-up windows, menus, scroll bars, dialog boxes, icons and other interface elements.

The development tool is Visual C++. Visual C++ is a very powerful visualization application development tool. It is one of the most outstanding application development tool for computer recognized. Visual C++ provides a powerful, fast programming tools.

4.3. Modular Design of Software

Modular design of software is shown in Figure 3. In the scan planning module, according to the requirement of measurement area size and accuracy, we can pre determine the basic parameters of the scanning process. In the automatic scanning module, we can control the laser probe according to the scanning input parameters of the trajectory. In the fault diagnosis module, we can check the I/O status flags and print an error information Table.

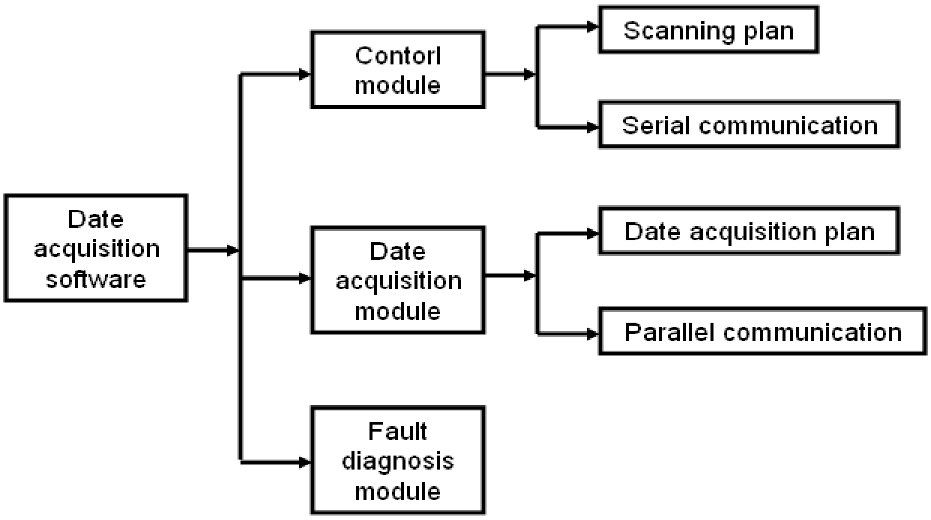

Figure 3. Modular Design of Software

4.4. Design of Software System Framework

According to the characteristics of the software, in order to realize the scanning efficiency and the real-time high-speed data acquisition, we adopt VxD technology to realize Windows platform interrupt and dual buffer technique. We use the OpenGL technology and ActiveX technology to realize data real-time 3D display.

We don't need a database to process single scanning data files because the date files are big and the number of them is small. The system structure of software is shown in Figure

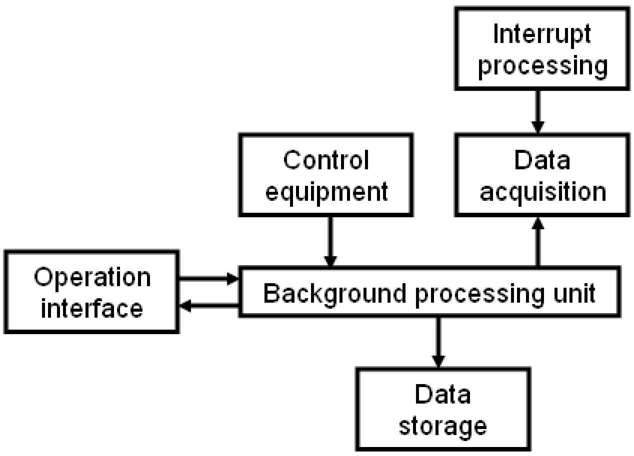

Figure 4. The Software System Structure

5. Information Fusion of 3D Data Acquisition

5.1. The Data Acquisition Process

The software of data acquisition is programmed by Visual C++. The software is run in the Windows 7 environment. The interactive interface is friendly. The date input is completed by keyboard and mouse. The main function of data acquisition software is the management and control of the scanning process. Parameter setting function mainly complete the scanning parameters from the input interface through the serial port to send to the tilt controller. Scanning control function control scanning process by start, stop, continue command. The sensor will transmit the 3D scan data to the host computer through the parallel port, and the host computer will display the date real time in the form of 3D [26-27]. In the data storage function, these data will be stored in accordance with the viewpoint structure into a format file. The date can be provided to the dimension scanning system reconstruction software or other data processing software. The system structure diagram is shown in Figure 5.

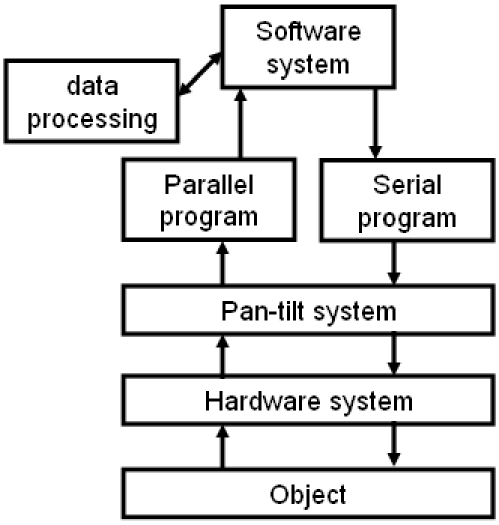

Figure 5. The System Structure Diagram

Data acquisition system is based on the combination of software and hardware. First of all, the host computer will set up the scanning parameters and send scan parameters to 80C51 through the RS232 serial communication. The IC will control pan-tilt's level, pitching movement. The pan-tilt will drive the laser range finder to move. With pan-tilt turning, angle encoder will record the horizontal and vertical angle, and laser range finder records the point distance value. The data will be send to the computer memory through the counter. In order to carry out real-time angle measurement of fixed-point, the counter must be used. So, we can record the measured angle truthfully. We can analyze and process these data and prepare for the modeling work for the future. The whole process of acquisition is shown in Figure 6.

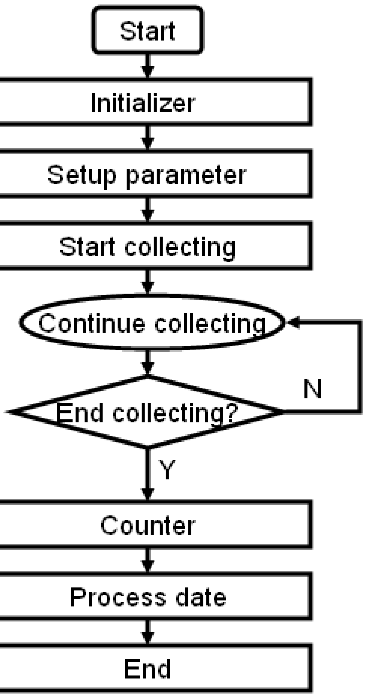

Figure 6. The Process of Acquisition

5.2. The Original Measurement Data Acquisition

The sensor associated with the laser 3D shape data acquisition is divided into 3 kinds: the laser range finder, horizontal angle encoder and vertical angle encoder. The date they measured has:

a. Each scan line number (256 per scan line repeat).

b. Get in a moment of scanner center point to surface distance value (maximum distance of 100 meters, the maximum accuracy of 0.001 meters).

c. The scanning angle according to the number of scan points at maximum and minimum scanning angle and each line of the calculated a scanning point, including the horizontal angle and vertical angle.

d. According to their time counter scanner scanning precision of time.

Because the data acquisition frequency of each sensor is different, in order to ensure the scanning point horizontal angle, vertical angle, distance matching, We put the synchronous signal in date acquisition as reference, take the time as the symbol for data interpolation and data matching. Combined with the information of sensor, we get the scanning data of each scan line. In the time matching, sensors record the computer time at the same time of recording the measurement date [28]. Considering the influence of time precision, recording time is the large number of computer. It can be accurate to the millisecond. This also reduces the error of data collection.

6. Z Axis Focusing Test on the System

Z axis direction focusing resolution is a very important parameter. The Z axis test is obtained by using the optical microscope with the function of image acquisition, as shown in Figure 7, and Figure 8. The resolution of the camera is 640 * 480, 40 times of micro amplification. From a coke from the top layer of the circuit board printing layer of white coke (approximately 0.2mm thick). Z shaft lifting adjustment interval of 500 step (*i.e.,* 50 m interval), the vertical direction for positive, focusing evaluation function threshold is 240.

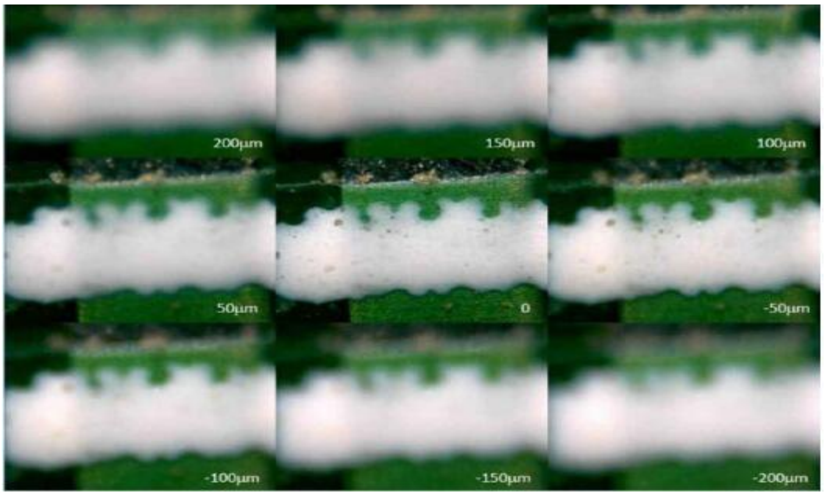

Figure 7. Test Images

Image number	Focus evaluation results
1	2583
2	3023
3	4013
4	4125
5	5014
6	4226
7	4075
8	3979
9	3318

Figure 8. System Test Data Results

The effect of micro focusing on the system Z axis is ideal, as shown in Figure 9. The focus of the polymer is about 20% higher than that of the upper and lower 50 m position. Because of the influence of the factors such as the magnification of the micro amplifier and the uneven illumination, the image of the smaller displacement step size is not focused.

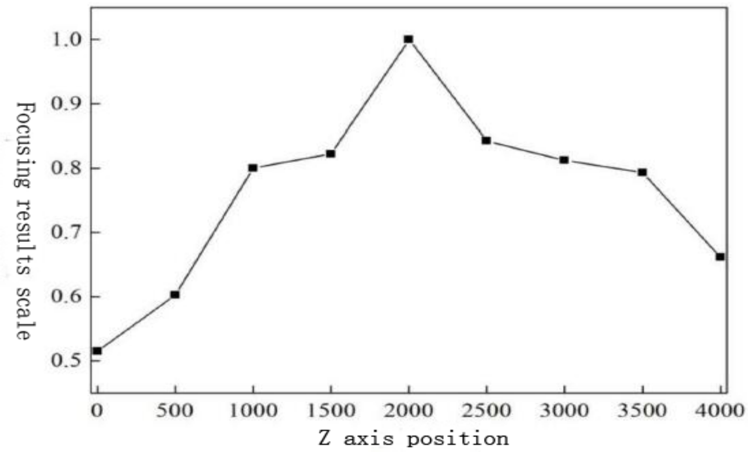

Figure 9. Normalized Curve of Image Focus

7. Conclusion

With the development of information technology in the world, a new digital era has come. 3D laser scanning technology is designed for acquiring 3D information of object. It is a new stereo measurement technology. Compared with traditional measurement techniques, it can realize the non-contact measurement and also can complete the irregular surface, flexible object scanning. The scanning precision and speed of it is high. All these characteristics make 3D scanning technology is widely used in the fields of reverse engineering, Studio Entertainment industry, national defense, medical, cultural relic protection. We can apply this technology to protect handicrafts.

This paper designs the main hardware and software of 3D data acquisition system on handicrafts. The main achievements are:

a. The hardware system design.

b. The software system design.

c. Based on 3D data acquisition, completed the fusion and matching of point cloud data.

Prospect of the future practical applications, there are some problems which need to be solved:

a. The accuracy of data acquisition system needs to be improved.

b. The program design of data acquisition software should further improve.

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