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Three-dimensional Scanning System Design and its Application in a Small Aircraft Shaped Pieces Precision Measurement and the Application of Damage Repair

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ABSTRACT

Using 3D scanning technology to build a set of binocular active 3D scanning system and introduces the working principle and composition of system and is applied to the general aviation shaped pieces or accurate size measurement and damage repair of complex parts. Using this system can not only improve the measurement precision and efficiency of special-shaped pieces, can also be used to create a digital model of remanufacturing damage parts, combined with 3D printing technology to realization of complex parts and shaped pieces of domestic production.

Key words: 3D scanning, general aviation, shaped pieces, accurate measurement, remanufacturing

INTRODUCTION

General aviation small aircraft primarily used for flight training, aviation club, agriculture, forestry, search and rescue and other areas, due to low prices, easy to operate and easy to maintain, in the world has achieved rapid development. In the general aviation industry, the rise of China, the number of small aircraft has increased year by year, a variety of general aviation operating companies and operators training schools have sprung up (Wang and Cao, 2011).

While the above advantages but in small aircraft use and maintenance, has a lot of hidden dangers that are basically small aircraft industry in the United States and several other developed countries general aviation manufactured by, for example, the United States CESSNA company and France SOCTA company etc. aircraft production companies, foreign manufacturers have a congenital lack of aviation material and technical support, etc., in other aspects of the repair process and technology research and accumulation is still a long way to go, especially in precision measurement and reverse repair of shaped pieces, due to the lack of professional high-precision measurement equipment and means, thus giving a lot of security risks to training and flight.

This research with the aid of advanced measurement technique and method, using 3D scanning technology to build a binocular active 3D scanning system and is applied to the general aviation or complex irregular parts of accurate size measurement and damage repair practice (Fang and Wan, 2014).

MATERIALS AND METHODS

Emerging three-dimensional scanning and 3D printing technology can apply in general aviation small aircraft shaped pieces of precision measurement and repair areas. Binocular active 3D scanning system used in this study is mainly composed of industrial camera, light source (projector), PC and David software, its prototype system see Fig. 1.

Fig. 1: Binocular active 3D scanning system prototype

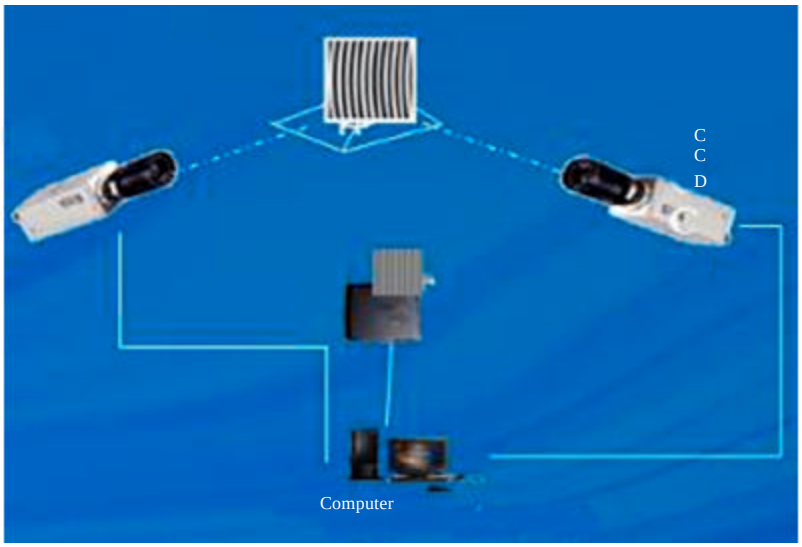

Fig. 2: Binocular active 3D scanning technology principle

Three-dimensional scanning is divided into active and passive methods; this study uses a binocular active 3D scanning technology, through increases an active longitudinal infrared light source in the tested parts surface to improve the measurement accuracy and the basic working principle is shown in Fig. 2.

Binocular active 3D scanning system is the surface scanning way, by projecting active longitudinal infrared light in the surfaces, through the image analysis process computing three-dimensional coordinates of the object surface point using triangulation method (Ye *et al.*, 2004). The design uses a non-contact 3D optical scanning mode; you can easily get the part surface information, is available to scan and detect for the appearance of complex, free-form surfaces, flexible and easy to wear objects (Lu, 2006).

Through detection of special-shaped complex surface parts, analyzed the shape of real world objects or environments (geometric configuration) and the appearance data (such as the nature of color, surface albedo, etc.) according to data collected to calculate three-dimensional reconstruction, in the virtual world create a digital model of the actual object (Gao *et al*., 2007; Yang *et al*., 2010). Using this digital model can measure the damage surface to determine the airworthiness of parts, can also remanufacturing and repair the damage surface of parts and ascertain whether the repaired special-shaped workpiece surface meet the technical parameters of the original part (Cheng and Xie, 2010).

RESULTS

Three-dimensional surface measurement system constructed in this study and its reconstruction results are shown in Fig. 3 and 4.

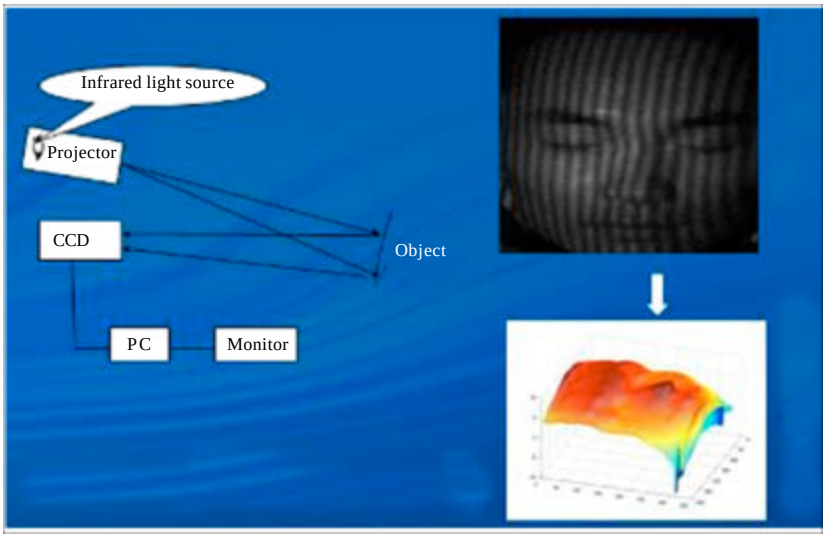

Fig. 3: Infrared three-dimensional surface measurement system

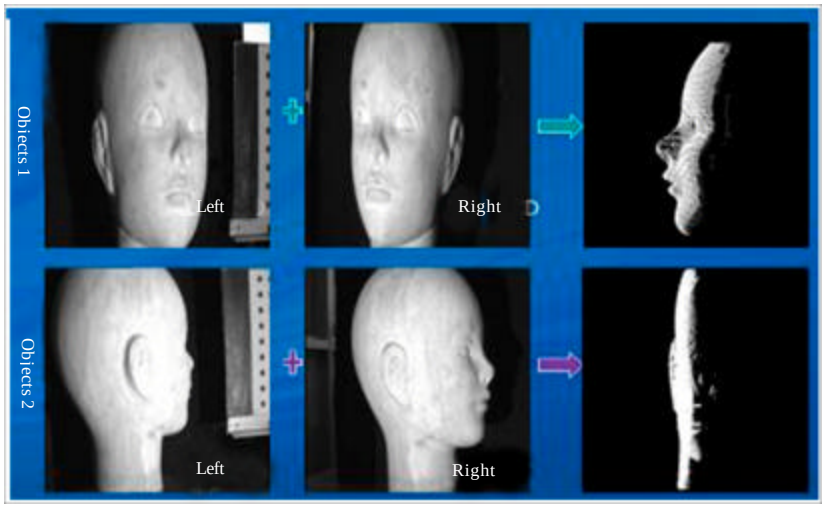

Fig. 4: Reconstruction results

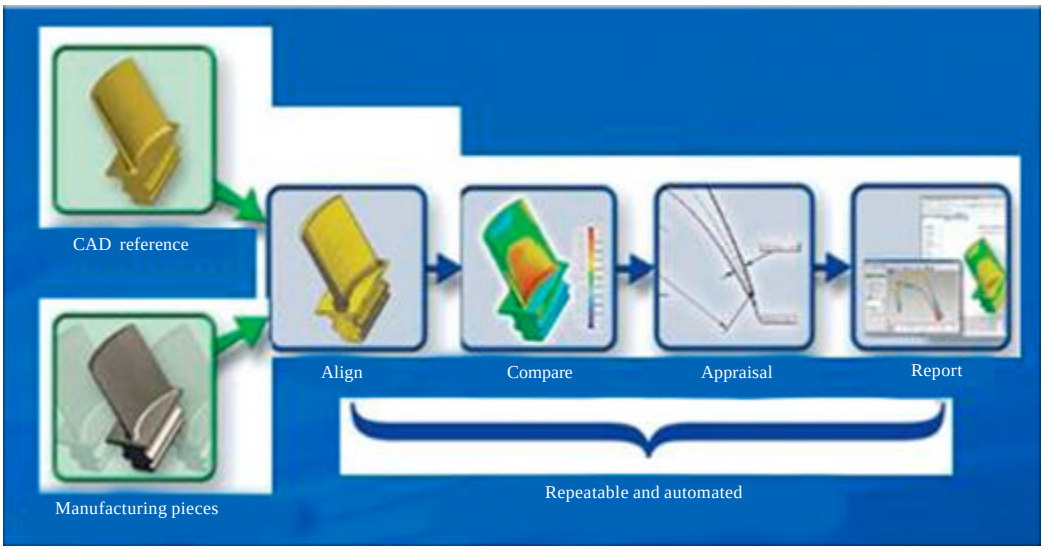

Fig. 5: Workflow of three-dimensional scanning measurement techniques

Three-dimensional scanning measurement techniques general flow of work shown in Fig. 5. Comparative physical and digital models established, corrected and amended report is given to determination of the measurement parameters or the repaired dimensions (Liu *et al*., 2010).

DISCUSSION

Traditional non-contact measurement is the use of Interaction physical phenomena occur on the surface of the object, such as light, sound and electromagnetic, etc., to obtain three-dimensional coordinates information of the object surface (Li and Zhang, 2009). Currently the most widely used is the use of optics developed triangle method, structured light method, computer vision, laser interferometry, laser diffraction method and other modern three-dimensional shape measurement method. Non-contact measurement can effectively avoid the system error and random error caused by measurement stress in high accurate measurement, convenient to realize the measurement of soft and thin shaped object surface shape, has fast measurement speed, high precision and high efficiency (Luo and Zhu, 2005).

This study constructed a three-dimensional scanning of binocular active infrared detection system and successfully applied to the non-contact precision measurement of general aviation shaped pieces, not only can quickly and accurately determine whether the complex or profiled size out-of-tolerance and determine the missing part of the information such as the shape and size and can be based on a digital model of manufacture obtained after the repair of parts to detect and correct, if combined with the current 3D printing technology can quickly make domestic production of the complex and irregular parts.

Using this three-dimensional measurement system, you can quickly ascertain whether the shaped pieces size exceed the standard size, and, as appropriate, to repair the damage. Firstly, use the original new parts to build digital models by three-dimensional scanning; the use of digital models to detect the pieces dimensions and other technical parameters meets the requirements, thus achieving the purpose of accurate measurement. For the excessive size parts, especially shaped pieces, using the model can quickly detect and ascertain the location and shape of the missing parts,

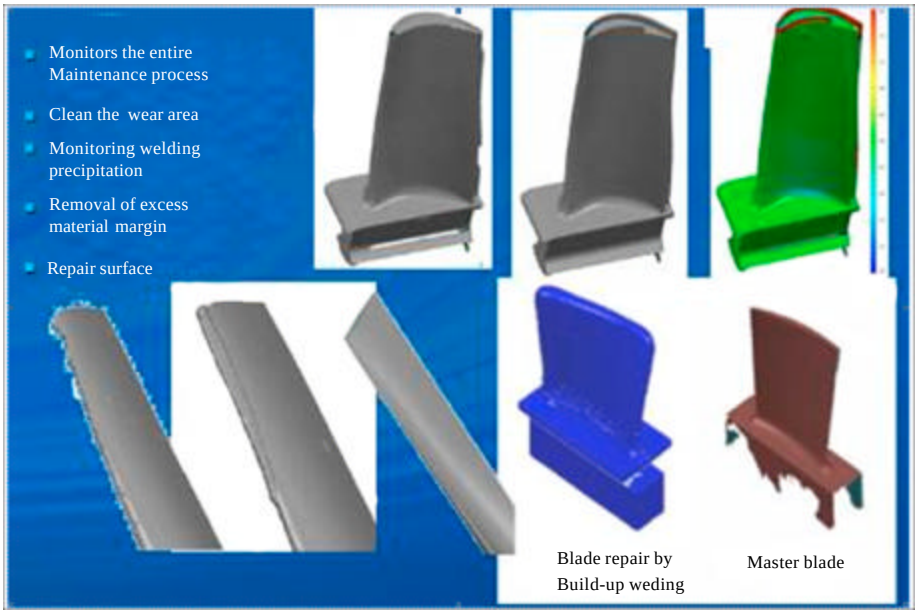

Fig. 6: Repair process schematic

size, etc., the use of remanufacturing process to plastic repair the damage shaped pieces parts and finally again to repair parts determination. Repairs to the blades, for example as shown in Fig. 6 showing the detection and repair process shaped pieces parts.

CONCLUSION

This study constructed a three-dimensional scanning of binocular active infrared detection system and successfully applied to the non-contact precision measurement of general aviation shaped pieces, not only can quickly and accurately determine whether the complex or profiled size out-of-tolerance and determine the missing part of the information such as the shape and size and can be based on a digital model of manufacture obtained after the repair of parts to detect and correct, if combined with the current 3D printing technology can quickly make domestic production of the complex and irregular parts (Wu and Zhang, 2014).

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