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High Precision Measurement Technology of Geometric Parameters Based on Binocular Stereo Vision Application and Development Prospect of The System in Metrology and Detection

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Abstract: Computer vision is widely used in many fields such as robot navigation and binocular vision ranging. For the measurement and detection of large area, the manual operation process of the traditional method is relatively simple.For the difficulty, the use of measurement technology based on computer vision can play a greater advantage and value.This technology is a non-contact measurement technology, which does not need manual work in dangerous working environment. Operation, with high measurement accuracy, can further reduce the cost of measurement, the operation process is relatively simple, so in industry, medicine and space mapping has a wide range of applications. Scene and greater disciplinary research value. Based on this, the high precision measurement technology of binocular stereo vision is studied in this paper, and the application requirements in measurement and detection are put forward point and future development prospects.

Keywords: Binocular Stereo Vision Geometry, High Precision Measurement Technology, Metrological Detection.

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1 INTRODUCTION

Binocular stereo vision is a hot topic in the field of computer vision research in our country, which can simulate human vision, and can measure the stereo information of sceneries under various conditions, and has a value that other computer measurement technologies are difficult to replace [1]. Therefore, the research of this technology, whether based on the perspective of visual physiology or engineering practice, has important practical role. The research work of stereo vision originated in the mid-1960s, which realized the transformation of 2D image to 3D image research [2]. In the following decades, through the continuous research of relevant researchers, the technology has become a new discipline.

2 COMMON MEASUREMENT TECHNIQUES

2.1 LASER TRACKER MEASUREMENT METHOD

Laser tracking measuring instrument technology is mainly through the rational use of spherical coordinate system to solve the three-dimensional coordinate of the target point. In the process of using this technology, the length L can be obtained directly by using the laser interference principle, and the α and β can be obtained by different Angle encoders. If you want to obtain the workpiece coordinates in the process of practical work, it is necessary to carry out the radius compensation processing simultaneously. Therefore, when using this technology, the mirror cannot move faster than required. If the loss of light of the target lens occurs during the measurement, the measurement work cannot continue, but needs to be readjusted. It can be seen that the technical efficiency of the laser tracking measuring instrument is relatively low, the operation process has a large skill, the technical efficiency of the demand instrument is relatively low, the operation process has a large skill, and the relevant staff needs to have rich work experience. The staff concerned should have extensive work experience.

2.2 INDOOR GPS MEASUREMENT METHOD

Indoor global positioning system (GPS) measurement technology is mainly through the rational use of triangulation measurement technology to achieve global positioning function. The structure of the whole system is similar to that of satellite network [3]. Although indoor GPS technology can meet the large-scale and large-area spatial dynamic measurement standards, the use of this technology has a high cost input. [4] At the same time, the measurement accuracy cannot meet the requirements of high-precision measurement.

In addition, the number of receivers is limited, and the number of obtained spatial coordinates is also limited, and there is still a lot of room for progress in the use of high-precision indoor GPS technology in China.

2.3 Visual Measurement Method

Compared with other technologies, the advantage and value of visual measurement technology is that it has better measurement efficiency, and the measurement flexibility will be significantly improved. With better measurement efficiency, measurement flexibility will be significantly improved. Stereovision measurement technology is represented by stereovision measurement technology, is an important branch of visual measurement technology, is one of the important branches of visual measurement technology, is widely used in practical work. Stereo vision measurement is divided into three parts, which are widely used in practical work. Stereo vision measurement is divided into three steps, which are the preparation before the measurement, the collection of information and the subsequent steps, which are the preparation before the measurement, the collection of information and the subsequent algorithm processing.

The algorithm processing of stereo vision measurement technique used earlier in engineering practice. The stereo vision measurement technology used in engineering practice can be traced back to the 1970s. In 1978, a company in the United States developed the V-STARS system, the system was applied in aviation manufacturing, etc [5,6]. Developed the V-STARS system, the system was applied in aviation manufacturing and other equipment production activities. In 2005, the V-STARS system began to be introduced into equipment production activities, which has played an important value in the field of communication space in China [7].

After a comprehensive improvement of the system, Guangzhou Shipyard International Company Limited (GSI) has launched a new generation of measurement systems that can meet the needs of high-precision measurement. At the same time, the new generation of dual-camera systems and typical measurement accuracy has reached 10 μm+10 μm/m. China's stereovision measurement technology has been widely 10μm+10μm/m [8]. China's stereovision measurement technology has been widely used in large size measurement work, such as stereo vision measurement technology can be used in large size measurement work, stereo vision measurement technology can be used to automatically measure the body, design vehicle parameter measurement system, and quickly measure the geometric parameters of the vehicle size.

Compared with visual measurement technology, other measurement technology or equipment measurement efficiency is lower, or the operation process has higher technical requirements, or the equipment cost is higher. Therefore, it is necessary to develop an efficient, accurate and cost-effective stereo vision measurement technology system to meet the rapid measurement needs of large sizes.

3 PRINCIPLE OF HIGH PRECISION MEASUREMENT TECHNOLOGY OF BINOCULAR STEREO VISION GEOMETRY

Binocular stereo vision mainly relies on the dynamic simulation of human data principle by computer technology, and realizes the passive perception of distance with the help of computer [9]. The method is based on two or more points looking at the environment of the same object, resulting in images of different dimensions. Then, according to the matching degree of pixels in the image, the principle of triangulation is used to obtain the offset data of space points in the two images, and finally the three-dimensional data information of the object is obtained [10,11]. People can not only obtain the actual depth of field data of the object, but also clearly understand the true distance between the object and the camera, and can grasp the three-dimensional size of the object, so as to determine the true distance between the two points.

The value of binocular stereo vision measurement technology lies in its high efficiency, scientific and reasonable precision, simple system structure and low cost, which is more suitable for online non-contact product detection and quality control work in the manufacturing site [12,13]. Binocular stereo vision system is one of the main technology of computer vision in our country, which can obtain the distance information of three times the scene, and is the key content in computer science research. Compared with other stereo-vision measurement and tracking methods, binocular stereo-vision technology can directly simulate the way of human eyes processing objects and obtain data. [14] The results are more reliable and convenient, and it has good application value in many fields. For example, the technology can be useful for position detection and control of microoperating systems, robot navigation, aerospace three-dimensional measurement and virtual reality [15,16].

In the field of computer vision technology, binocular stereo vision system mainly relies on dual cameras to simultaneously capture two digital photos of the observed object from multiple angles, or to capture two digital photos of the observed object at various time points and angles through the camera, and use the principle of visual deviation to repair the three-dimensional geometric information of the object [17,18]. Reshape the three-dimensional shape and position of an object. The design of binocular vision systems has its own characteristics and can adapt to various environments. For those cases where extensive, large-scale measurements are required and high accuracy is required, binocular stereo vision systems with dual cameras can be selected [19]. For objects with relatively small measurement range, strict vision system and quality requirements, and need to be measured in real time at a faster speed, a single camera

for optical imaging can be used [20].

The installation method of the vision system will have a direct impact on the accuracy of the measurement results. The binocular stereo vision system using two cameras must be installed on a stable platform, and then the binocular vision system calibration is carried out. Or in the process of using the system to measure, it is necessary to ensure the stability of the built-in parameters of the camera and the relative position of the two cameras, and the whole process cannot be changed. If one of the links changes, it is necessary to re-calibrate the binocular stereo vision system. In the binocular stereo vision calibration, it is necessary to use high-precision calibration template, more perfect and scientific mathematical model of camera calibration, based on complex environmental conditions, to ensure the rationality of field calibration system. The image coordinates of the left and right image feature points are used to measure the feature points effectively in the three-dimensional coordinate space [21,22].

The research of binocular stereo vision has always been a hot topic in our vision research, but also a difficult topic. The three-dimensional contour of an object can be determined by the binocular stereo vision system, and the three-dimensional coordinates of any point can be obtained from the contour [23]. Therefore, binocular stereo vision system has a wide application prospect in the whole field of machine vision and mapping. In order to apply this technology in different projects, it is necessary to optimize the efficiency and accuracy of the algorithm, and use the image correction stereo vision system to simplify the stereo matching comprehensively, and improve the efficiency and quality by means of filtering, distribution classifier and collection realization [24,25].

4 APPLICATION OF HIGH PRECISION MEASUREMENT TECHNOLOGY OF BINOCULAR STEREO VISION IN METROLOGICAL INSPECTION KEY POINTS OF APPLICATION IN MEASUREMENT

4.1 Camera Calibration

The camera is an important measurement tool for constructing the physical world using computer technology [26]. Because in the process of using the camera, its parameters will change to different degrees under the influence of related factors such as environment, temperature, and condition changes, for this reason, in order to ensure the accuracy and effectiveness of positioning, camera calibration work must be carried out [27,28]. In general, a single camera calibration technique can be used first, and then a set of fixed points in the same world coordinates can be used to clarify the position relationship between the bidirectional mechanisms. At present, the calibration methods are mainly divided into two categories, linear calibration and nonlinear calibration. When calibrating a single camera, perspective transformation matrix and direct linear transformation are commonly used [29]. When calibrating binocular cameras, whether the external parameters can be guaranteed to be accurate and effective will have a direct impact on the final result. In general, it is necessary to determine 8 or more known world coordinates in order to obtain a scientifically reasonable parameter matrix.

4.2 Feature Point Extraction

During measurement, the accuracy of measurement will have a direct impact on the accuracy of two-dimensional image coordinate point extraction. For this reason, the accuracy of feature point selection has a direct impact on the extraction. Therefore, in the extraction, the feature points need to be adapted to the sensor type and technical situation, and at the same time, the consistency and robustness of the feature point extraction need to be ensured [30]. In the process of image acquisition, there may be other noise sources. In order to further optimize the comprehensive quality of the image and highlight the feature points of the image, before further optimizing the comprehensive quality of the image and highlighting the feature points of the image, the image pre-processing should be carried out first [31]. At present, the common and effective feature point extraction methods are mainly the minimum gray difference method, the interest operator method and the edge extraction method. The edge extraction method and the interest operator method have higher light sensitivity. If the gray scale of the adjacent surface of the object is similar, the two higher light sensitivity methods can achieve effective generalization and extraction of the feature points under the requirement of low precision [32]. However, if a pixel has local gray difference regions or different gray values, it needs to have different gray values when carrying out relevant operations in adjacent regions, and it needs to be comprehensively considered when carrying out relevant operations in adjacent regions to determine whether it can accurately extract feature points.

5 APPLICATION SCENARIO OF HIGH PRECISION MEASUREMENT TECHNOLOGY OF BINOCULAR STEREO VISION GEOMETRY

5.1 Lane Detection

In lane detection, vision needs real-time feedback analysis of road conditions such as road bending, shadows, road surface changes and sign line changes, and real-time feedback analysis of road conditions such as deep learning computation and sign line changes, and automatic generation of vehicle optimal driving route through deep learning

algorithms [33]. In order to realize fast maneuver inversion, the optimal driving route of the vehicle is automatically generated. In order to achieve fast maneuvering response, high-speed environment acquisition capability is required. The image response of binocular vision inertia module requires high-speed environment acquisition capability. The image acquisition frame rate of binocular vision inertia module is fast, and the lane change is quickly detected when the lane change is encountered [34]. It can also analyze the lane change trend through continuous multi-frame analysis, and provide the automatic driving algorithm with accurate and fast environmental information data in many aspects through continuous multi-frame analysis of the lane change trend, and assist the algorithm to achieve high-mobility automatic driving. For many accurate and fast environmental information data, to assist the algorithm to achieve high mobility automatic driving.

5.2 Material Testing

In the inspection process, vision needs real-time feedback analysis of changes in material size, shadow, surface wear, etc., and automatically generates real-time feedback analysis of detection changes through deep learning algorithms, and automatically generates detection results through deep learning algorithms [35]. In order to achieve fast maneuvering reaction, high-speed environmental energy acquisition results are needed. In order to achieve fast maneuverable response, high-speed environment acquisition capability is required. The image acquisition frame rate of the binocular vision module can reach 200 frames, and the binocular vision module can quickly detect materials at a speed of 0.005 s/frame [36]. And through continuous multi-frame analysis of surface defects, to provide a variety of accurate and rapid environmental information data, auxiliary algorithms to achieve high-performance surface detection.

5.3 Robot Vacuum Cleaner

As the visual navigation system continues to ferment in the head camp of iRobot, Dyson and other sweeping robots, the technical problems of visual navigation monocular and binocular have also continued to ferment, and the technical problems of visual navigation monocular and binocular have also received extensive attention from sweeping robot manufacturers [37]. Binocular visual navigation is positioned to the wide concern of vacuum sweeping robot manufacturers. Binocular vision navigation is a sweeping robot navigation scheme with higher positioning accuracy, stronger systematization and more intelligent. A sweeping robot navigation scheme with higher precision, stronger systematization and more intelligent can better lead the sweeping robot to transform into a household cleaning intelligent assistant [38]. It can better lead the transformation of sweeping robots into intelligent household cleaning assistants. With the continuous progress of technology, it can be predicted that the binocular vision navigation system will gradually become the mainstream navigation and positioning scheme for sweeping robots with the continuous progress of technology [38].

6 THE FUTURE PROSPECT OF BINOCULAR STEREO VISION SYSTEM

Vision technology has been widely used in measurement and inspection work around the world. For example, the Institute of Mechanical Systems at Osaka University in Japan has developed an adaptive binocular vision servo system; The University of Washington, in collaboration with Microsoft, has developed a wide-baseline stereo vision system that can accurately locate and navigate within kilometers of Mars. But overall, in order to truly create a universal binocular vision that is no different from the human eye, the following points are summarized:

First, benefiting from the increasing improvement of 5G supporting infrastructure, the comprehensive expansion of the development scale of the manufacturing industry, the continuous improvement of the level of intelligence, coupled with favorable policies, China's binocular stereo vision market demand will also increase comprehensively. Therefore, in the context of the improvement of the technical level of the industry and the increasingly extensive application field of products, the future machine vision market will be expanded in an all-round way.

Second, the market space is huge. It is predicted that by 2025, the global machine vision market will exceed $15 billion. With the comprehensive expansion of the application market, the market demand will be expanded in all directions. Faced with the expanding market, most companies will choose to use binocular vision measurement technology to obtain more mature development experience in image algorithms.

Third, the binocular vision chip shows a good future development trend. The image processing algorithm is initially completed by the software algorithm of the server, but with the full maturity of 5G technology and intelligent technology, it will be gradually expand to the cloud computing to complete. This will also put forward higher standards and requirements for the computing amount of cloud servers, requiring greater network bandwidth. Therefore, the binocular vision chip has more obvious technical advantages, which can further reduce the cost input and improve the computing power.

Fourth, machine vision is a strong demand. In today's era, the field of computer vision has shown a new development trend, in addition to can be used in mobile phones, personal computers and process testing, computer vision technology in robotics, intelligent driving, augmented reality and many other fields have appeared different forms of application, therefore, computer vision will usher in the era of explosive growth of applications.

The fifth is to explore a new and more widely applicable stereo vision calculation theory and matching methods, select scientific and reasonable matching principles, clarify the algorithm structure, and fundamentally solve key problems such as gray distortion, geometric distortion, noise interference, and special structures.

The sixth is the development of the algorithm towards parallelization, further improving the speed and reducing the total number of operations of the relevant staff, so that the practicability of the system is enhanced, and the constraints of the scene and task are strengthened. The practicability of different systems is enhanced, the constraints of the scene and task are strengthened, and the stereo system with certain goals is built in the face of different application purposes.

To sum up, testing in the production process is an important work, which plays a vital role in the improvement of product quality. Therefore, in order to improve the efficiency and accuracy of product quality inspection, many enterprises have begun to use machine vision technology. This paper mainly introduces the application and development prospect of the high precision measurement technology of binocular stereo vision geometry in metrology and inspection, and analyzes it briefly, hoping to provide some references for related workers.

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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