Design of Intelligent Collision Detection System for Multi-robot Body Based on 3D Vision Technology

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Keywords: 3D vision technology, Dynamic collision, Intelligent detection system, Design.

Abstract: With the development of scientific and technological information, human research and exploration of intelligent products is also deepening. At present, the simulation of 3D vision technology for dynamic collision detection between multi-robot bodies has become a hot research topic. Therefore, based on the application of 3D vision technology to the current situation in the field of dynamic collision between robots, the intelligent detection system of multi-robot interbody dynamic collision is designed and tested based on 3D vision technology. The results show that the intelligent detection system can recognize the dynamic collision signal very well.

1. Research background

1.1 Literature review

Dynamic collision between robots based on 3D vision technology is an important plate in intelligent human-computer interaction. Research topics among human-computer interaction include domestic service, human training, biological research, body-sensing games and so on. The dynamic collision intelligent system based on 3D vision technology multi-robot body is of great practical significance to improve the practicality and robustness of human-computer interaction system, so many scholars have carried out in-depth study. Jinning et al. system designed the intelligent robot based on the human action recognition of STM32. The robot under the control of the system can imitate the human hand command to carry out the corresponding action, such as left and right turn, hand lift, chest nod and so on. At the same time, the system can also realize the function of barrier avoidance and voice control, can be widely used in domestic service, dangerous environment exploration, high-risk work and so on (Jin et al, 2018). Tian And others to improve the intelligence and initiative of robot services, the use of Kinect body sense device to obtain the human body's joint point data to solve the human behavior recognition problem. The final result also shows that the behavior chosen indicates that the characteristic quantity has rotation and translation invariance. And the practice also shows that the behavior recognition algorithm proposed in the article can achieve good recognition effect (Tian et al, 2014). Shi Zheng et al. found in the simulation collision test of accidental collision with human body in the course of the work of the robot arm that the UR robot can realize the function of “collision-avoidance-recovery work” of the robot arm in the case of collision force less than 150 N, which can effectively protect the hit object and the robot arm body (Shi et body) al, 2015). Wang Wei and others use PLC to control the five degrees of freedom polishing and polishing robot body, so as to achieve intelligent control of complex surfaces. The experimental results show that the control system can monitor the field parameters in real time, set the process parameters, facilitate operation and maintenance, and, compared with manual polishing, the efficiency of the system polishing and grinding is increased by 47% (Wang et al, 2015). Through the above-mentioned scholars research results, most of the research is proposed to improve the efficiency of intelligent robots, but based on 3D vision technology intelligent collision detection system is less research, so this paper from the intelligent detection system, the multi-robot dynamic collision intelligent system in-depth study.

1.2 Research purpose

With the continuous development of modern information technology, intelligent robots are more

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and more applied to the social life of the public. With the progress of high-tech, the public put forward higher requirements for intelligent products, intelligent, efficient, convenient, practical and affordable also become the goal and direction of the development of intelligent robots (Pan et al, 2014). The current research on intelligent robot collision is mainly carried out by voice, action, number and so on under human-computer interaction. The intelligent system will capture the sound or action, identify the detection, and then through the corresponding contact information connection with the robot, to achieve intelligent manipulation of the robot. However, this way, generally on the basis of 2D human action recognition, the intelligent manipulation of the robot system, and then realize the robot's motion analysis, human-computer interaction, audio-visual retrieval and so on. Therefore, this paper further upgrades 2D human motion capture to 3D vision technology capture, and designs the multi-robot interbody dynamic collision intelligent detection system.

2. 3D vision technology applied to the field of dynamic collision between robots

At present, 3D vision technology is applied to the study of dynamic collision between robots, most of which is still based on 2D motion capture. But such steps require a 2D to 3D connection, on the way to contact or cause some information to be lost. Because capturing 3D visual rendering from 2D action requires more algorithmic assumptions and higher complexity. Therefore, in order to reduce this step program, 3D vision technology began to gradually eliminate 2D motion capture, direct use of 3D imaging for motion capture, reduce the algorithm detection steps (Zheng and Zhang, 2015). So far, the methods used by 3D vision technology in the field of dynamic collision between robots can be broadly summarized in two ways.

One is to capture the difference of 3D information by using 2D motion capture parallax. This method uses more than two camera lenses from the same angle to record the capture of objects, and then uses imaging technology to capture the difference in digital information, the three-dimensional object depth calculation. But usually, there are some drawbacks to such poor information capture. First, at least two or more camera lenses are required for angle capture during 2D motion capture parallax. Secondly, in order to better present 3D information, the camera lens should not be too close to each other, resulting in the camera bit is difficult to make simple and compact arrangement. Finally, the calculation of 3D information difference needs to be pre-processed by two or more 2D imaging information, which requires higher processing and computing power of the chip.

The second is to use holographic imaging technology to obtain three-dimensional information. This method mainly uses holographic imaging technology to capture and record the information required to record the light and shadow image of an object. The three-dimensional presentation of the information after the light and shadow imaging allows the object to be displayed in a simple and clear way. However, such imaging also has a certain degree of defect system of the light source must be coherent light source, while the material and reference light must meet the corresponding prerequisites, and these conditions to some extent will limit the detection of system information.

3. Intelligent detection system design of multi-robot interbody-to-body based on 3d vision technology

The intelligent detection of multi-robot interbody-to-body collisions based on 3D vision technology includes target detection, depth detection and target tracking. Among them, the target detection is to use 3D vision technology, from the robot motion imaging information to detect the need to identify the collision control information, and then the information separation. Thus, the target information of motion is detected based on the method of detecting the changing region, and the first-order image gradient information is obtained in combination with the Sobel operator. This reduces the amount of computation generated during recovery after a robot collision. Depth detection uses an infrared transmitter to emit encoded light to a light image sensor, and the information the sensor will obtain uses a depth acquisition algorithm to decode the encoded light to calculate the depth information for each pixel. Target tracking is the tracking and detection of collision information by using the detection system on the basis of analyzing the depth information.

The entire intelligent detection system is shown in Figure 1.

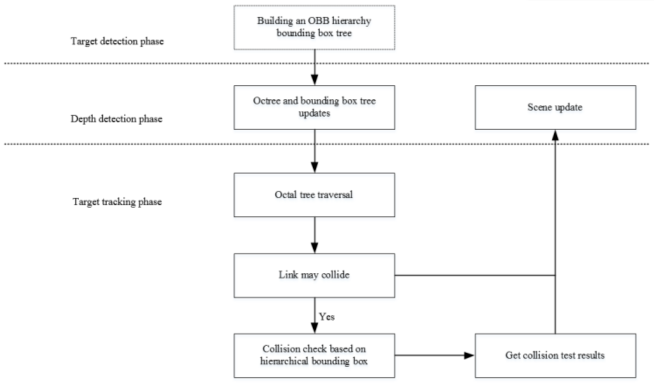

Figure 1.Collision Detection Algorithm Process

The key to multi-robot interbody collision detection algorithm based on 3D vision technology lies in two points. On the one hand, in the huge amount of computing data information, the rapid and accurate identification of the collision generated by the flow of information, excluding all disjointed object information. On the other hand, in the case of data information, accurately determine the intersection of objects, and ensure real-time. Therefore, the detection algorithm proposed by this paper is a mixed collision detection algorithm for collision detection through spatial segmentation and hierarchical enclosure. This detection method requires spatial segmentation through the improved octagon tree at the initial stage. At the same time, the search, insertion and updating of constant time complexity are completed in the octagonal tree, and the search and segmentation of the object information flow intersecting in the initial stage of the robot collision is completed.

The intelligent robot multi-degree of freedom structure, based on the degree of freedom structure after modeling the resulting model is an articulated model. The components of the hinged model intelligent robot are multi-type rigid, so no matter what operating environment, it will not change easily. And each mechanical link is orderly series, adjacent links are not easily separated, each link in the movement of a certain relative position relationship. Therefore, when the intelligent robot collides dynamically, the OBB-enveloping box-level tree can be built in advance during the target detection phase. In the event of a collision, simply update the corresponding link position in the OBB surround box, without the need for repeated calculation of the dimensions of the bracketed box, greatly saving time and waste of time.

The standard for judging the OBB surround box lies in whether the link information is in a computationally complex spatial grid. Usually AABB surroundbox parallel to the axes, compared to oBB surround box it will be easier to determine its own space grid. Therefore, in order to better determine the collision data information in the link, it is necessary to embed the AABB bracket box into each OBB surround box tree outside the root node. This results in faster and more accurate traversal, insertion, and update of collision information to be detected in the octagon tree. In the detection phase of robot object collision information, first traverse the octagonal tree system, find out the array of objects, find out all the information group objects that may collide, and then the accurate collision detection based on the hierarchical enclosure method between these objects.

4. Intelligent detection experiment of multi-robot interbody-to-body based on 3d vision technology

To further detect the collision intelligence detection system mentioned above, the experimental object selected in this paper is the GY-2913 axis accelerometer sensor module. The sensor has a high resolution and the output format is in the form of a 16-bit complement. The digital/analog converter uses the YL-40 conversion module of the integrated PCF8591 conversion chip, which controls the analog output of the analog output through the input digital amount of the I2C serial control number/analog converter of the chip, thus controlling the output current of the driver. The selected sensor first needs to collect the acceleration at the end of the robot's dynamic collision, which transmits and transforms the information through the sensor via the acceleration signal. From this, it can be seen that the control program of the detection system can be divided into three parts: acceleration data information collection program, data information transmission program and data information conversion program.

One contact of the contact sensor switch can be mounted on the side of the collision sensor, while the other contact needs to be mounted on the guide block, which moves with the movement of the guide block. During this process, a certain collision force value can be set in the sensor system, and when the external impact force is greater than this value, the contact switch at the other contact will perform the disconnect operation, at which point the robot will stop working. In the intelligent collision sensor, servo electromagnet as the key component, its working performance determines the reliability of the sensor signal transmission. Further, the article experiments on the electromagnetic suction force of servo electromagnets, as shown in Chart 1 of the data obtained. As can be seen from Table 1, changes in current will have a corresponding effect on electromagnetic suction, and the greater the current, the greater the strength of the electromagnetic suction force. However, the maximum value of electromagnetic suction force is not much different from the theoretical maximum value, therefore, the servo electromagnet meets the requirements set by the article sensor.

Table 1.Current and Electromagnetic Suction Relationship Table

current/A	Electromagnetic suction/N
0.045	2.5
0.079	7.2
0.102	11.6
0.121	16.5
1.139	21.0
1.150	24.3
1.167	30.6

Based on 3D vision technology, when detecting the sudden stop or start operation of a robot encountered by a robot, the contact switch of the sensor is disconnected in time, and the input axis of the intelligent collision sensor is in a horizontal and vertical direction, respectively. Wherein, when the input shaft of the intelligent collision sensor is in a horizontal direction, the maximum acceleration is 0.301gn (1gn?10 m/s2), the contact switch is not open, and when the input shaft of the intelligent collision sensor is in a vertical direction, the maximum acceleration value is 0.398gn (1 s10 m/s2). The contact switch is not open. From this, it can be seen that the intelligent collision sensor can transmit the signal well when it collides.

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