Software design of intelligent robot arm

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Abstract

The intelligent robotic arm is mainly to provide more convenient services for the disabled who are separated from the shoulders. To complete the grabbing of the target object, the robotic arm must obtain the pose information of the target object relative to the base coordinate system of the arm. For an arm working in an unstructured environment, the target object being operated is not fixed, and the position of the target object is not fixed. Without the pose information of the target object, the robot cannot perform inverse kinematics calculations. Therefore, for the upper arm of the shoulder-off type, how to find the operation target automatically by using the arm or using some information to find the operation target without using the help of others is an important technical indicator for checking the intelligence of the upper arm.

Keywords

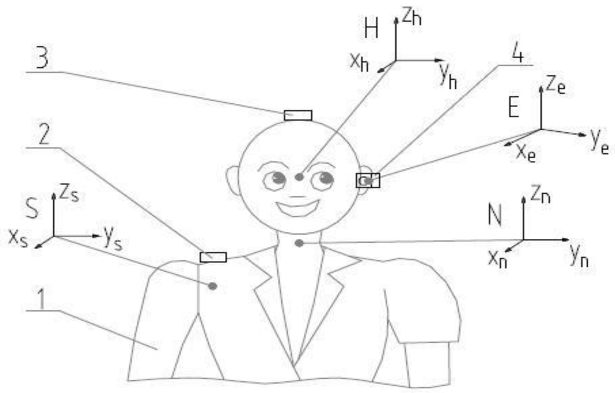
Robotic arm; pose information; coordinate system.

1. Introduction

Every year, millions of people are amputated for diseases, traffic accidents and accidental injuries. With the development of the economy and the improvement of people's living standards, the requirements for the quality of life of the disabled are becoming more and more urgent. The intelligent arm is an artificial device designed and processed to restore the shape and function of the human body to complete the defects caused by amputation. The installation of the upper limb is an important means for the amputee to meet the basic needs of life. The number of amputees in China is large. According to the data of the second National Disability Sample Survey in 2006, there are 2.26 million amputees among the 24.12 million physically disabled . In 1981, Southeast University began to study the forearm and upper arm electric prosthesis. The results were listed by the Ministry of Civil Affairs as the “seventh five-year” promotion and application products. In 1988, the micro-computer double-arm prosthesis was successfully developed. The two double-armed limbs tried for about half a month. The training can use the intelligent upper arm to eat, drink, write, open and call independently . In 2003, Tsinghua University and Hangzhou University of Electronic Science and Technology developed a pseudo-hand force feedback device using PVDF piezoelectric film. The tactile function of the myoelectric electric prosthetic hand was awarded the third prize of Zhejiang Science and Technology in 2010 . With the advancement of society and the improvement of people's living standards, the amputee's requirements for the performance of the arm will be higher and higher, and the bionic level of the appearance, function and control of the arm will gradually increase.

2. Target location method

This part mainly proposes a method for locating random targets in space. The three-dimensional attitude sensor and laser ranging sensor are used to locate random targets. The specific plan is shown below:



1-arm, 2-attitude sensor 1,3- attitude sensor 2,4-laser range finder,
Fig 1 sensor installation diagram

The three-dimensional attitude sensor combines three-axis acceleration, three-axis gyroscope and three-axis magnetometer, relying on geomagnetic positioning. If only one sensor is installed on the head of the user, and the head end timing is taken as the zero point, the angle of the head tilt can be obtained according to the angle difference between the current angle and the zero position. However, the zero angle of the head rotation is not fixed. When the person is in different orientations, the angle of the zero point is also different. Therefore, two attitude sensors must be used, one to detect the rotation of the head and one to be the calibration of the zero point attitude.

Figure 1 shows the mounting position of the attitude sensor. The attitude sensor 1 is mounted on the arm for attitude calibration. The posture sensor 2 is mounted on the top of the user's head and can move in accordance with the movement of the head for detecting the posture of the head. When the user's head end is looking straight ahead, the data of the attitude sensor 1 and the attitude sensor 2 should be identical. When the user's head is tilted up or down or left and right, the current posture of the head can be obtained by analyzing the data of the attitude sensor 1. The angle of the head pitch and rotation can be obtained by comparing with the data of the attitude sensor 2. The posture sensor 1 is mounted on the arm and rotates as the body rotates. At this time, the data of the attitude sensor 1 is the zero point posture of the current orientation.

The confirmation of the operation target is achieved by a laser range finder. The laser range finder is mounted above the left ear and rotates following the rotation of the body and head. Theoretically, the distance from any point in the space relative to the laser rangefinder can be measured. By adjusting the posture of the head, the user projects the spot emitted by the laser range finder to the target to be operated, and also obtains the distance of the operation target while confirming the operation target.

3. Target positioning principle

This section mainly uses the legend to elaborate the principle of random target space location. as shown in picture 2:

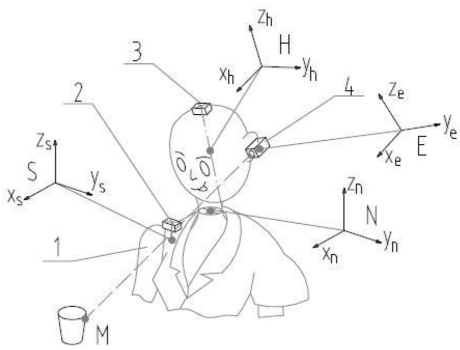


Fig. 2 Schematic diagram of random target measurement

First, we make the following conventions for several coordinate systems used in the positioning process:"S"represents the basic coordinate system of the arm;"N" represents the user's neck center coordinate system; "H" represents the head median coordinate system; E represents the laser rangefinder coordinates. system. The following conventions are also made for conversion between different coordinate systems:The rotation angle of a coordinate system around the x-axis of other coordinate systems is α_i ,The angle of rotation around the y-axis is β_i ,The angle of rotation around the z-axis is γ_i ,The description of the origin of a coordinate system in another coordinate system is (x_i, y_i, z_i) ;The subscript i indicates the description in the i coordinate system. The transformation matrix of one coordinate system relative to another is described by K. For example, HNK represents the description of the "H" coordinate system relative to the "N"coordinate system. When the posture of the user's head end in front of the head is called the initial posture of the head, the calibration of each coordinate system is completed when the head is in the initial state.

The "S"coordinate system is built on the arm as the base coordinate system of the entire target space positioning system. The "S" coordinate system is the robot base coordinate system O-XYZ defined in the previous section. The position information of the target measured by the system is a description relative to the arm-based coordinate system, which facilitates the calculation of inverse kinematics.

The "N" coordinate system is established in the center of the user's neck to describe the rotation of the head. When the user's head is in the initial state, the orientation of each coordinate axis of the "N" coordinate system coincides with the coordinate axis orientation of the "S" coordinate system. When the user's head is tilted up and down, the "N" coordinate system rotates around the y axis of the "S" coordinate system. The angle of rotation can be obtained by comparing the data of the two attitude sensors. Suppose the rotation angle of the "S" coordinate system around the y axis of the "N" coordinate system is β_s , The origin of the S coordinate system is described in the "N" coordinate system as a fixed value. The origin of the "S" coordinate system is described in the "N" coordinate system as a fixed value. It is related to the parameters of the user's body. Then the next transformation matrix NSK of the "N" coordinate system with respect to the S coordinate is

$$ {}_N^S K = \begin{bmatrix} \cos\beta_s & 0 & \sin\beta_s & x_s \\ 0 & 1 & 0 & y_s \\ -\sin\beta_s & 0 & \cos\beta_s & z_s \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (1) $$

The "H"coordinate system is established in the middle of the user's head. When the user's head is in the initial position, the origin of the "H" coordinate system is in the positive direction of the z-axis of the "N" coordinate system, and the orientation of each coordinate axis is consistent with he orientation of the "N" coordinate system. . When the user's head rotates left and right, the "H" coordinate system rotates around the z axis of the "S"coordinate system. The angle of rotation can be obtained by comparing the data of the two attitude sensors.

Suppose the rotation angle of the "H" coordinate system around the z coordinate of the "S"coordinate system is γ_n ,The origin of the "H" coordinate system is described in the "N" coordinate system as a fixed value (0,0, z_n),It is related to the parameters of the user's body. Then the H-coordinate system with respect to the N-coordinate transformation matrix HNK is

$$ {}_H^N K = \begin{bmatrix} \cos\gamma_n & -\sin\gamma_n & 0 & 0 \\ \sin\gamma_n & \cos\gamma_n & 0 & 0 \\ 0 & 0 & 1 & z_n \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (2) $$

The “E” coordinate system is built on the laser range finder. When the head is in the initial state, the origin of “E” is in the positive direction of the y axis of the “H” coordinate system. The orientation of the y-axis of the “E” coordinate system coincides with the y-axis direction of the “H” coordinate system, and the orientation of the x-axis coincides with the orientation of the laser beam.The orientation of the z-axis has a fixed rotation angle with the z-axis in the “H” coordinate system, that is, the “E” coordinate system is rotated by an angle β_h around the y-axis of the “H” coordinate system. The size of β_h is a fixed value, depending on where the laser rangefinder is mounted on the head. The origin position of the “E” coordinate system also depends on the parameters of the user's body and the structural parameters of the laser rangefinder itself. The second transformation matrix EHK of the “E” coordinate system with respect to the “H”coordinate is

$$ {}_{E}^{H}K = \begin{bmatrix} \cos\beta_h & 0 & \sin\beta_h & o \\ 0 & 1 & 0 & y_h \\ -\sin\beta_h & 0 & \cos\beta_h & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{3} $$

“M” is the distance of the current laser point measured by the laser range finder in real time and is expressed as a homogeneous matrix:

$$ M = [m_x \quad m_y \quad m_z \quad 1]^T = [d \quad 0 \quad 0 \quad 1]^T \tag{4} $$

“M” is the distance of the current laser point measured by the laser range finder in real time, and the user adjusts the posture of the head autonomously, and aligns the laser beam emitted by the laser range finder with the operation target, and detects the target relative and “E” in real time. The distance value “M” of the coordinate system is calculated simultaneously, and the relative attitude angle deviation value between the two attitude sensors is calculated, and the NSK value and the HNK value are obtained. Through the coordinate transformation, the real-time spatial coordinate value P of the operation target in the arm base coordinate system can be obtained.

$$ P = {}_{N}^{S}K \cdot {}_{H}^{N}K \cdot {}_{E}^{H}K \cdot M $$

$$ = \begin{bmatrix} \cos\beta_s & 0 & \sin\beta_s & x_s \\ 0 & 1 & 0 & y_s \\ -\sin\beta_s & 0 & \cos\beta_s & z_s \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\gamma_n & -\sin\gamma_n & 0 & 0 \\ \sin\gamma_n & \cos\gamma_n & 0 & 0 \\ 0 & 0 & 1 & z_n \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\beta_h & 0 & \sin\beta_h & o \\ 0 & 1 & 0 & y_h \\ -\sin\beta_h & 0 & \cos\beta_h & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} d \\ 0 \\ 0 \\ 1 \end{bmatrix} $$

$$ = \begin{bmatrix} z_n \sin\beta_s - d(\sin\beta_h \sin\beta_s - \cos\beta_s \cos\beta_h \cos\gamma_n) - y_h \sin\gamma_n \cos\beta_s + x_s \\ y_h \cos\gamma_n + d \sin\gamma_n \cos\beta_h + y_s \\ z_s \cos\beta_s - d(\cos\beta_s \sin\beta_h + \sin\beta_s \cos\beta_h \cos\gamma_n) + y_h \sin\beta_s \sin\gamma_n + z_s \\ 1 \end{bmatrix} $$

4. Conlusion

This paper is a software design for a smart upper limb. It mainly studies the positioning principle and target positioning method. It proposes a three-dimensional attitude sensor and laser ranging sensor and the user's own parameters to obtain the operation target position information. Random target location system. Two attitude sensors are used, one to detect the rotation of the head and one to be the calibration of the zero point attitude. It provides a guarantee for the accurate positioning of the target of the arm, and studies the principle of the target positioning. After calculation and experiment, some theories are obtained, and the paper is briefly explained in the paper, and the autonomous grab space is realized on the basis of accurate positioning. Object. The intelligent robot arm we designed has been intelligent, and can automatically adjust the system parameters according to changes in external conditions and work requirements, which is better than the ordinary robot arm for better bionics and adaptability .

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