Design of small humanoid fighting robot based on target recognition algorithm

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Abstract
In the past, robots can only do simple walking, but now robots can perform complex actions such as running, attacking and automatically standing up after falling to the ground. The humanoid robot competition is very interesting and has great significance for the study. The speed and accuracy of robots in domestic competitions still need to be improved. In this article, a design scheme of a small humanoid fighting robot based on the target recognition algorithm is proposed. In this article, a design scheme of a small humanoid fighting robot based on the target recognition algorithm is proposed, for the case where the mobile robot has a low recognition rate in a complicated working environment. In this article, based on the matching of single colour features, the matching of shapes is added to more accurately identify the target. In addition, visual information added to achieve information fusion, the algorithm is simpler and can achieve positioning more quickly and effectively. The humanoid robot is to detect different states of the target, and needs to measure the target, trajectory of the target and analyse the target motion. In the era of popular 5G networks, it is hoped that in the future, robots that use 5G networks for communication can be designed, so that robots can be remotely controlled anytime and anywhere. There will be more kinds of robots entering our lives, which will promote the construction and application of smart homes and smart cities.

Keywords
Humanoid fighting robot, target recognition, visual information, 5G networks

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Introduction
Humanoid robots now generally refer to robots with human shapes and one or more capabilities, and research on this has now made good progress. As a kind of humanoid robot, the humanoid fighting robot has also begun to receive attention from all lifestyles. The humanoid fighting robot is designed to demonstrate the research results of the robot through the robot fight competition, and continuously enhance the robot development technology through such competitions.¹ As an important embodiment level of national robot research, humanoid robots have been researched a lot and achieved good research results. The research of humanoid robots began from the walking mechanism, and then people began to study the vision of humanoid robots, making robots more and more like humans. At the same time, image processing technology has gradually entered the development of humanoid robots. The humanoid robot can perform face recognition and recognize the contours, thus achieving a true humanoid

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robot. In the late 21st century, the Chinese robot industry ushered in a new development climax. As early as 1960, a female professor of the Nanjing Institute of Technology invented China’s first robot. It is a giant of more than 2 m and can do 28 moves. In 2013, China’s industrial robots already occupied an important market share. In 2014, China’s robot development received unprecedented attention. The biped walking structure of the humanoid robot can make it walk on the ground with relatively large obstacles, it can climb stairs and walk on roads with poor road conditions, and it can reach many places. Humanoid robots are not only similar to humans, but also can fit into our living space.

The autonomous motion-related technology of the humanoid fighting robot has a certain relationship with the number of servos of the robot itself, the weight and size of the robot, so different robots have different research methods, but in general, the following aspects need to be studied.

First, the degree of freedom of the humanoid fighting robot determines the diversification and sophistication of robot movement. The choice of robot’s degree of freedom depends on specific application scenarios or specific requirements of the competition rules. The humanoid robots have 16 degrees of freedom and 41 degrees of freedom. The degree of freedom consists of the freedom of the joints such as the legs, waist, feet, neck, shoulders and arms. The humanoid fighting robot designed in this work contains three degrees of freedom for each leg, which ensures that the robot can complete the basic upright walking. Each shoulder contains a degree of freedom that controls the arm to attack the target. Each arm has two degrees of freedom, and you can swing your fist to hit the target. The neck contains a degree of freedom, the camera can be turned to achieve the target search function, and the waist contains two degrees of freedom, which can achieve rapid lateral movement, which is very important for the robot’s running and attacking actions. Each foot also has a degree of freedom that can be used with other joints. The centre of gravity of the robot has offset, so that the robot contains 17 degrees of freedom.

Second, the choice of servo steering gear. For a robot, the servo is the source of its power, and the choice of servo type is very important. For the dynamic performance of the robot, a servo with a 120°, 180°, 270° or 360° rotation angle can be selected. The difference in the angle of rotation of the steering gear has an effect on the motion of the robot. We chose a 270° servo because 270° steering gear can mimic the angle of the human joint. The 120° and 180° steering gears may make some hitting actions impossible, and the 360° steering gear is a continuously rotating steering gear that cannot be well positioned and controlled. The size of the steering gear should also be considered. Too large and too small will affect the overall size of the robot. In addition, the price of the steering gear is also an important factor affecting the choice of steering gear.

Third, the design of the control system. The robot motion controller needs to control multiple servos at the same time, and it is required to respond in time. The processor not only needs to process the data of the servo but also needs to complete the function of command status information. The robot carries two processors, one for controlling the motion of the robot and the sensor signal acquisition and the other for image processing and motion decision-making.

Fourth, the robot can use the accelerometer to sense its state, so that when the robot accidentally falls during the operation, the acceleration sensor will suddenly change, and then the controller will send the information to the robot and issue instructions to make the robot stand up again. Robot vision is very important for the humanoid robot to recognize the target. It only uses the camera to identify the target, no longer uses other sensors, and only uses image processing means to obtain the state and position information of the target without relying on other means.

This model realizes the communication between the host computer and the robot control system, and then exchanges information through wireless transmission technology. On this basis, the robot receives information from the server. The transmission of information is mutual. When the motion controller transmits the motion process or sensor information to the host computer, it also needs to upload to the upper computer first. In this way, we can connect to the robot anytime, anywhere and send or retrieve information to or from the robot. The subject of this thesis is the design of a small humanoid fighting robot based on robot vision. The specific process is to complete the image processing and action decision to transmit the action instruction to the motion controller, and the motion controller returns the action execution state and the sensor signal. The robot motion debugging software and image processing debugging PC (personal computer) software were written to realize the debugging of the robot motion and the debugging of the robot vision system. The rest of this article is organized as follows. The second section discusses related theories and methods, which include ‘System structure design’ and ‘Visual image processing’. In the third section, the construction of small humanoid fighting robot based on target recognition algorithm was studied. The fourth section presents the analysis of test results. Finally, the full text is summarized in the fifth section.

Related theories and methods
System structure design
In the production process of the humanoid robot, the overall design of the prototype should include the following two aspects. (1) The robot is a human-like bipedal walking robot. It must have obvious human body structures such as the head, torso, arms and legs. It conforms to the human
structural characteristics and is in harmony with the structure ratio of the human body. (2) The structure of the legs and feet of the robot is similar to that of human beings. It is required that the feet must conform to the flat shape of the human foot with a basic shape. The joint design of the legs must satisfy the robot’s two-legged upright walking to achieve front, rear and left and right movements.

The mechanical structure design of the small humanoid fighting robot is the most basic part of this model. In terms of mechanical design, the design of this model needs to meet the requirements of gait planning and the ability to complete the specified actions. The mechanical design determines the flexibility and stability of the robot. In this work, we also designed the way the robot travels and moves. The mechanical design is shown in Figure 1.

In this work, when designing the mechanical structure, the proportional configuration and the degree of freedom of the robot are selected. When gait planning a robot, it is necessary to plan the action and select the way of travel. After the gait planning is completed, the robot’s motion needs to be designed. In addition to designing the basic motion, the robot is required to respond quickly to the sensor’s signal. The design of the motion control system requires the design of the hardware and software aspects of the motion control system, and the two are well integrated. The control of the robot’s steering gear is completed and the motion debugging software can program the motion of the robot. The motion control system is shown in Figure 2.

In the hardware circuit design and analysis of the control system, the hardware circuit comprises a power supply
circuit, a clock circuit, a sensor circuit and a PWM circuit. The function of the power supply circuit is to supply power to the chip and the steering gear, which is the power source of the robot. The clock circuit is the heart of the microcontroller, enabling the robot to perform all the actions. The sensor circuit can acquire the attitude information of the robot, so that the robot can move quickly and can stand up automatically after falling down. The PWM circuit outputs a control signal to the steering gear to control the operation of the steering gear. In the control system, the software design of the control system is mainly composed of the upper computer and the lower computer. The upper computer is the software written by the computer. The lower computer is the single-chip microcomputer that directly controls the servo. The upper computer issues the command to the lower computer. The lower computer controls the robot steering gear to complete various actions according to the programmed motion of the upper computer.

**Visual image processing**

To achieve target recognition, it is first necessary to extract the target features according to the characteristics of the target. To achieve target recognition, it is first necessary to extract the target features according to the characteristics of the target. Since the target position to identify the background, position, size and rotation angle of the target in the image are changed. Therefore, the selected features must satisfy the translation, scale and rotation invariance. It should have recognized that the three-dimensional object in space is to identify, and its different orientation imaging similarity depends on the complexity shape of the object itself, for objects of complex shape and asymmetry. The different angles of imaging may show great differences, which puts higher demands on the recognition algorithm. In order to be applicable to a robot system with high real-time requirements, the selected target to identify is an object with a single colour and a relatively simple shape. The environment in which the object is located is an indoor environment with few interference factors. After comparison, the recognition algorithm combining colour threshold segmentation and contour invariant moment is selected. In machines and human vision, colour is a very important piece of information for judging different objects. In the digital image processing of machine vision, there are mainly RGB colour models, and colour space models such as HSV, CMYK and YUV based on this (Figure 3).

Using machine vision for target recognition, this model needs to use colour discrimination ability and colour model with reasonable sensitivity to light intensity. In this work, two web images loaded by the robot are used to collect two different colour images (left and right) as shown in Figure 4, and the original image is extracted and displayed by RGB component. The brightness of each component of RGB under light and dark conditions can be found that under different illumination intensities of the same target, the illumination intensity has a great influence on the image. The RGB component brightness with stronger illumination is larger than the RGB component with weaker illumination, and the three components have an influence on the total brightness of the image, which is not conducive to the recognition of the same colour under different illumination conditions.

In the design of the vision system, the camera first acquires the image, the colour image is converted into a grey image and the acquired image is preprocessed. The target is then separated from the background, followed by binarization and morphological corrosion and expansion. After the treatment is finished, the target is extracted. Then, it performs a simple target location and then traces the targeted targets. After finally determining the state and distance of the target, the target is attacked. In the visual system, not only the image needs to be processed, but also the action of attacking and defending the target needs to be determined.

**Simplification and establishment of small humanoid fighting robot based on target recognition algorithm**

**Simplification and establishment of humanoid robot model**

After the 3D model of the fighting robot is established, the dynamic simulation software to complete the robot motion planning task can perform the simulation. Although UG has a dynamic analysis module, the analysis function is weak and needs to be completed using professional dynamic simulation software. Adams is one of the most widely used mechanical dynamics simulation software in the world and is very powerful. Therefore, Adams powerful mechanical dynamics can be used to dynamically simulate the fighting robot. Adams’ own modelling capabilities are not powerful enough, but can be simulated directly by calling a model of other modelling software through a reserved interface. The UG assembly model file is output as a Parasolid file format, and Adams can directly call the file to
create a simulation model for motion simulation. In order to save computing time and improve computing efficiency, the simulation model in Adams can be simplified as appropriate. The model simplification can be carried out according to the following principles.

This study removes parts that have no effect or minimal effect on model motion simulation, such as servo lines. A part model with no relative motion and similar materials is defined as a rigid body to simplify the model, reduce the computational difficulty and improve the calculation efficiency. For example, two aluminium parts connected by screws and nuts can be defined as a rigid body, which is simplified according to the above rules. The model is shown in Figure 5. The definition of the fighting robot constraints defines the general motion rules of the robot and cannot be reversed. Adams provided 11 motion pairs for designers to develop and use, and Adams software used these motion pairs to achieve constraints. All the sports associates in Adams can find their corresponding physical models in reality.

Before performing the simulation analysis, it is necessary to set the physical properties such as the mass and the moment of inertia of the virtual prototype model components. The part models created in UG are lost during the data conversion process. Therefore, after importing the UG model, Adams needs to add its physical attribute parameters according to the actual situation. Considering the actual situation of the physical prototype, the force state of the robot during the movement needs to be the same as the actual force condition,
The intelligent control of the fighting robot can be understood as a mobile device that has the same ability of human vision, listening and the like, and has certain adaptability and learning to change its environment. At present, research on machine vision and hearing has stood as a mobile device that has the same ability of human vision, listening and the like, and has certain adaptability and learning to change its environment. The prototype parameters of the fighting robot are shown in Table 1.

Since the robot has a symmetrical structure, the parameters of the left and right limbs of the robot are the same, so the parameters in the table are omitted. Only the weight of the left limb of the robot and the weight of some individual limbs are listed here. The robot parts are uniform materials, and the physical parameters of the parts are calculated by software. In the overall prototype model environment setting, the gravity acceleration value is set to 9.8 N/kg, the static friction coefficient is set to 0.3, the dynamic friction coefficient is 0.1 and the stiffness between objects is set as large as possible.

**Vision-based fighting robot system**

The intelligent control of the fighting robot can be understood as a mobile device that has the same ability of human vision, listening and the like, and has certain adaptability and learning to change its environment. At present, research on machine vision and hearing has become a hot trend in the field of fighting robots. The research objects of robotic audio-visual systems are robot vision, auditory, speech functions and related implementation methods. With the development of radio frequency technology, wireless local area networks are becoming more and more common in people’s work and life, and remote control of robots is becoming more convenient and popular. The realization of the function of the intelligent control system based on vision-based fighting robot requires a reliable hardware platform and an effective software system structure to support, design software and hardware systems according to the functions to realize, and perform hardware selection.

The function that the robot intelligent control system should have is as follows. The user can establish a connection with the robot lower position machine through the wireless communication system through the terminal, thereby realizing the remote transmission of the control command and the wireless control of the robot. In this model, the command is sent to the embedded chip through the serial communication interface of the wireless communication system, and the corresponding joint angle and speed parameters are sent to the AX-12A digital servo through the serial port to control the robot to perform the corresponding motion.

**Autonomous fighting robot software system**

In this project, the robot must complete the task of object recognition and operation in the set environment, so the software system is designed to realize the control. The robot software system consists of wireless network communication software, lower computer software and client PC software. The overall software architecture is shown in Figure 6. The lower computer software is used to realize the motion control of the robot and the robot arm, the collection and wireless transmission of the surrounding environment information including the image information, and the control command transmitted remotely from the host computer. The client PC establishes a TCP connection with the wireless communication system, receives the status information and surrounding environment information transmitted by the lower computer via the wireless communication module in real time, processes and displays the multi-sensor information and performs image through the video signal collected by the camera. Process, extract related information such as colour, centroid etc. and achieve remote intelligent control of the robot based on this important information and given tasks, so that the robot can realize autonomous motion and operation after receiving the task.

To build a hardware platform for humanoid fighting robots, we need to write the robot motion debugging software and the execution program of the robot controller, so that the robot system can be controlled and debugged in real time through the PC, or in accordance with the graphics processing module. The instruction information obtained after processing the image in real time executes the corresponding action code. The preparation of the upper computer software and the lower computer software requires a certain understanding of the MCU (microprogrammed control unit) software programming and the Windows software programming, and is proficient in the communication skills of the commands between the two. We use the C language to program the MCU on the robot controller side and the high-level programming language C# language running on the .NET Framework in the Windows operating system environment. The two uses a universal serial bus for communication.

**Target recognition of object nodes**

The choice of object features has important implications for the results of object cognition. The characteristics of object nodes should reflect the commonality of similar objects and the differences with other objects. In addition, a good feature model should reflect object information as much as possible. In order to improve the accuracy of cognition, a

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Table 1. Robot simulation model parameters.

| Name     | Quality (g) |
|----------|-------------|
| Head     | 62.2        |
| Body     | 360.0       |
| Shoulders| 40.2        |
| Arms     | 216.1       |
| Legs     | 387.5       |
| Feet     | 212.6       |
variety of features can be used to achieve object recognition. In the Markov random field composed of indoor scene frame elements and indoor object nodes, the height of the object conforms to the Gaussian distribution, and the height characteristic function of the object is as follows

\[ f_{\text{height}} = \frac{1}{\sqrt{2\pi}\sigma_n} \exp \left( -\frac{(h_s - \mu_n)^2}{2\sigma_n^2} \right) \] (1)

In the formula, \( h_s \) is the height value of the current object, and \( \mu_n, \sigma_n \) is the classification parameter of the \( n \)-type standard model object, which is the height mean and the height variance, respectively. According to the definition of the Gaussian function, when the object parameter in the minimum scene is closer to the parameter \( y \) of the model library object, the value of the feature function is larger. The closer an object in an unknown scene is to the object of the model library, the more likely it is that the object is recognized as the object. Conversely, the less likely it is to be identified as the object. In different lighting and scenes, a certain number \( \lambda \) of objects are combined to form a set \( S', \) and the formula for calculating the classification parameters of the objects is as follows

\[ \mu_n = \frac{1}{S'} \sum_{s \in S} h_s, \quad \sigma_n = \sqrt{\frac{1}{S'} \sum_{s \in S} (h_s - \mu_n)^2} \] (2)

In the experiment, the classification parameters of various objects in the indoor scene are obtained, and the object model database of the indoor scene cognition is constructed for the object cognition in the unknown scene. Set the frame and object nodes in the room to form a Markov random field, set the set of all object nodes to \( S, S = \{ s_1, s_2, \ldots, s_N \} \), \( N \) is the number of object nodes. \( \omega \) is set as the classification label vector \( \omega = \{ \omega_1, \omega_2, \ldots, \omega_N \} \) of the object node, then all the node labels form a vector. The problem of marking the object node identification is then transformed into a label field that solves the purchase of a node that satisfies the maximum posterior probability. Each node corresponds to a classification label \( \omega \), which is between 0 and \( L \), and \( L \) is the number of categories to be classified. Thus, the identification mark problem of the object node is transformed into the optimal solution problem of the following objective function. According to the maximum posterior probability criterion, there are the following

\[ p(\omega|F) = \frac{1}{p(F)} p(\omega)p(F|\omega) \] (3)

In the formula, \( p(F) \) is the observation data of the indoor frame node and the indoor object node. \( p(\omega) \) is the a priori Gibbs joint distribution of the Markov random field node label field, which satisfies the properties of the Markov neighbourhood and is a global description. The form of the neighbourhood function \( p(\omega) \) depends on how the potential functions of the neighbourhood system and the cluster are defined, as shown in the following equation

\[ P(\omega) = \exp \left( \sum_{c \in C} -V_c(\omega_c) \right) \] (4)

In the formula, \( C \) represents the set of random bank clusters and \( V_c(\omega_c) \) is the potential function associated with clusters. \( p(F|\omega) \) represents a likelihood probability. In the framework and object nodes of this model, it is considered that the nodes are independent and identically distributed, and the following relationship is satisfied

\[ p(F|\omega) = \prod_s P(F_s|\omega_s) \] (5)

For the convenience of calculation, the objective function \( \ln P(\omega) + \ln P(F|\omega) \) is obtained by taking the

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**Figure 6.** Robot control system overall software architecture diagram.
Following objective function transformed into the optimal solution problem of the following objective function. Thus, the cognitive problem of the object node is obtained. Therefore, the likelihood probability expression \( P(\omega) \) of the target recognition function \( \omega \) can be obtained. Thus, the cognitive problem of the object node is transformed into the optimal solution problem of the following objective function

\[
\arg \max_{\omega} \prod_{s \in S} P(F_s|\omega_s) \prod_{c \in C} P(\omega) \quad (6)
\]

In equation (6), \( P(F_s|\omega_s) \) is a likelihood probability function used to represent the characteristics of an object node. \( P(\omega) \) satisfies the Markov neighbourhood property, and \( v \) is the neighbourhood function between the nodes, which is used to express the relationship between the node and the neighbour node. \( C \) is a neighbourhood cluster.

**Fight robot software implementation**

The fighting robot PC system can be regarded as the ‘brain’ of the robot, which provides the basis for the intelligence of the fighting robot. It can process the received data and display it to the user in real time on the human–machine interface, or provide the data to other programs. If the lower computer only implements some data processing or control functions, the execution speed and efficiency may be unsatisfactory or difficult to implement. For example, when dealing with video image processing and recognition, which requires a large amount of data processing with speed and accuracy, you can pay Control the host computer. According to the functions to be realized, the real-time control can be placed on the lower computer. The complex or data-related control can be placed on the upper computer to form a complete control system, which forms a reasonable task assignment and complementary functions. In practical applications, the upper computer is used to integrate the overall resources of the system, and multiple modules are combined to process the algorithm to provide decision information for the intelligent behaviour of the robot. The main task that the host computer needs to implement is to establish a TCP connection with the wireless communication system, and to realize the wireless transmission and reception of information, analysis and processing, control command transmission, as well as the extraction of environmental information analysis, processing, display, color and other targets. Relevant information such as the centroid, and the target ranging, the host computer performs the motion control and navigation decision of the robot according to the acquired environmental information and the coordinate information of the target, and the operation of the robot arm to the target. According to the above task analysis, the host computer of this subject should include the following seven functions: (1) data wireless transceiver; (2) web camera video information acceptance and processing; (3) multi-sensor signal reception and display; (4) HSV image segmentation and geometric centre extraction; (5) robot user control; (6) robot vision feedback control; (7) robot arm motion control. These functions cooperate with each other to form a host computer system, and each function button communicates with the server according to the protocol, which can better meet the task requirements of the robot.

Based on Visual Studio 2010/MFC, this model selects modular and multithreaded technology to realize the strategy development and execution of robot motion control and target operation. It mainly includes the following threads: machine vision thread, robot motion control and target operation thread, environment information monitoring and display thread. The main thread of the client PC software is shown in Figure 7. After running the host computer, we initialize it first, establish a TCP connection with the server, run each thread to execute it continuously and adjust the execution order between threads according to the needs.

**Analysis of test results**

**Target state judgement**

In the state judgement of the target, various states of the small humanoid fighting robot are trained. In the experiment, we take 100 pictures in the image library to verify, and use different forms of the robot to verify the positive and negative samples. In the sample, we are based on the detection of the state of the robot. In the 100 sample images used, since the attitude of the positive sample collected is more than that of the negative sample collected, the number of positive and negative samples is also slightly different. There are 60 pictures similar to the positive sample and 40 pictures similar to the negative sample. In the SVM (support vector machine) classifier, the positive sample detection accuracy is 0.95 and the negative sample detection accuracy is 0.93. According to the SVM classifier, the positive sample model is more typical than the negative sample model, and the features are more obvious. In addition, the accuracy of this test is closely related to the establishment of the sample library. When the sample is built, we have samples that are more positive and fewer negative samples.

**Fighting robot running bionic trajectory**

In this model, the colour target is identified and the centroid is extracted. The software and hardware platform is built, and the robot can be manually controlled remotely. The image information collected by the camera in real time can be sent to the client splayed and processed, and the target centroid coordinates are acquired and transmitted to the robot control system as an important parameter of the...
autonomous motion. The planning of the robot refers to the process in which the robot finds a reasonable solution to realize the task according to the set tasks. This chapter will conduct experiments based on visual speech perception, target recognition on the established system, and plan, verify the robot motion navigation, robot arm motion and target operation. The main working process is divided into two stages. The first stage is the target approaching stage. At this stage, the robot extracts the image coordinates of the target geometric centre of the image data collected by the camera and the depth information collected by the infrared ranging sensor according to the upper computer, which comprehensively analyses the end of the mechanical arm. And the pixel coordinate deviation of the operation target and the distance information between the robot and the PC image wireless reception.

**Figure 7.** The main thread of the client PC software. PC: personal computer.

**Figure 8.** Arm movement in three directions.
wall, the upper computer system makes a decision according to the sensor information sent by the lower computer, and wirelessly sends the command parameter to the lower computer to make the robot smoothly approach the target. When the robot is 24 cm away from the wall, it stops moving and switches to the second stage of motion. The second stage is the target operation phase of the manipulator. When the first stage robot approaches the target and reaches a certain distance, the robot stops moving. The coordinates of the centre point of the upper arm according to the end of the arm and the image coordinates of the target material heart acquired in the previous stage. The error is made to make the end of the arm close to the target. The collision sensor signal of the lower machine is used to help determine whether the end of the arm has touched the target to complete the operation task. When the operation task is successfully executed, the actuator end returns to the initial state.

The humanoid robot creates a robotic arm model and uses the dynamics analysis to add a single component torque. By selecting the corresponding options, the velocity curves (Figure 8) and motion trajectories (Figure 9) in the three directions of the end point of the arm are respectively drawn.

In view of the tasks to be performed by the robot, the process of robot motion control is described in detail. Firstly, according to the difference of two-dimensional image coordinates, the navigation strategy of the robot approaching the target is analysed, which mainly includes two stages: target search and robot adjustment and movement. The robot is allowed to reach the operable range of the arm according to the control method. Experiments show that the vision-based fighting robot control system has better effect on target object recognition and centroid extraction of specific colours and shapes. The robot exhibits better intelligence and human–computer interaction. After receiving and recognizing the voice command, the specified task can be executed without interference, and the effectiveness of the control strategy is verified. The system has certain practical value.

Conclusion

With the advancement of robotics, the information society continues to develop. Developing robots that are thoughtful, tactile and capable of independent thinking and decision-making is an important direction for the future development of robots. With the development of robotics, there will be more kinds of robots entering our lives. The main content of this work is to design a humanoid fighting robot. Various aspects of the humanoid fighting robot were planned. The mechanical design, motion control system, vision system and transmission system of the small humanoid fighting robot were planned, and the various parts were connected to form a real humanoid fighting robot. The overall performance of the robot was tested. In this work, the state of the target is judged. After the design of the classifier is performed, the acquired image is used again to judge the state of the robot to detect the accuracy of the classifier. The distance of the target is also measured, the distance is judged using the principle of central fluoroscopic imaging, and then the relationship between the pixel value and the actual distance is obtained in the experiment. Then the time when the continuous drawing of the image processing is sent to the upper computer and the time that is not sent to the upper computer are compared, so that the delay can be determined. Then we experiment on the transmission time and transmission file size and transmission quality, respectively, and explain the necessity of compressing the image. Finally, the overall performance of the robot is tested. In the experiment, the trajectory and performance of the robot are tested, respectively, and the ideal results are obtained. The action decision of the robot is improved. During the humanoid robot’s mobile combat, the combat reflex force is distributed to each joint of the
humanoid robot’s body, and each joint responds with output torque. Changing the body posture and relying on the mass of the body can change the ability of the humanoid robot to output combat power, which will continue to be studied in the future.

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**References**
1. Wei Y and Zhao J. Designing robot behavior in human robot interaction based on emotion expression. *Ind Robot* 2016; 43(4): 380–389.
2. Koolen T, Bertrand S, Thomas G, et al. Design of a momentum-based control framework and application to the humanoid robot Atlas. *Int J Hum Robot* 2016; 13(1): 1650007.
3. Clever D, Harant M, Koch KH, et al. A novel approach for the generation of complex humanoid walking sequences based on a combination of optimal control and learning of movement primitives. *Robot Auton Syst* 2016; 83(C): 287–298.
4. Madhan Mohan P, Nagarajan V and Vignesh JC. Spot and continuous monitoring of heart rate by combining time and frequency domain analysis of photoplethysmographic signals at rest conditions. *IET Signal Process* 2018; 11(9): 1076–1082.
5. He W, Ge W, Li Y, et al. Model identification and control design for a humanoid robot. *IEEE Trans Syst Man Cybern Syst* 2016; 47(1): 1–13.
6. Kowalski R, Capan M and Lodato P. Optimizing usability and signal capture: a proactive risk assessment for the implementation of a wireless vital sign monitoring system. *J Med Eng Technol* 2017; 41(8): 623–629.
7. Li THS, Ho YF, Kuo PH, et al. Natural walking reference generation based on double-link LIPM gait planning algorithm. *IEEE Access* 2017; 5: 2459–2469.
8. Shi G, He Y, Luo Q, et al. Portable device for acetone detection based on cataluminescence sensor utilizing wireless communication technique. *Sens Actuators B Chem* 2018; 257: 451–459.
9. Teague CN, Hersek S and Toreyin H. Novel methods for sensing acoustical emissions from the knee for wearable joint health assessment. *IEEE Trans Biomed Eng* 2016; 63(8): 1581–1590.
10. Cao Z, Yin L, Fu Y, et al. Robust adaptive control for vision-based stabilization of a wheeled humanoid robot. *Int J Hum Robot* 2016; 13(3): 1650010.
11. Hu X, Huang X, Hu T, et al. A minimal dataset construction method based on similar training for capture position recognition of space robot. *Wireless Pers Commun* 2018; 102(8): 1–14.
12. Gong P. Road recognition method of wheel tracked robot based on multi sensor information fusion. *J of Shanghai Jiaotong University* 2017; 51(4): 398–402.
13. Yuan J, Li Y, Dong X, et al. Target trajectorying with a mobile robot based on on-line classification for motion patterns. *Yi Qi Yi Biao Xue Bao/Chinese J Sci Instrum* 2017; 38(3): 568–577.
14. Chen J and Li H. Airfoil optimization of land-yacht robot based on hybrid PSO and GA. *Int J Pattern Recogn Artif Intell* 2019; 33(3): 1959041.
15. Kang M, Ji K, Leng X, et al. Synthetic aperture radar target recognition with feature fusion based on a stacked autoencoder. *J Radar* 2017; 17(1): 192.
16. Li Z, Wang B, Yang H, et al. Rapid satellite capture by a space robot based on delay compensation. *Ind Robot* 2017; 44(3): 363–376.
17. You B, Wu K, Xu J, et al. Design and research of automatic plug-in system based on machine vision. *Opto-Electron Eng* 2017; 44(9): 919–926.
18. Xu C, Feng X, Zhang J, et al. The design of a fuzzy control rule library based on improved bacterial foraging optimization. *J of Chongqing University* 2017; 40(7): 63–71.
19. Wang D, Song H and He D. Research advance on vision system of apple picking robot. *Trans Chinese Soc Agricult Eng* 2017; 33(10): 59–69.
20. Wang K, Long XX, Li RF, et al. A discriminative algorithm for indoor place recognition based on clustering of features and images. *Int J Autom Comput* 2017; 14(4): 1–13.
21. Wei Y, Liang D and Xing S. Visual identification and localization algorithm for robot based on the multimodal information. *Guangdian Gongcheng/Opto-Electron Eng* 2018; 45(2): 170650.