Design of a robot target recognition system based on deep learning algorithms

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Abstract. Due to the poor multi-scale conversion of matching models constructed by traditional systems, resulting in a poor recognition rate of robot target recognition systems, the design of a robot target recognition system based on deep learning algorithms is investigated. In the hardware design, an image collector is used to collect image information. In the software design, the image acquisition program is set up, the image information is pre-processed, the matching model is constructed based on the deep learning algorithm, the image features are extracted at multiple scales, and the target is recognised using image smoothing and denoising techniques. The experimental results show that the average recognition rate of the designed system is 96.2%, and the average recognition rate of the traditional system is 89.4%, the recognition rate is improved by 6.8%, and the robot target recognition system designed based on deep learning algorithm has better recognition effect and adapts to various recognition environments.

1. Introduction
With the continuous progress and development of artificial intelligence technology, more and more artificial intelligence technology is used in various industries and fields. Artificial intelligence technology is mainly manifested in the production and application of robots and intelligent devices, more and more robots are put into use, and robots are developed in medical care, military industry, education industry and production life[1]. In the medical industry, robots can ensure the accuracy of surgical operations and treat the human body through micro-robots, in the military industry, robots can accurately disarm and defuse bombs, enhancing the country's military power, in the education industry, people program robots to complete learning objectives, schools can use robots to teach and improve the quality of teaching, and in production life, industrial robots can automate production and can use robots to carry out high-risk work, improving the production level and quality of life in society [2]. As China's robots are still in the development stage, at this stage, the designed robot target recognition system still has some problems, can not accurately identify the target object, the picture resolution is not clear. The deep learning algorithm is used as the innovation point of this system design to form a deep learning structure that can effectively represent the overall characteristics of the data, so as to achieve accurate recognition and study the robot target recognition system designed based on the deep learning algorithm.
2. Hardware design of the system

In the design of the robot target recognition system, mainly relying on the computer to achieve the deep learning algorithm as the innovation point of the system design, hardware facilities as the basis of the overall operation of the system, so to select the better performance of the hardware [3]. The hardware of the robot target recognition system designed based on the deep learning algorithm generally includes a data collector, image collector, memory, sensor, CCD camera, processor, serial board and main control computer. The hardware structure of the robot target recognition system based on the deep learning algorithm is shown in Figure 1 below.

![System hardware architecture diagram](image)

According to figure 1 shows, found that the hardware structure of the composition system is relatively complex, when selecting the hardware, generally use the hardware equipment with better flexibility, based on the deep learning algorithm meter robot target recognition system will switch different modes according to the application scene, need to upgrade and optimize the system, the flexibility of the hardware performance reflects its extensibility, the extensibility of the hardware equipment is conducive to simplify the system optimization steps. From the above hardware, the main analysis of the image collector, it is the core equipment of the system hardware, using special picture recognition technology, to obtain picture information, CCD camera is the basis of picture acquisition, CCD camera shooting pictures, through the picture sensor transmission to the picture collector, the collector will determine the picture position and picture characteristics according to the information from the picture feedback [4].

3. System software design

3.1. Setting up the image acquisition program

The robot target recognition system designed based on deep learning algorithm is captured by CCD camera to collect images of individual objects, the images are mainly output in RGB format, and the output image information is imported into the system program by the sensor [5]. The images in RGB format are colour images, and in order to save the storage space inside the system, the images are processed in grey scale using weighted average method, and the image colour intensity weighted The average value is shown in the following equation (1).

\[ Q = WE + TY + UI \quad (1) \]

In the above formula, \( Q \) denotes the total image total colour weight, \( W \) denotes the colour sensitivity degree weight of R colour, \( T \) denotes the colour sensitivity degree weight of G colour, \( U \) denotes the colour sensitivity degree weight of B colour, \( E \), \( Y \) and \( I \) denote R, G and B colour intensity values respectively. The image acquisition program set up by the system is capable of pre-processing the image, processing the image pixels and image filtering, converting the image
information into data information, extracting the grading characteristics of the image based on the data information, and the analysed image characteristics become the basis for target recognition.

3.2. Building matching models based on deep learning algorithms

Based on deep learning algorithms to build matching models, mainly through the target features for classification, read the target object feature data, robot recognition system in multiple target objects to identify, multiple target body can be represented by the set, the representation formula as shown in the following formula (2).

\[ P = \{A_1, A_2, A_3, \ldots, A_s\} \]  (2)

In the above equation, \( P \) denotes the set of all target objects, \( A \) denotes a single target body and \( s \) denotes the number of target bodies. The average value of the target object feature data is found from the obtained set and is calculated as shown in the following equation (3).

\[ D = \frac{1}{s} \sum_{i=1}^{s} A_f \]  (3)

In the above equation, \( D \) denotes the target set feature mean and \( F \) denotes the dimensional vector of the target individual. Based on the mean value of the target set features, the feature vector value of the target object is derived from the variance matrix. The matching model constructed based on the deep learning algorithm is capable of multi-scale transformation, and multi-scale transformation can improve the accuracy of identifying target object features [6]. The built matching model uses the image acquisition procedure set up by the system to search for the area covered by the most targets, subdividing the recognition area and narrowing it down, making it easier to recognise the target body features in small areas. The CCD camera is used to capture the image, and the shared convolutional layer intercepts the image features and divides the target body region to finalise the recognition.

3.3. Image smoothing and denoising techniques to identify targets

The target recognition system of the robot is the acquisition of the target signal, the target signal in the process of transmission is easily disturbed by external factors. The target signal is identified, and different types of image smoothing and denoising techniques can be used to reduce the influence of external noise on the image signal transmission, which improves the image quality and clarity. Images are subject to different degrees of noise interference, and different types of image smoothing and denoising techniques are used to change the filter value in the image [7]. Image smoothing denoising techniques generally use low-pass trapezoidal filters and low-pass Gaussian filters to eliminate image noise, which can effectively eliminate high-frequency noise and help to improve the degree of horizontal and vertical resolution of the image. Image information will be weakened and image marginalisation in the process of image delivery, using image smoothing technology to process the image and correct the geometric distortion of the image, the main objects of image correction are image spatial position and image difference correction, reducing the error value between the actual target body position and the system measurement of the target body position, to achieve accurate target recognition. The image features are extracted through the set image acquisition procedure, and the features are used as the basis for the system's target recognition. A matching model is built based on a deep learning algorithm, on which the target recognition is achieved using image smoothing and denoising techniques, and the image smoothing and denoising techniques further solidify the matching model.

4. Experimentation and analysis

4.1. Experimental preparation

In order to verify the effectiveness of the use of a robot target recognition system designed based on deep learning algorithms, performance testing experiments were carried out. The area was used as the experimental environment and the device type was used as the recognition target. A large number of
device pictures were collected to establish the experimental dataset and identify the target device by the robot performing photography. Three types of devices were selected as target recognition objects, denoted by A1, A2 and A3 respectively. Different target templates are selected as recognition criteria, and the robot recognition system uses the target templates as the basis for recognition, setting up three experimental environments: dim environment, bright environment and overlapping environment for target object recognition, using this system and the traditional system for target recognition, and observing the recognition effect of both systems.

4.2. Experimental results
The studied robot target recognition system designed based on deep learning algorithm is required to recognize devices in various complex environments to ensure good recognition results in different environments. A1, A2 and A3 target devices were tested in bright environment, dim environment and overlapping environment respectively, and the recognition experimental results are shown in Figure 2 below.

![Figure 2. Target recognition effect](image)

From Figure 2 above, it can be seen that the robot target recognition system designed based on deep learning algorithm can recognize the preset target devices in different environments. The recognition rate of the three environments were analyzed using the system in this paper and the traditional system respectively, and the recognition rate effect is shown in Table 1 below.

| Testing scenarios | Text system | Traditional system |
|-------------------|-------------|--------------------|
| Bright environment| 96.8        | 90.6               |
| Dim environment   | 95.4        | 88.4               |
| Device overlap environment | 96.4 | 89.2               |

The average recognition rate of this paper's system under the three environments was calculated to be 96.2%, and the average recognition rate of the traditional system was 89.4%. The recognition rate of this paper's system was 6.8% higher than that of the traditional system, which verified that the robot target recognition system designed based on the deep learning algorithm could recognize the target objects under different environments and the recognition effect was better.

5. Conclusion
The deep learning algorithm-based robot target recognition system in this paper can accurately identify target objects and classify them according to the features identified. By extracting the overall
features of the target object and comparing all the identified features of the target object, accurate recognition results can finally be output. There are still many shortcomings in the software design of this system, the design is relatively complex, the stability of the system operation is not effective, and the system is prone to crashing problems. It is hoped that in the next study, the software facilities of the system will be further optimised to simplify the operation steps and achieve a more accurate target recognition system.

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