An Image Recognition Method Based on Correct Parking of Intelligent Medical Vehicles

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Abstract. This paper introduces a circular object recognition method based on image processing technology. With the continuous development of robot technology, there is an increasing demand for efficient and accurate image processing technology in the fields of robot vision navigation and automated production. Therefore, this paper aims to propose an image processing method that can effectively recognize circular targets, and provide technical support for applications in the fields of robot vision navigation and automated production. The method first reads the image and converts it to a binary image, then constructs and closes the graph structure elements and fills the holes. By calculating the area and perimeter of the circular target, the method of threshold matching is used to determine the circular target. In this paper, the red and green circular targets are taken as examples to identify them respectively and judge whether the recognition is successful through logical operations. The experimental results show that the method can effectively identify circular targets under different clearing conditions, and has high accuracy and robustness. This technology can be applied in the fields of robot visual navigation, automatic production, etc., and provides technical support for realizing intelligent and efficient production and service. At the same time, the research method of this paper also provides reference and references for the solution of other object recognition problems.

Keywords: Image processing, circular target recognition, binarization, morphology processing, robot vision navigation.

1. Introduction

With the continuous development of society, the aging population, and the increase of chronic diseases, the use of drugs is also increasing [1]. In hospitals and pharmacies, the management and transportation of medicines are essential links. The traditional drug management and transportation method requires manual operation, but it is prone to errors and waste, and the efficiency could be higher. At present, the position of the intelligent medical vehicle, when it performs various functions, needs to be more accurate, resulting in a low success rate of grabbing medicines and causing waste when the medicines fall on the ground. When the automatic pathfinding increases with the distance, the route error becomes larger and larger, resulting in pathfinding. Algorithms fail. All of the above must have an efficient and reliable positioning algorithm to ensure the stable operation of the medical vehicle functions. Therefore, the image recognition method for the correct stop of the intelligent medical car came into being. This method can automatically grab the medicine and provide it to the corresponding patient by recognizing the specific image. In addition, intelligent medical vehicles can also realize automatic delivery and correct docking by recognizing different images, reducing manual intervention, and improving the quality and efficiency of medical services. Therefore, the image recognition method for the correct parking of intelligent medical vehicles is of great significance in improving the operation stability of medical vehicles, reducing drug waste, and improving safety [2].

2. Principle of Image Recognition

2.1. Selection of Sensors

The camera model of the intelligent medical vehicle is OV7670. OV7670 is an image sensor with an operating temperature range of -30°C-70°C and an analog voltage of 2.5-3.0V. The sensor is small

in size and low in operating voltage. It provides all the functions of a single-chip VGA camera and image processor. The image sensor will be connected with Arduino UNO to realize the image recognition function (as shown in Fig.1). This project uses an OV7670 camera module with a FIFO buffer to match the lower running speed of Arduino UNO. The FIFO buffer can temporarily store the data captured by the camera so that Arduino UNO can read the data at a slower speed and send it to the host computer for display through the serial port.



Fig. 1 OV7670 [3].

2.2. Image Acquisition

To ensure the accuracy and safety of the system, the recognition pictures of the system will come from specific pictures of specific areas of the hospital (as shown in Fig.2). The OV7670 image sensor can ensure the clarity and quality of the pictures and avoid blurring and distortion.

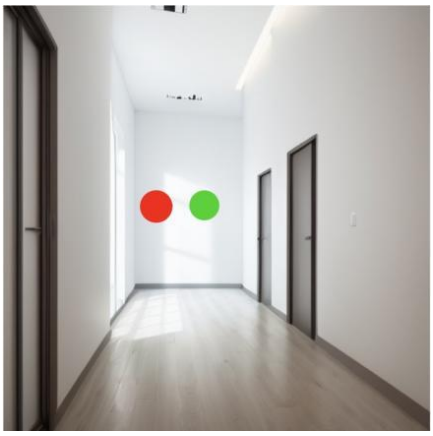


Fig. 2 Specific pictures of specific areas (Picture credit: Original)

3. Image Preprocessing

Image preprocessing refers to the grayscale processing and binarization of the collected pictures to improve the accuracy and efficiency of the subsequent recognition process. By converting a color image to a grayscale image, the amount of image data can be reduced, and processing can be simplified. Binarization can convert the pixel values in the image into black and white, which is convenient for subsequent image segmentation and feature extraction. The preprocessed image can better adapt to various recognition algorithms and improve the recognition rate and accuracy [4].

3.1. Grayscale Image Processing

A grayscale image is one with only two colors, black and white, where black represents the lowest brightness value of a pixel, and white represents the highest brightness value of a pixel. In a grayscale image, the brightness value of each pixel is an integer between 0 and 255, where 0 represents black,

255 represents white and other numbers represent different gray levels. Grayscale processing is equalizing the RGB component values of a color image. Since the RGB value ranges from 0 to 255, grayscale images can only display 256 grayscales. There are three main methods of grayscale processing: maximum method, average method, and weighted average method. Among them, the maximum value method will form a grayscale image with high brightness, the average value method will form a softer grayscale image, and the weighted average method can form different grayscale images according to different weight distributions. Since the human eye has the highest sensitivity to green, the second to red, and the lowest to blue, the best grayscale image can be obtained when Wr=0.30, Wg=0.59, and Wb=0.11. Use MATLAB's rgb2gray () function to convert the image to grayscale [5].

3.2. Binary image

The process of converting a color image to a grayscale image is to convert the color value of each pixel to a grayscale value, thereby obtaining a gray image. To further process the image, the grayscale image needs to be binarized. This process requires the use of a specific algorithm to determine the threshold. Then it compares the gray value of each pixel with the threshold to classify it into two categories: target and background. After binarization, the pixels in the image have only two gray values, namely 0 and 255, representing the background and the target, respectively. If the pixel's gray value is greater than or equal to the threshold, it is set as the target, and the gray value is 255; if the gray value is less than the threshold, it is set as the background, and the gray value is 0 [6].

The basic process of binarization is as follows:

- Preprocess the image by applying a low-pass filter to attenuate or remove noise.
- Use an algorithm to determine the optimal threshold to ensure that target and background regions are well separated below the threshold.
- Set the gray value of all points in the image more significant than the calculated threshold to 255 and set the gray value of all points more minor than 0. Therefore, the generated image has only two colors, black and white, and the image is divided into two areas: the target area and the non-target area, and the image binarization is completed [7].

In image recognition, it may be affected by various factors, such as image quality, light conditions, shooting angle, and image resolution. These factors may cause image clarity, color, and contrast changes， affecting image recognition accuracy. In addition, there may be problems such as noise, occlusion, and deformation in the image, which will also cause difficulties in image recognition. Therefore, when performing image recognition, these factors need to be considered, and corresponding preprocessing and algorithm optimization measures should be taken to improve the accuracy and stability of image recognition [8, 9].

3.3. Morphological operations

Binary images are processed using the following steps: [10]

- Use the bwareaopen function to remove connected regions more petite than a particular area in the binary image, usually noise or unwanted regions.
- Use the steel function to build a structural element of appropriate size, which can be in the shape of a circle or square1. Consider breaking up longer paragraphs into smaller, more digestible chunks to improve readability and flow.
- Provide more context for readers needing to become more familiar with specific technical terms or concepts.
- Include more real-world examples of how this image recognition method can benefit the healthcare industry and impact patient care., for morphological operations.
- Use the close function to close the binary image, which can fill some holes or connect some damaged areas.

- Use the fill function to fill the hole, filling the hole in the binary image with the same pixel value as the surrounding area.

It should be noted that when performing image processing, appropriate parameters and methods should be selected according to the actual situation to achieve the best results. At the same time, it is also necessary to pay attention to whether the processed image meets the actual needs to avoid misjudgment or missed judgment.

4. Extract the red and green parts

Color the red and green circles in this image white and black. The specific implementation method uses MATLAB to judge the RGB value of each pixel. Read in an image and get its size. Then, set two thresholds, level(15) and level 2 (75), to judge whether the pixel is red or green. For each pixel, if its red channel value minus the green channel value is more significant than level 2 and the red channel value minus the blue channel value is more significant than level 2, the pixel is considered red. If its green channel value minus the red channel value is greater than the level and the green channel value minus the blue channel value is greater than the level, the pixel is considered green. The pixels are dyed white for the red and green parts, and the others are dyed black. In the final image, only the red and green parts are white, and the others are black. After MATLAB recognizes the picture, the result is obtained (as shown in Fig.3).

As we can see in the picture, only the red and green circles are colored white, and the rest of the colors are colored black.

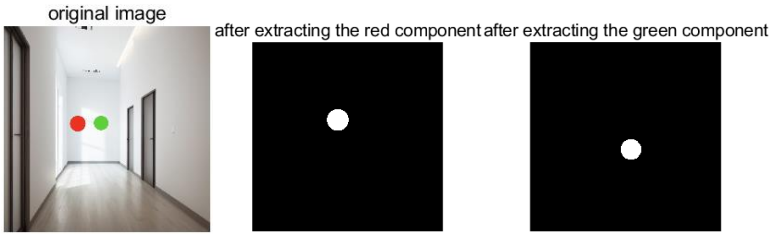


Fig. 3 Extract red and green targets (Picture credit: Original)

5. Identify the circular target in the picture

Threshold segmentation is a commonly used image segmentation technique, which divides the image into two types of regions by using the difference in grayscale characteristics between the target and the background. Choosing an appropriate threshold can determine whether each pixel belongs to the object or the background. Threshold segmentation can reduce data storage capacity and simplify subsequent analysis and processing steps [11]. Segment the image, separate the red target, and use the function `label2rgb` and `@jet` parameters to mark the segmented target with different colors. For boundary detection of the segmented target, the function `region props` is used to obtain the area and centroid of the target, and the `diff` function and the `sum` function are used to calculate the target's perimeter. Then calculate a metric `metric` based on the area and perimeter of the target, metric = 4*pi*area/perimeter^2

The closer the value is to 1, the closer the target is to a circle. Under the same conditions, a circle has the most significant area because the relationship between the circumference and area of a circle is fixed. Specifically, for any given circumference, the circle has the largest area. It is because a circle has the largest area of all shapes with the same perimeter. Therefore, when calculating the above formula, the area of the circle is the largest, so its corresponding metric value is the largest. According to the set threshold `threshold` to judge whether the target is a circle, the target is considered a circle if the `metric` is greater than the threshold. If there is a circular target, the variable `red_circle` is assigned a value of 1, indicating that there are red and green circular targets. After MATLAB recognizes the picture, the following pictures are obtained (see Fig.4).



Fig. 4 Red target and green target (Picture credit: Original)

Add a code in Matlab to make the robot stop only when it recognizes the red and green circles (see Fig.5).

```
ide=red_circle&&green_circle;
if(ide==1)
    disp('recognized successfully')
else
    disp('recognition failed')
end
```

Fig. 5 Code in Matlab(Picture credit: Original)

Various situations are often encountered during the recognition process. For example, the recognition failure will be displayed if the correct color is recognized but not a circle (see Fig.6).

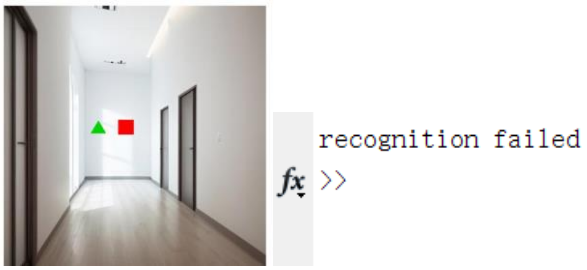


Fig. 6 Recognition failed (Picture credit: Original)

It is also possible that the circle is recognized, but the color is not red and green, and the recognition failure will also be displayed (as shown in Fig.7).

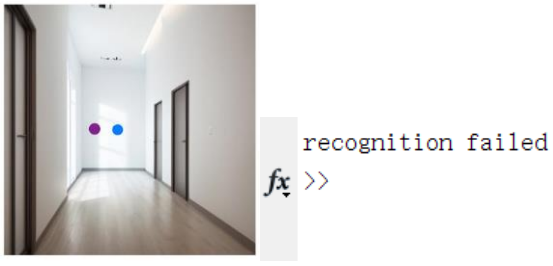


Fig. 7 Recognition failed (Picture credit: Original)

As shown in Fig.6 and Fig.7, when the machine recognizes the correct color but the wrong shape and the correct shape and wrong color, the recognition will fail.

The failed command output recognized by Matlab is connected to the robot through the serial port of the computer. If the robot has a serial port interface, you can use a microcontroller to convert the serial port signal into a signal that the robot can recognize, to realize the connection with the robot.

When the robot receives an instruction of recognition failure, the robot will not stop or drive the machine to grab the medicine until the correct image is recognized.

6. Conclusion

This paper proposes a circular object recognition method based on image processing technology, which can effectively recognize circular objects by constructing and closing operations of graphic

structural elements and filling holes. Experimental results show that the method has high accuracy，and can be applied to robot vision navigation and automated production.

This research has important implications for robotic visual navigation and automated production. In terms of robot vision navigation, this method can help the robot more accurately identify circular targets in the environment, to better complete the navigation task. In terms of automated production, this method can help automated production lines identify circular parts in products more quickly, thereby improving production efficiency and product quality.

This method can be further optimized and improved to suit a wider range of application scenarios. For example, the method can be applied to object recognition in other shapes, such as rectangles, triangles, etc. At the same time, the method can be combined with techniques such as deep learning to improve recognition accuracy and robustness. In addition, this method can also be applied to intelligent transportation, medical imaging, and other fields, and has broad application prospects.

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