Research on Vision Perception Technology of Auto Fueling Robot on opencv-based gas tank cap recognition

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Abstract. Designing a suitable algorithm to recognize the fuel tank cap and perform automatic refueling by manipulating a robotic arm. In exploring a new recognition algorithm for automatic vehicle refueling technology, for motor vehicle fuel tank lid, through the difference of images taken by binocular camera, combined with the basic calculation principles such as the imaging principle of binocular camera and the conversion relationship between coordinate systems, the recognition of ROI area is carried out automatically, then a closed-loop system is formed for real-time tracking, and finally the accurate positioning of fuel tank lid position is completed. The matching recognition and tracking technology of the target combines the comprehensive discipline research of mathematical analysis, image processing, object kinematics, artificial intelligence, automation control and other related fields, and has a very important status and research value in military aerospace, industrial production, intelligent medical care, security monitoring, intelligent driving, human-computer interaction and other fields.

Keywords: algorithm design, oily cover recognition, data processing, Deflection Angle calculation, manipulation of robotic arm, real-time sensing.

1. Introduction
Our research is to design the APP for the target users and, with the help of a special binocular camera and using third-party tools, pinpoint the location of the car's gas cap with the help of a suitable algorithm. And manipulate the mechanical arm and the fuel gun connected to it to achieve the effect of automatic refueling. The reason is that the current domestic gas station management informationization level is not high, the management is inefficient, and the workload is high while human errors are easily generated. When business is busy, this situation increases the labor intensity of the staff on the one hand, and brings great inconvenience to the life of customers on the other. Automatic filling technology for this project is intended to explore a new recognition algorithm, for motor vehicles, oil through binocular camera image differences, combining with the binocular
camera imaging principle and the basic calculation principle, such as coordinate transformation relationship between automated ROI region recognition, and then form a closed loop system for real-time tracking, finally complete the cap position precision positioning. This project includes three research contents: image recognition, stereo vision and three-dimensional structural analysis, and real-time tracking, in order to realize automation and intelligence of refueling. This project will use image processing technology and deep learning technology to carry out research. If this design is applied in practice, it can solve the problems of low information level and low efficiency of gas stations, free our hands and make life more convenient and easier.

2. ROI Region Selection
Firstly, for the motor vehicle fuel tank cover, the recognition of ROI region is carried out automatically through the difference of images taken by binocular camera, combined with the basic calculation principles such as the imaging principle of binocular camera and the conversion relationship between coordinate systems. According to the position of the preselection box, the corresponding region is pooled into a fixed-size feature map in the feature map, so as to conduct subsequent classification and bounding box regression operations. We combine the above knowledge points with our topic to get the result of intelligent identification of car fuel tank cap.

3. Precise Positioning of the Tank
   (1) Target matching and localization
   In this process, we use the concept of single-image matrix in 2D planar mapping to first normalize the image coordinates, and then use a third-party tool, Opencv, which has integrated the function findHomography to find the single-image matrix, and simply input the corresponding matching feature points, target, screening Then, through a third-party tool, Opencv, which has integrated the function to findHomography, it is easy to find the single response matrix of the corresponding plane image by inputting the corresponding matching feature points, target, screening threshold, iteration number and other parameters. Then, the Hough circle detection is performed on the tank graphics to fit the elliptical shape of the tank cover. Thus, the effect of identifying and locating the target in the unknown image is achieved.

   (2) Estimation of relative deflection angle
   In the "Horizontal relative pose recognition algorithm based on binocular camera", the horizontal deflection angle of a spatial plane relative to the camera can be obtained by determining two vertical edge lines in the spatial plane and localizing them in the left and right images of the binocular camera. The four edge points of the target object in the video stream to be matched are determined and framed by the SURF algorithm and the single response matrix. The right figure shows that the left and right edges of the target object are marked, and thus the pixel information of the left and right edges of the target in the left and right cameras can be obtained. The combination of SURF algorithm and "horizontal relative pose recognition algorithm based on binocular camera" can achieve the purpose of pose recognition, and thus find the horizontal deflection angle of this spatial plane relative to the camera.

4. Structured Data Analysis
   STEP 1: Read RGB pictures, generally JPG, PNG
   STEP 2: determine whether the stored image variable is empty, if empty, print the reason and exit the program
   STEP 3: digital images in its formation, transmission of the record process is often contaminated by a lot of noise, such as: pretzel noise, Gaussian noise, etc., in order to suppress and eliminate the noise generated and improve the quality of the image, it is necessary to go, the image of the denoising process, denoising is also known as filtering process. Median filtering is a method of image smoothing. It is a nonlinear smoothing filtering technique that can overcome the blurring of image details brought about by linear filtering under certain conditions, especially for images contaminated by pretzel noise.
STEP 4: cvColor COLOR_BGR2GRAY parameter makes the RGB image to be converted to a single channel grayscale map for use as a parameter of the Hough circle algorithm.

STEP 5: GaussianBlur Gaussian smoothing To overcome the drawbacks of simple local averaging (image blurring), many local smoothing algorithms have been proposed to maintain edges and details. Their starting points all focus on how to choose the size, shape and direction of the neighborhood, the parameters plus the average and the weight coefficients of each store in the neighborhood.

Image Gaussian smoothing is also a method of smoothing an image with the idea of neighborhood averaging, in which pixels at different locations are given different weights when averaging the image in image Gaussian smoothing. Gaussian smoothing is different from simple smoothing in that it gives different weights to pixels at different locations when averaging pixels in the neighborhood.

STEP 6: Same as STEP 3

STEP 7: The essence of Canny's work is that expressing the previous three criteria mathematically. Thus the steps of Canny are as follows.

Perform Gaussian smoothing on the input image to reduce the error rate. Calculate the gradient magnitude and direction to estimate the edge strength and direction at each point. Apply non-maximal suppression to the gradient amplitude based on the gradient direction. Essentially, it is a further refinement of the results of Sobel, Prewitt and other operators. The edges are processed and connected with double thresholding.

STEP 8: Hough circle transformation is the process of converting a circle in the two-dimensional image space into a point in the three-dimensional parameter space determined by the radius of that circle and the horizontal and vertical coordinates of the center of the circle, so that the circle determined by any three points on the circumference of the circle should correspond to a point in the three-dimensional parameter space after the Hough transformation. The process is similar to the election voting process, where any three points on the circumference of a circle are an elector, and the circle determined by these three points is a candidate (hereinafter called the candidate circle). All points on the circumference of the circle are traversed, and the candidate circle determined by any three points is voted on. At the end of the iteration, the circle determined by the highest number of votes (theoretically, the circle determined by any three points on the circumference of the circle corresponds to the same point in the three-dimensional parameter space after the Hough transformation) is the circle determined by the majority of points on the circumference of the circle (hereinafter referred to as the elected circle), i.e., the majority of points are on the circumference of the elected circle, thus determining the circle.
Figure 1. flow- process diagram

Running effect picture.
1 is the image obtained through the camera.
Canny is the image after single-channel grayscale conversion and median filtering twice
Image is the image after Hoff circle recognition, the circle information is saved and reflected in the median filtered image
5. Form a Closed Loop to Optimize the Accuracy

We first purify and optimize the SURF matched feature points for the first time, according to the matching relationship between known image and unknown image feature points, we rank the effect of the paired feature points and extract the part of matched feature point pairs with the best matching results. After the first matching optimization, it can be found that most of the false matching points have been eliminated, but there are still a few false matching feature points left. At this point, the
optimization effect is obvious, and the optimized points can be used for the subsequent calculation of the required positions.

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6. Project features and innovation points

This project based on the design of automatic refueling robot, for other similar projects, can be in the center of the fuel cap selection of data, determined, structured analysis and manipulation of the mechanical arm fitting method, generalized to other similar projects, not only confined to the shape and the use of equipment material, and is of a qualitative guidance. This project integrated the advantages of previous related studies and made some improvements, making the selection of ROI region more detailed and accurate. Moreover, the real-time sensing function of the manipulator is optimized so that it has the ability to deal with all kinds of special situations such as tank stains. In addition, this project also tries to promote the informatization of domestic gas stations comprehensively through the research of refueling robot, which has certain reference value for related research. And we adopt and reference in the design of target recognition and tracking technology as a hot research direction in computer vision, and aims at continuous streaming through specific recognition algorithm will target object in the image from the background image positioning, and in the subsequent continuous image, to predict information such as position and speed of the target object positioning, in order to realize the real-time dynamic tracking of the target object. Target matching recognition and tracking technology is a combination of mathematical analysis, image processing, kinematics objects, in the field of artificial intelligence, automatic control or related comprehensive subject research, in the military aerospace, industrial production, intelligent medical, security monitoring, intelligent driving, in the field of human-computer interaction and so on have very important status and research value.

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