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Automatic Identifying and Tracing System for Floating Objects based on Machine Vision

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Abstract

An automatic identifying and tracing system of floating objects in water area based on machine vision is developed, which can help water cleaning devices to identify floating targets and their locations. Firstly, the system carries out feature analysis and AI recognition for the target in the water surface image, and determines the attributes and location of it; secondly, the tracking and positioning algorithms are developed for floating objects; then, the real-time sun position measurements are realized. Furthermore, the system can control the orientation of the solar panel to always face the sun through the steering gear, so that the system can clean the water surface for a long time.

Keywords

Floating objects in waters; Machine vision; Automatic search.

1. Introduction

Water areas refer to oceans, rivers, lakes, canals, channels, reservoirs, reservoirs and the scope of their management [1]. It is one of the most important ecological environments in the ecosystem, supporting human survival and social development. Especially with the rapid development of economy and society, the expansion of city scale and the continuous growth of population, the protection and construction of water ecological environment develop along the clue of water resources, water environment, water ecology, water landscape and water culture [2]. China is in a state of serious drought and water shortage. The per capita share of fresh water resources is only 0.24 M. in this case, solving the problem of water pollution and improving the utilization efficiency of water resources can not only protect the environment, but also avoid environmental deterioration and alleviate the problem of water resources. In order to solve the problem of floating garbage on the water surface, the relevant departments all carry out manual salvage by irregular means, which not only consumes a lot of labor, but also has relatively large labor intensity and relatively long cycle, but the actual effect is not ideal [3, 4]. The emergence of the early intelligent water surface cleaning unmanned ship reduces the risk coefficient, reduces the labor cost and improves the work efficiency to a certain extent [5].

In this work, an automatic cleaning system for floating objects in water area based on machine vision is developed, which can help the water surface device to identify and locate water surface targets, and cruise automatically until the target collection is completed.

(1) The system carries out feature analysis and AI recognition for the target in the water surface image, and determines the attribute and location of the target;

(2) The system can automatically set the cruise route of the collection device according to the tracking and positioning of floating objects on the water surface;

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(3) The system can measure the real-time position of the sun, and control the orientation of the solar panel to always face the sun through the steering gear, so that the system can be used to clean the water surface for a long time.

2. Dynamic Target Identifying Technology

2.1. Feature Selection and Extraction of Floating Objects on Water Surface

Feature selection and extraction is also a key step in machine vision, since image features contain image information, which will directly affect the image classification. However, due to the influence of environment and other factors, segmentation results have errors, which makes it difficult to extract shape features and texture features from binary images to represent the number of floating objects. According to the actual working condition of this subject, binary morphology operation is selected to supplement the information of the segmented binary image.

2.2. The Water Surface Image Is Processed to Get the Coordinate Position of Water Surface Garbage

The opencv computer vision library is used to program the water surface image, detect the target and process to get the coordinate position of the water surface garbage.

1) The images are scaled to 640 × 480 pixels and binarized. The binarization threshold is gradually reduced from 255, and the edge detection algorithm is used to extract the contour until the first edge is detected. The first edge is the area with the most significant contrast in the detected image when the threshold is reduced to a certain extent.

2) The Hough line detection is used to extract the line in the binary image. Hough transform maps a point in Cartesian coordinates to a curve described by polar coordinates by $r = x\cos\theta + y\sin\theta$. For multiple points on the same line in the image, it can be seen from the above formula that after Hough transformation, it is a number of curves intersecting at the same point.

3) For the water surface image below the straight line, adaptive binarization and Canny edge detection are applied, and multiple edges that may be detected are initially identified as garbage. Then, the area of the closed area inside the edge and the position of the center point of the closed area are calculated.

4) The area of the closed area is filtered, and the closed area within the range of 100 to 1600 pixels is extracted, that is, the edge with too small area is treated as water wave, and the edge with large area is treated as the reflection of the shore buildings and other interference factors.

5) After extracting the image features of the local image, the trained deep neural network is used to classify and judge whether it is garbage. The center point of the area that has been judged as garbage is taken as the coordinate position of garbage in the image. Combined with the coordinate position and camera perspective, the azimuth of garbage is calculated as the course of the ship.

2.3. Automatic Light Tracing Algorithm

The pitch angle and direction angle of the panel are controlled by the steering gear to aim at the direction of the sun in real time.

Both sides of the solar panel 9 are equipped with light intensity sensors to detect the position of the sun through the light intensity sensor, and the solar panel 9 is equipped with a digital compass to detect the orientation of the current solar panel through the digital compass; the azimuth and altitude of the sun are calculated through the current time and theoretical formula, and the steering angle and pitch of the solar panel are adjusted by PID controller and steering gear Elevation angle, to ensure that the solar panel is always facing the sun when the ship turns,

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to achieve the highest efficiency. The hull is also equipped with lithium battery auxiliary power supply, and when the solar power generation is sufficient, the electric energy is stored.

Where, the solar altitude angle a is expressed as:

$$\sin A=\sin\varphi\sin\delta+\cos\varphi\cos\delta\cos\omega \quad (1)$$

The solar azimuth B is expressed as:

$$\sin B=\cos\delta\sin\omega/\cos t \quad (2)$$

Where δ is the declination angle; ω is the time angle, where t is the local solar hour, in hours; and φ is the local latitude, which can be obtained by GPS module.

3. Evaluation and Simulation

A set of AI system based on machine vision for automatic search and cleaning of floating objects in water area is designed. The system testing work is mainly divided into the following parts:

(1) In the development environment of Python opencv, a set of target tracking algorithm is designed. By separating the foreground and background, the target is locked and the moving trajectory of the moving surface object is drawn, so as to calculate the cruise trajectory of the water device.

(2) In the development environment of Python opencv, a set of image preprocessing method is designed to select and extract the features of the target image, and detect the object attributes (size, shape, surface texture), so as to realize the rapid recognition of the target.

(3) A set of automatic light tracking algorithm is designed. The steering gear is used to control the orientation of the solar panel always facing the sun.

(4) The mircropython ARM core board system is designed as the central controller to control the data collection and processing of each sub module.

The test results show that the system can correctly identify the floating objects on the water surface and calculate their coordinate position; according to the target positioning, it can automatically set the route of the floating object cleaning robot to complete the collection of floating objects on the water surface. Through the machine learning algorithm, the feature machine learning model is created, and the accuracy of target attribute determination is not less than 97%. When the battery is fully charged, the average duration of the test is 3 hours / day in cloudy days and 8 hours / day in sunny days.

4. Conclusion

(1) The complex background in the image is often the technical bottleneck in image recognition. The target tracking algorithm based on correlation filter can solve the problem of complex background. Through the convolution operation of the image and the filter template, we can find the response peak in the prediction distribution, which can effectively solve the influence of the background image on the foreground target recognition. The technology is suitable for collection in different waters, and the system has strong environmental adaptability.

(2) Image preprocessing based on morphology in Canny edge detection algorithm, a new edge detection method is designed for the situation that the results are easy to lose weak boundaries or broken boundaries. Different from Canny algorithm, this method uses the fuzzy threshold to suppress the non-edge part of the image, and then uses the curve fitting path algorithm (CFR) to draw the set of pixels in the image which are regarded as the gradient peak. CFR algorithm

connects the gradient peaks in the image to form a continuous single edge curve, which supplements the missing information. The experiment in the early stage of the project shows that the output edge of the improved edge detection algorithm is clearer and more continuous, which is conducive to the realization of high-precision dimension measurement and feature recognition. At the same time, it improves the adaptability of the system to uncertain environmental factors.

(3) The random forest machine learning classifier is used to improve the recognition accuracy of the system. The system uses the random forest classifier trained by a large number of image samples to quickly convert the multi-dimensional target eigenvalues (size, edge number, etc.) into classification results. The recognition accuracy is basically the same as that of deep neural network (CNN), but the processing speed is only deep It not only improves the operation efficiency, but also greatly reduces the hardware requirements of the equipment.

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References

[1] D.W. Aha, D. Kibler and M.K. Albert, Instance-based learning algorithms. Machine Learning, vol. 6, pp. 37-66, 1991.

[2] M. Alhamdoosh and D. Wang, "Fast decorrelated neural network ensembles with random weights", Information Sciences, vol. 264, pp. 104-117, 2014.

[3] N.S. Altman, "An introduction to kernel and nearest-neighbor nonparametric regression", The American Statistician, vol. 46, no. 3, pp. 175-185, 1992.

[4] A. Alvarez, B. Sierra, A. Arruti, J.M. Lpez-Gil and N. Garay-Vitoria, "Classifier subset selection for the stacked generalization method applied to emotion recognition in speech", Sensors, vol. 16, no. 1, pp. 21, 2016.

[5] A. Arruti, I. Cearreta, A. Alvarez, E. Lazkano and B. Sierra, "Feature selection for speech emotion recognition in spanish and basque: On the use of machine learning to improve human-computer interaction", PloS one, vol. 9, no. 10, pp. e108-975, 2014.

[6] A. Batliner, K. Fischer, R. Huber, J. Spilker and E. Nöth, "Desperately seeking emotions or: Actors wizards and human beings", ISCA Tutorial and Research Workshop (ITRW)on Speech and Emotion, 2000.