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The composition function and realization of maritime distress personnel search system

Jin Ming
School of Energy and Power Engineering
Wuhan University of Technology, Wuhan 430063, China
e-mail: 1832170969@qq.com

***Abstract*—This project plans to design a kind of identification system which can be used to identify the maritime personnel in distress and equipment to be rescued under the clear sea surface.The system can be carried on unmanned aerial vehic le (UAV), and the existing YOLOV3 algorithm is used for ta rget recognition. It can identify the maritime distress person nel and rescue equipment wearing life jackets under clear se a surface, so as to assist in further search and rescue decision making, and solve or partially resolve the existing problems i n search and rescue technology.**

Keywords-YOLOV3 algorithm, target recognition and loss function

I. INTRODUCTION

With the development of science and technology,the shipping industry has also developed rapidly, marine economy has become an important part of the national economy, however, with the development of marine economy, water safety accidents are also increasing[1]。

In the existing technology, the initial location is usually carried out by ship borne GPS equipment, or the distress personnel send out distress signals through the traditional walk, ie talkie, then send aircraft or ships to the accident area for search and rescue, and observe and rescue the suspicious areas through staff's experience[2].

The existing search and rescue methods need to rely on the experience of the staff to search for the people in distress, which may lead to misjudgment. On the other hand, in the offshore area from the baseline of the territorial sea to 200 nautical miles, due to the harsh sea conditions, complex climate and changeable water environment, it is difficult to implement the existing methods. Therefore, there are some technical problems in the existing technology, such as inaccurate identification and difficult search and rescue[3].

II. SYSTEM COMPOSITION

In order to solve the above problems, the first aspect of the system provides a maritime distress personnel search system which can be carried on UAV. The system includes image acquisition module, first information transmission module, target recognition module, second information transmission module and information visualization module. The system structure diagram is shown in Figure 1.

The image acquisition module is a high-definition camera mounted on UAV, which is used to obtain the video image information in the distress sea area.

The first information transmitting module is used to transmit the video image information in the distress sea area to the target recognition module.

The target recognition module is used to identify the received video image information by using the Yolo algorithm to obtain the information of the target to be rescued. The recognition process of the Yolo algorithm includes: for each prediction box, the largest category is selected as its prediction label according to the category confidence, so as to obtain the prediction category and corresponding confidence value of each prediction box, and set the confidence threshold value, and set the confidence threshold valueThe prediction boxes whose confidence value is less than the confidence threshold are filtered to obtain the prediction boxes with higher confidence. These prediction boxes are screened by non maximum suppression algorithm to screen the target to be rescued with the highest confidence. In one implementation, the target recognition module includes optimization unit, which is used to: use loss function to connect the block with the boundary box and each boundary boxThe dimensions of confidence were unified. In one embodiment, the information of the target to be rescued includes the type of equipment to be rescued and the information of the person to be rescued. In one embodiment, the system also includes an alarm module for alarming after the target identification module recognizes the target to be rescued[4].

The second information sending module sends the information of the identified target to be rescued to the information visualization module.

The information visualization module is used to visually display the information of the identified target to be rescued for search and rescue.

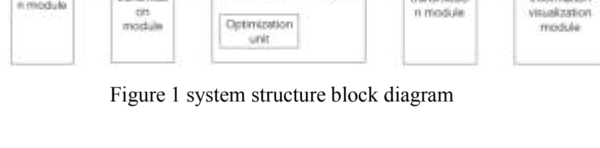

Figure 1 system structure block diagram

III. SYSTEM FLOW

There are many ways to implement the system. In one implementation mode, the video image information in the distress sea area is obtained by the high-definition camera mounted on the UAV, and the video image information in the distress sea area is sent to the target recognition module through the first information transmission module.Through the target recognition module, it is used to recognize the received video image information by using the Yolo algorithm to obtain the information of the target to be rescued. The recognition process of the Yolo algorithm includes: for each prediction box, the largest category is selected as its prediction label according to the category confidence, so as to get the prediction category and corresponding confidence value of each prediction box, and set the confidence threshold, filter the prediction box whose confidence value is less than the confidence threshold, and get the prediction box with higher confidence.Then, the non maximum suppression algorithm is used to screen these prediction boxes, and the target to be rescued with the highest confidence is selected.

YoloV3 mainly plays the role of target recognition in this system. Yolo algorithm intercepts and analyzes the key frames in the video transmitted by UAV, performs a CNN operation on them, and convolutes the input key frame images, which divides the images into N * n grids, the center of each grid is responsible for detecting whether it is a target to be rescued, and each cell predicts B bounding boxes and their confidence level[5]。The system flow chart is shown in the figure below.Figure 2 system flow chart.

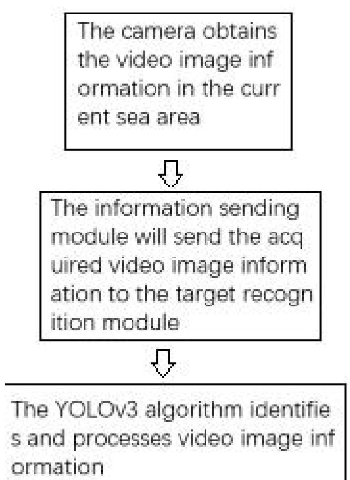

Fig.2 System flow

A.Establish the database of yolov3 algorithm

As the flying altitude of UAV can not be determined and the sea conditions are changeable, the difficulty of target detection is greatly increased. Therefore, it is necessary to obtain a large number of video samples of rescue personnel, lifeboats and liferafts wearing life jackets / lifebuoys for annotation and training within the flight altitude range of UAV.Among them, the marked data are shown in Table 1, and the training samples are shown in Table 2.

TABLE 1 MARKED DATA OF MARITIME DISTRESS PERSONNEL SEARCH SYSTEM WHICH CAN BE CARRIED ON UAV

Total quantity	lifeboat	Life raft	Water personnel
437892	15747	27421	31947

By marking a large number of data and considering the characteristics of different targets, the system can provide the basis for subsequent training and prediction, thus providing the accuracy of target recognition.

Table 2 a training sample of maritime distress personnel search system which can be carried on UAV

Training name	lifeboat	Life raft	Persons in distress
Training quantity	725	443	1127

In this embodiment, the detection targets are divided into three categories: lifeboat, liferaft and drowning personnel.Use labelimg tool to add sample label and establish basic database.The detailed parameters are shown in Table 1. The training sample selects the target with good characteristics to mark, and the test data needs to mark all the targets in the sample image. The XML tag is transformed into TXT text that can be recognized by Yolo, and the database is established.

B. Target model training

With darknet53 as the network framework and Yolo V3 as the detection model, the target detection system to be rescued is trained.

C.Yolov3 detection system

Yolov3 mainly plays the role of target recognition in this system. Yolo algorithm intercepts and analyzes the key frames in the video transmitted by UAV, performs a CNN operation on them, and convolutes the input key frame images, which divides the images into N * n grids, the center of each grid is responsible for detecting whether it is a target to be rescued, and each cell will predict B bounding boxes and their confidence level.

In one embodiment, the target recognition module includes an optimization unit, which is used to unify the block with the bounding box and the dimensions of the confidence obtained by each bounding box using the loss function.

Specifically, when predicting the confidence level, each block needs to predict a category information besides its own position (x, y, H) and confidence C.Due to the huge difference between the confidence dimensions of blocks, bounding boxes and each bounding box, and each block predicts multiple bounding boxes, in order to make the bounding box predict whether there is a target object more accurately or not, this system uses loss function to unify the confidence dimensions of blocks, bounding boxes and each bounding box, And it makes the confidence level of each bounding box more accurate[6].The loss function is shown in formula (1).

$$\lambda_{coord}\sum_{i=0}^{S^2}\sum_{j=0}^{B}\Pi_{ij}^{obj}(x_i-\hat{x}_i)^2+(y_i-\hat{y}_i$$
$$+\lambda_{coord}\sum_{i=0}^{S^2}\sum_{j=0}^{B}\Pi_{ij}^{obj}(\sqrt{\omega_i}-\sqrt{\hat{\omega}_i})^2+($$
$$+\sum_{i=0}^{S^2}\sum_{j=0}^{B}\Pi_{ij}^{obj}(c_i-\hat{c}_i)^2$$
$$+\sum_{i=0}^{S^2}\sum_{j=0}^{B}\Pi_{ij}^{noobj}(c_i-\hat{c}_i)^2$$
$$+\sum_{i=0}^{S^2}\Pi_{i}^{obj}\sum_{c\in classes}(p_i(c)-\hat{p}_i(c))^2 \quad (1)$$

Formula (1) is an arbitrary given constant, I and j are prediction values of block unit and bounding box respectively (I = 0,..., j = 0,..., b), (x, y) is the location of predicted boundary box, is the actual position obtained from the training data, represents the width and height of each grid prediction, represents the prediction confidence of each grid, and predicts the category information of each grid.The upper corner marks all represent the actual values obtained from the training data.

IV. SYSTEM STABILITY ANALYSIS

After a large number of training for the target object, the system randomly searches the relevant graph lines from the network for experiment. Table 3 shows the test result statistics.As shown in Fig. 3 and Fig. 4, part of the graphic recognition effect is displayed, in which figure 3 is the detection target for the rescue personnel, and Figure 4 is the detection target for the lifeboat.

Table 3,Number

Enter image name	Daytime lifeboat	Night lifeboat	Day raft	Night raft	People falling into the water during the day	People falling into the water at night
Number of input images	105	71	225	217	548	767
The number of images with ideal detection effect	104	64	223	209	548	754

After a large number of training for the target object, the system randomly searches relevant images from the network for experiments. Fig. 4 and Fig. 5 show the effect recognition diagram of the system for the drowning personnel and distress equipment.

Figure 3, target object,

Figure 4, target object,

The above representative test chart selection can intuitively display the test results of the rescue personnel and the marine rescue equipment that may be in distress by Yolo algorithm in this system.The detection results include reminding the system users and the name and quantity of the rescue personnel and the possible existence of the rescue personnel at sea.
In general, according to the detection results of the above graphs, the system can obtain the image information from different angles and process it well.

V. CONCLUSION

The system has a high precision identification for the maritime personnel in distress and the equipment to be rescued under the clear sea surface, and has a good auxiliary role for further rescue decision-making.

The system can be carried on UAV, and still has certain recognition ability to target objects in complex environment, but the system is poor in night operation. The project is expected to further improve the night operation ability and system integrity of the system.

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