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COMPUTER VISION TECHNOLOGY FOR QUADROTOR

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Introduction

The development of microprocessor technology and computer science has made a breakthrough in aviation, through which it became possible to build such a new class ofunmanned aircraft - quadrotor. This type of drone, have four electric motors, flight controller, radio module and also equipped with cameras, which allow it to be used for aerial photography. However, the use of computer vision and machine learning technologies significantly expand the possibilities and areas of quadrotors'application. One example of the new capabilities of commercial drones is object detection and tracking.

Materials and Methods

The object of research is a programmable quadrotor, which uses computer vision technology.

The main objective of the work is to show how to combine computer vision technology and quadrotor control system on the example of human face detection and following it.

To realize the ability to detect objects, it is proposed to use the method of Haar cascade classifier, specifically theViola Jones Algorithm [1].

For the tracking taskProportional-Differential (PD)controller is used [2].

Results

To implement Viola Jones' algorithm, a trained cascade classifier that incorporates certain Haar-like features must be used. These features consist of a class of local features that are computed by subtracting the sum of the feature subregion from the sum of the remaining feature region.

Next, to detect the object, the original image is split into multiple rectangular patches, each of which is added to the cascade. If a rectangular frame corresponds to a cascade of features at all stages of the classification, it isdefined as positive. In this way, the algorithm extracts the desired object from the general background. An illustration of the algorithm is representedin Figure 1.

Once the face is detected, the tracking phase follows. First, the area in pixels of the box with our object and the area of the output image from the drone's camera are calculated. Then, the forward motion algorithm is realized by introducing a "dead zone". If the object is farther or closer, the area of the box decreases or increases. The quadcopter receives a corresponding command to move

forward or backward. If the object is inside the restricted area, the quadcopter hovers in place.

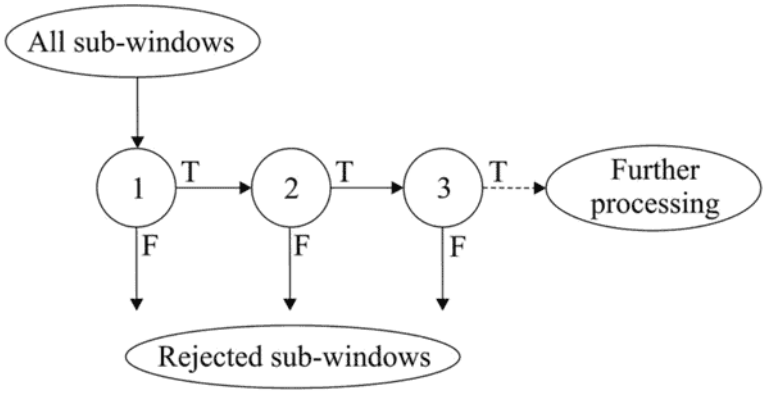

Figure 1. Representation of Viola Jones cascade detection algorithm

The rotation algorithm is implemented in such a way that the object should always be in the center of the screen.If the detected object is shifted to the side, at the same moment a signal is sent through the yaw channel to the flight controller to rotate to the desired angle.It compensates for the difference between the coordinates of the object and the center of the image. To eliminate the moment of inertia, a PD controller is synthesized that predicts and eliminates the rotational error. General formula of a PD controller is presented below:

$$u(t) = K_p e(t) + K_d \frac{d}{dt} e(t)$$

The coefficients of PD controllerare tuned with the help of theZiegler-Nichols method [3].

Conclusion

Based on the results of the work, we can conclude that the technology of object classification and detection, allows to use of quadrotors in a wide range of tasks such as rescue operations, detection of fire sources, protection of the state borders, reconnaissance missions etc.

References:

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