Software module for capturing and tracking moving targets

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Abstract—**Software for drones has been created that allows tracking objects in real time. A software module has been developed that provides automatic capture and tracking of moving targets. The developed software uses computer vision algorithms and machine learning technologies. The object tracking mechanism has been integrated using CSRT or KCF trackers. An algorithm for automatic image scaling taking into account target movement has been implemented. Video stream processing has been optimized to ensure stable tracking of object movement in real time. Interactive control of the tracking process using control keys has been implemented.**

Keywords—software; drone; computer vision algorithms; machine learning

I. Introduction

In the modern world, drones have become an integral part of many areas of activity - from military operations and reconnaissance to industrial monitoring, agriculture and search and rescue missions. Due to their mobility, autonomy and ability to work in difficult conditions, unmanned aerial vehicles have significantly expanded the capabilities of control, surveillance and performing specialized tasks. In order to increase the variety of tasks that drones can perform, special software modules with various functions are being developed for them. Modern computer vision methods integrated into unmanned systems allow to significantly increase the efficiency of their work, automate image analysis processes and minimize the human factor in the control process. The use of video processing algorithms and machine learning allows not only to identify targets, but also to predict their movement, adapt tracking strategies and respond to changing environmental conditions.

The work was carried out on behalf of the company "AMLAB" LLC during the internship. This company plays an important role in strengthening the country's defense capabilities, as it produces unmanned aerial vehicles and electronic warfare systems, which are actively used for military needs. In addition, the company cooperates with charitable foundations and military units, partly working on a volunteer basis.

In this work, software for drones has been developed that allows for real-time object tracking. The developed software uses computer vision algorithms and machine learning technologies.

II. Analysis of the functionality of the software module

The main goal of this work is to develop a software module for drones that provides automatic capture and tracking of moving targets.

The following tasks were completed:

- Using OpenCV to implement computer vision algorithms.
- Integration of the object tracking mechanism using CSRT or KCF trackers.
- Development of an algorithm for automatic image scaling taking into account target movement.
- Optimization of video stream processing to ensure stable real-time tracking.
- Interactive control of the tracking process using control keys.

The software module is developed in Python using the OpenCV library [1]. The program uses computer vision algorithms [2] to determine the position of an object in the frame and scale it for improved display. The code initializes the webcam, processes video frames, determines a region of interest in the center of

the frame, and also applies tracking algorithms to track moving objects.

CSRT (Channel and Spatial Reliability Tracker) and KCF (Kernelized Correlation Filter) are two popular object tracking algorithms in computer vision, used for video stream analysis, for example in drone control systems. CSRT has high accuracy and support for scaling, while KCF has fast real-time tracking [3].

Tracker initialization. This part of the code checks if the OpenCV library supports CSRT or KCF trackers. If CSRT is available, it is used by default. If CSRT is not available, KCF is used. If neither is supported, the program terminates with an appropriate error message.

Initializing variables:

- tracking it is indicates whether tracking is active.
- tracker is tracker object.
- frame_center_rect_size is size of the central square for selecting the area.
- zoom_factor is area enlargement factor.
- enlarged_region is variable for storing the enlarged image.
- cap = cv2.VideoCapture(0) it is opens the video stream from the camera.

Function to draw a central rectangle. This function draws a central square (rectangle) that is used to define the tracking area.

The main video stream processing loop. This loop receives frames from the camera, checks their correctness, and continues processing.

Object tracking. If tracking is active, the program updates the object's position, draws a blue rectangle, and crops the area for magnification.

Key management. This part of the program handles key presses:

- `q` is exits the program.
- `Space` it is turns tracking on/off.

To get started, run the program from the command line using the command: *python tracker.py*. After starting, a window with a video stream from the camera will open. The program checks whether the current version of OpenCV supports CSRT or KCF trackers. If both trackers are not available, the program terminates with an error message. The `cv2.VideoCapture(0)` object is used to open the stream from the first connected camera.

The program reads the first frame to determine the video dimensions. A fixed frame (50x50 pixels) is displayed in the center of the screen, which defines the initial tracking area.

To start or stop tracking an object within the central area, place the object to track in this area and press Spacebar.

If tracking is active, the program initializes the tracker and constantly updates the position of the object. If the object is successfully tracked, a blue rectangle is drawn around it. At the same time, the selected area is magnified twice (using `cv2.resize`) and displayed at the top of the window.

If the tracker cannot find the object, a red message "Tracking lost!" appears on the screen. The program continues to display the last recorded area, even if tracking is stopped or lost.

Application possibilities [4-5]:

- Video surveillance: Real-time tracking of moving objects for territory protection.
- Behavior analysis: Monitoring the activity and behavior of objects in the frame for research or automated systems.
- Research goals: Studying computer vision methods and tracking algorithms, setting tracker parameters for different types of objects.

CONCLUSIONS

Automation of the process of target detection and tracking is one of the important tasks in the field of modern technologies of unmanned aerial vehicles. The use of such algorithms allows to reduce the influence of the human factor, increase the accuracy and efficiency of task performance, as well as ensure the autonomous operation of drones in difficult conditions. The developed software can be used for military purposes for reconnaissance, tracking of suspicious objects or for civilian applications, such as crowd control, transport surveillance or research of natural phenomena.

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