Autonomous Drone Flight Control System for Object Tracking

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Introduction

Capturing a video of a moving object is considered a difficult task when using commercial Unmanned Aerial Vehicles (UAVs). These UAVs are usually controlled by a human pilot to record a video, which is then required to be stationary in the air while the camera is maneuvered by the pilot. However, with the advancement in autonomous drone control systems, the ability of a UAV to track a moving object can be achieved autonomously. By analyzing different solutions of implementing an efficient working flight control system, we are able to provide a solution to track a moving object autonomously.

Objectives

Create an efficient working flight control system to track a moving object autonomously:
- Autonomously track a moving object with up to speeds of 10 m/s
- Research and implement a light weight image processing algorithm to support object detection and tracking

Hardware

The Intel Aero RTF Drone development kit was utilized in order to design and implement a UAV with autonomous object detection and tracking. This includes the Intel Aero Compute Board and the Intel Real Sense camera (R200).

Fig 1. Intel Aero RTF Drone

Fig 2. Intel Aero Compute Board

Top-Level Software Flowchart

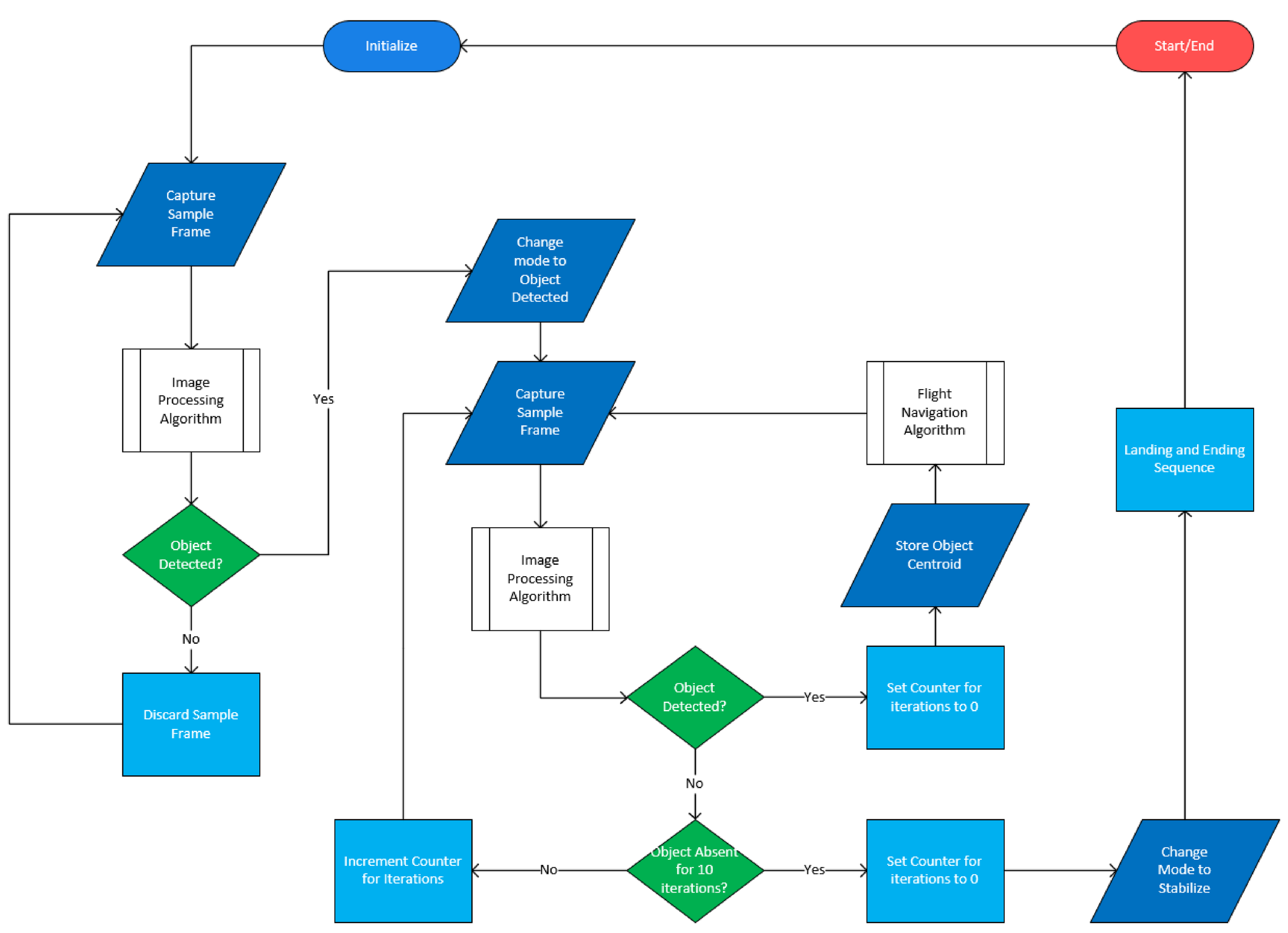

Fig 3. Top-Level Software Flowchart

This Top-Level Software architecture is designed to integrate a series of smaller functions in a continuous loop for continuous processing. The initial loop continuously captures sample frames until the desired object is detected. Once the target object is identified, the system will enter another loop to begin tracking the targeted object. The system then calculates and logs the centroid of the object as an input to the navigation control algorithm. In the case that the object cannot be identified, the algorithm will continue and restart the process. However, if object is absent for 10 consecutive iterations, the system will proceed to ending sequences.

Image Processing Algorithm Design

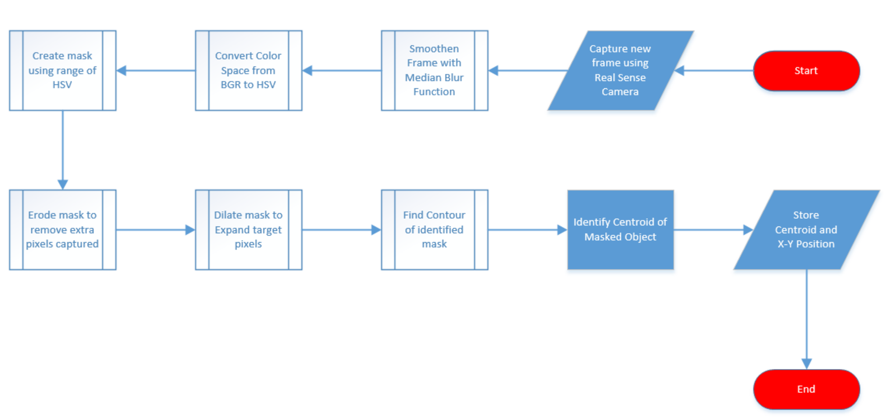

Fig 4. Image Processing Flowchart

Navigation Control Algorithm Design

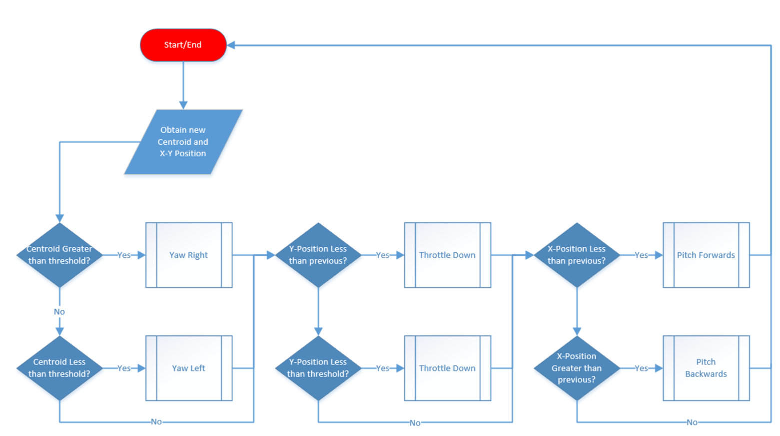

Fig 5. Navigation Control Flowchart

Image Processing Implementation & Results

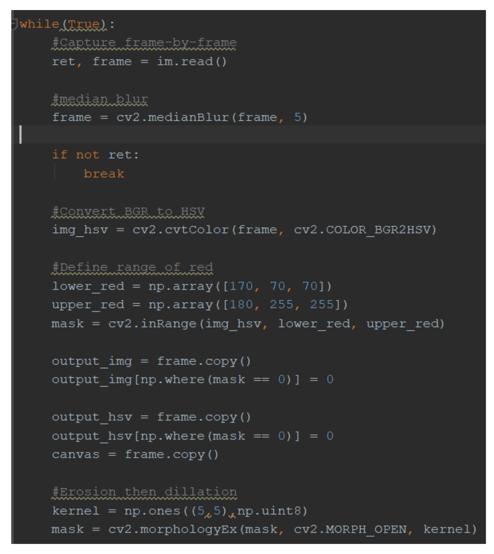

Fig 6. Python Script to generate mask

Fig 7. Frame after median blur applied

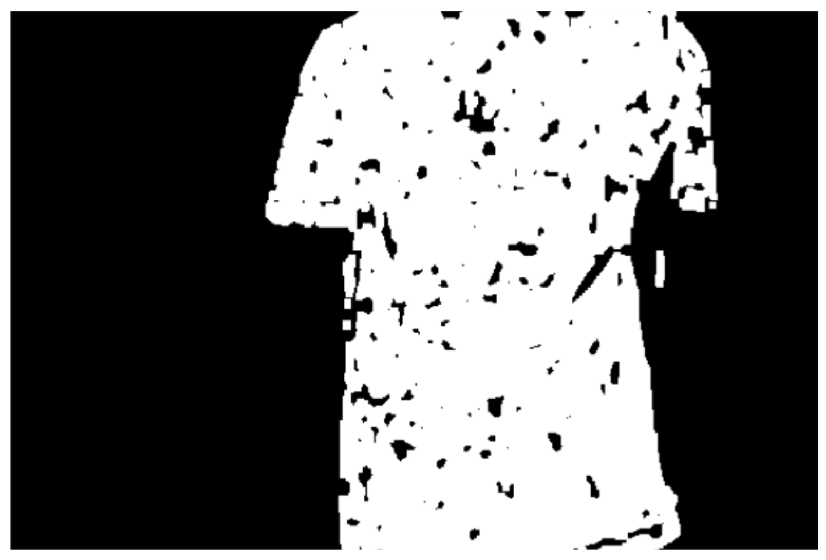

Fig 8. Final Mask after erosion and dilation

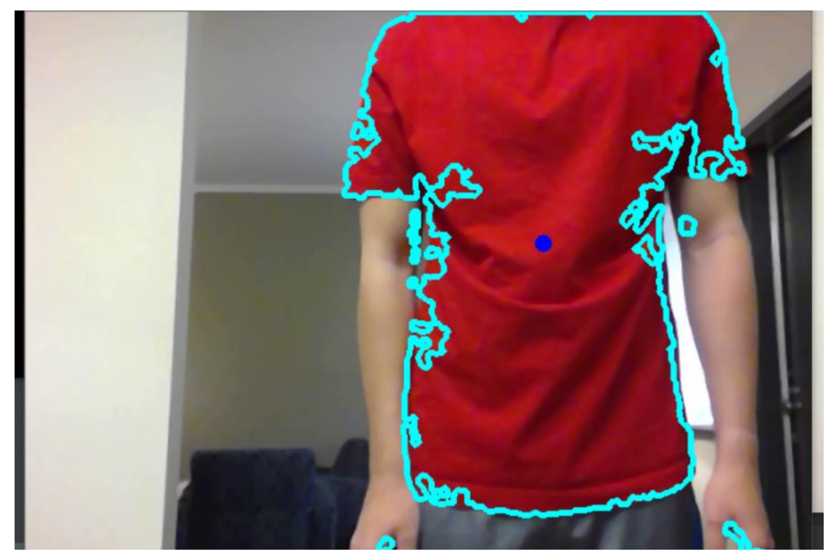

Fig 9. Original Frame with contour lines and centroid

Flight Navigation Control Simulation

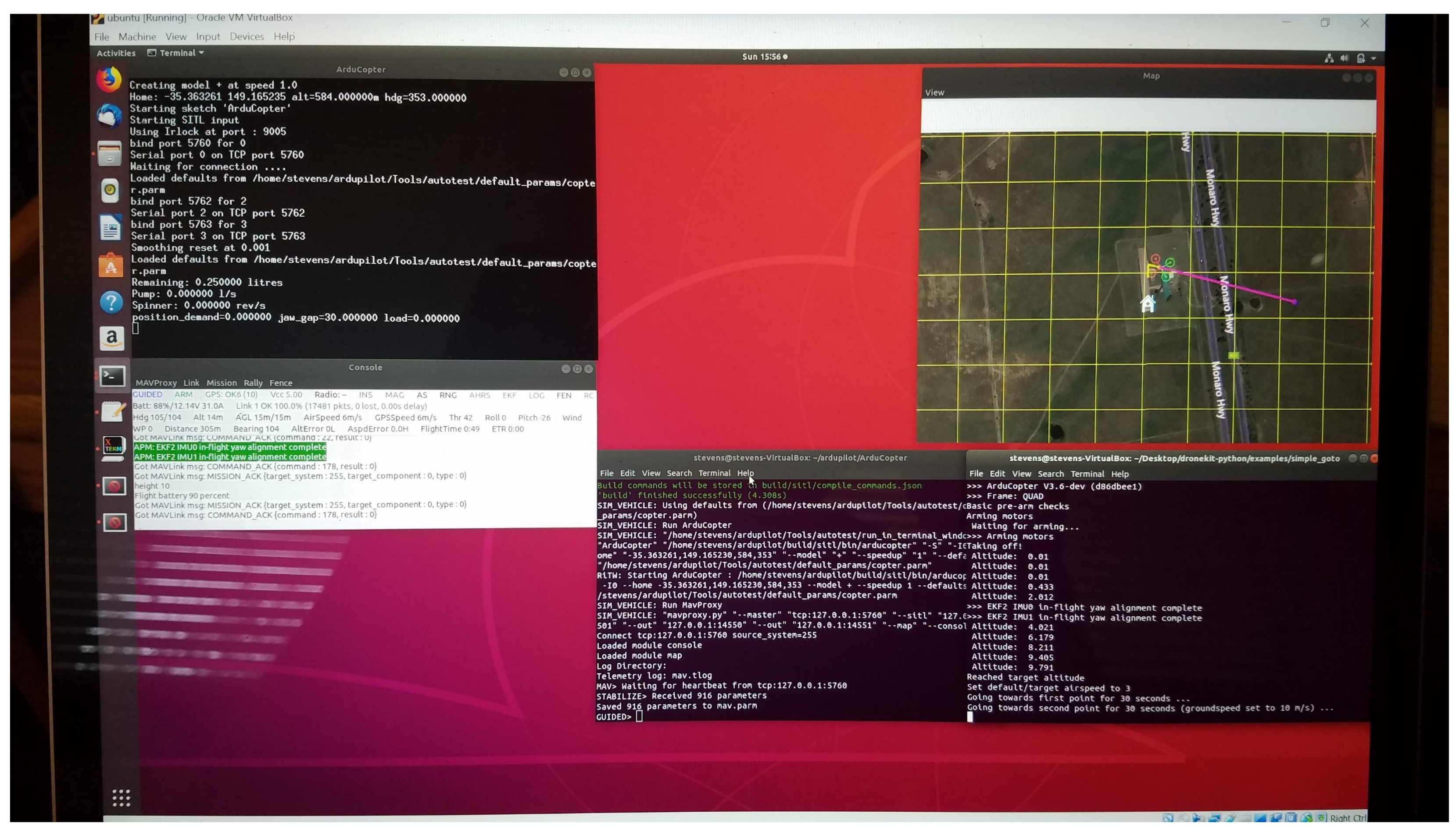

Fig 10. SITL simulation software for Drones

In order to test our Navigation Control python scripts, we utilized a simulation software called Software in the Loop (SITL) provided by drone kit.

Conclusion and Further Research

After testing the Image Processing Algorithm and Navigation Control Algorithm utilizing the SITL simulator separately, further research needs to be conducted to combine these functions into one flight control system. This will be made possible with the Intel Aero RTF drone development kit. After integration, we expect to see a efficient working flight control system to track an object autonomously.

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