Automated Drone Control System

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Abstract

Most autonomous tracking applications used by aerial vehicles today rely on instrumented targets to perform basic tracking tasks. This paper introduces an approach which does not require instrumented targets to autonomously control a vehicle while tracking using pressure snakes. With only one camera mounted onto a quad copter via gimbal, we can track an object of any shape or size without the use of an instrument attached to the target.

Problem

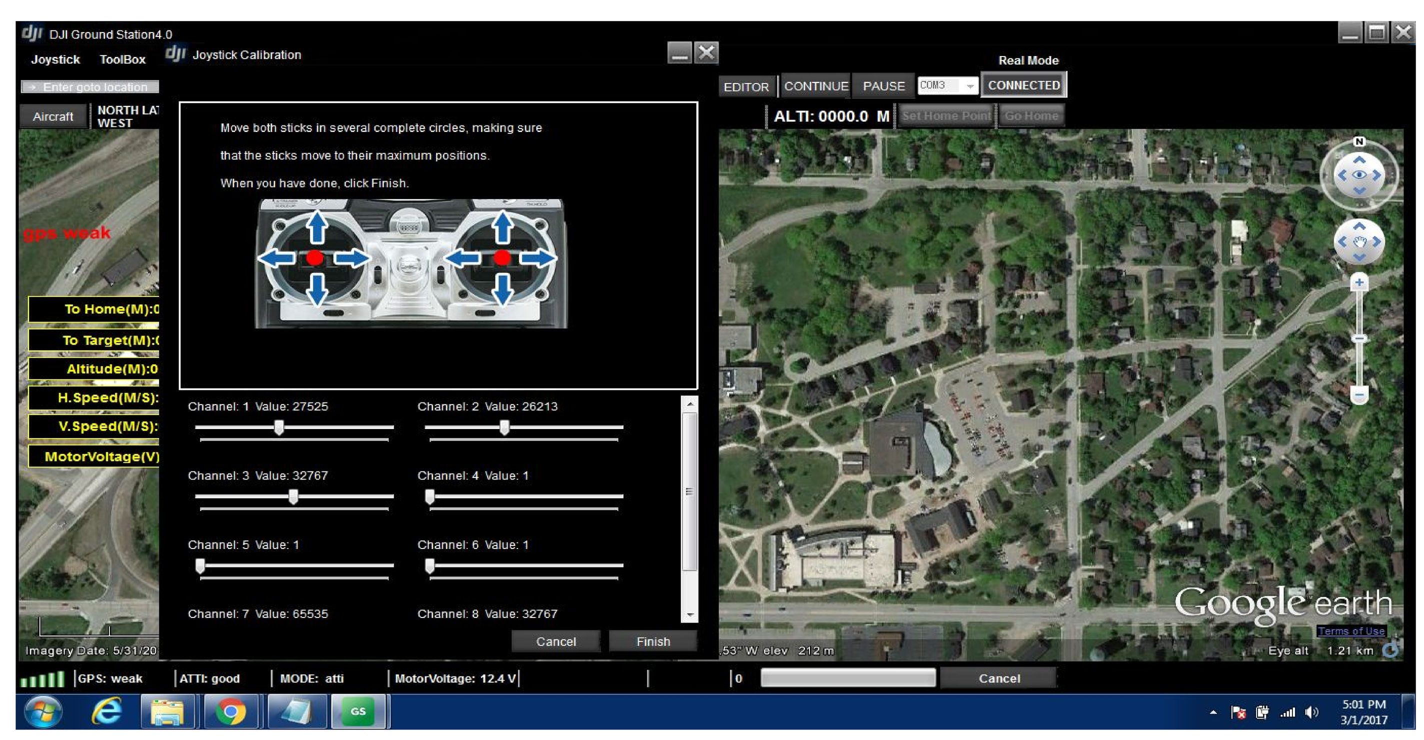
With the advent of personal aerial vehicles, the market for tracking applications has had significant growth. Aerial vehicle uses now range from security applications to the recording of sports. As demand increases, so too increases the need for advancement in automation technologies for areas where instrumentation or piloting are either impractical or monetarily not feasible.
Having identified this, our client has requested a means to perform visual tracking without any instrumentation on the target. This allows the user to track objects of various sizes, shapes and colors without the added expense of tracking equipment.

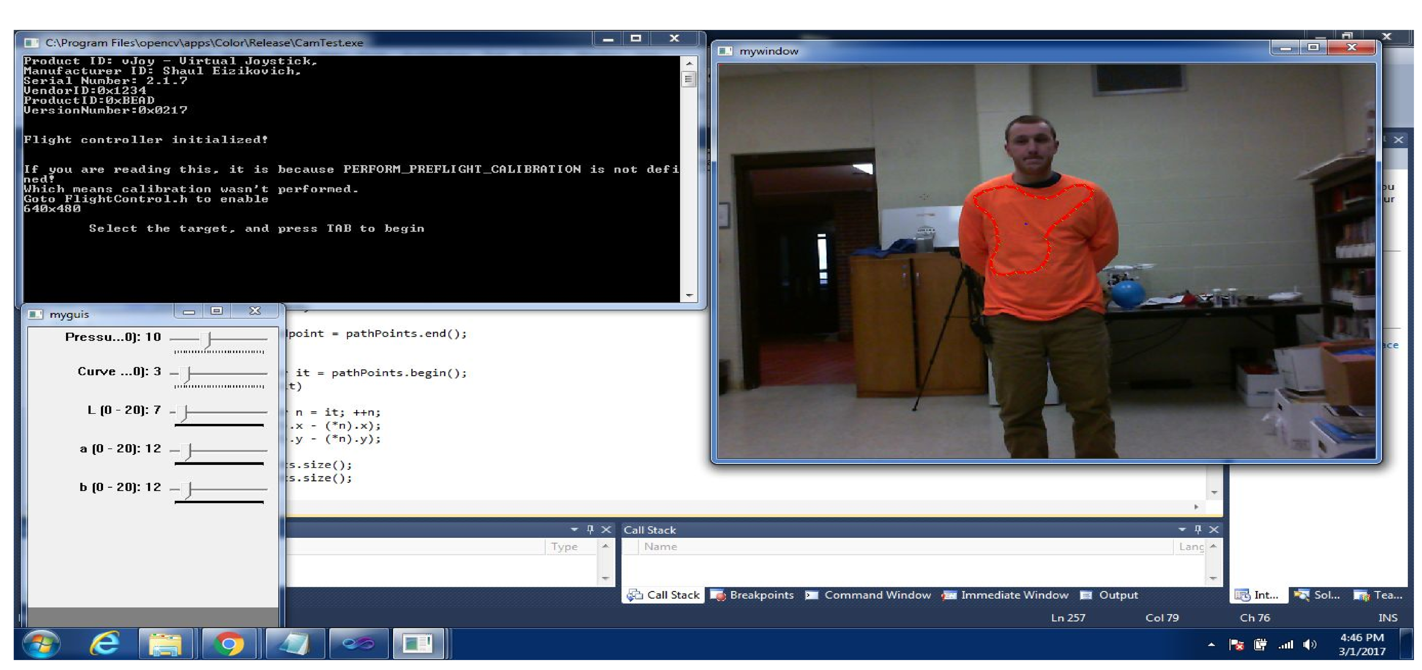
Overview of Program

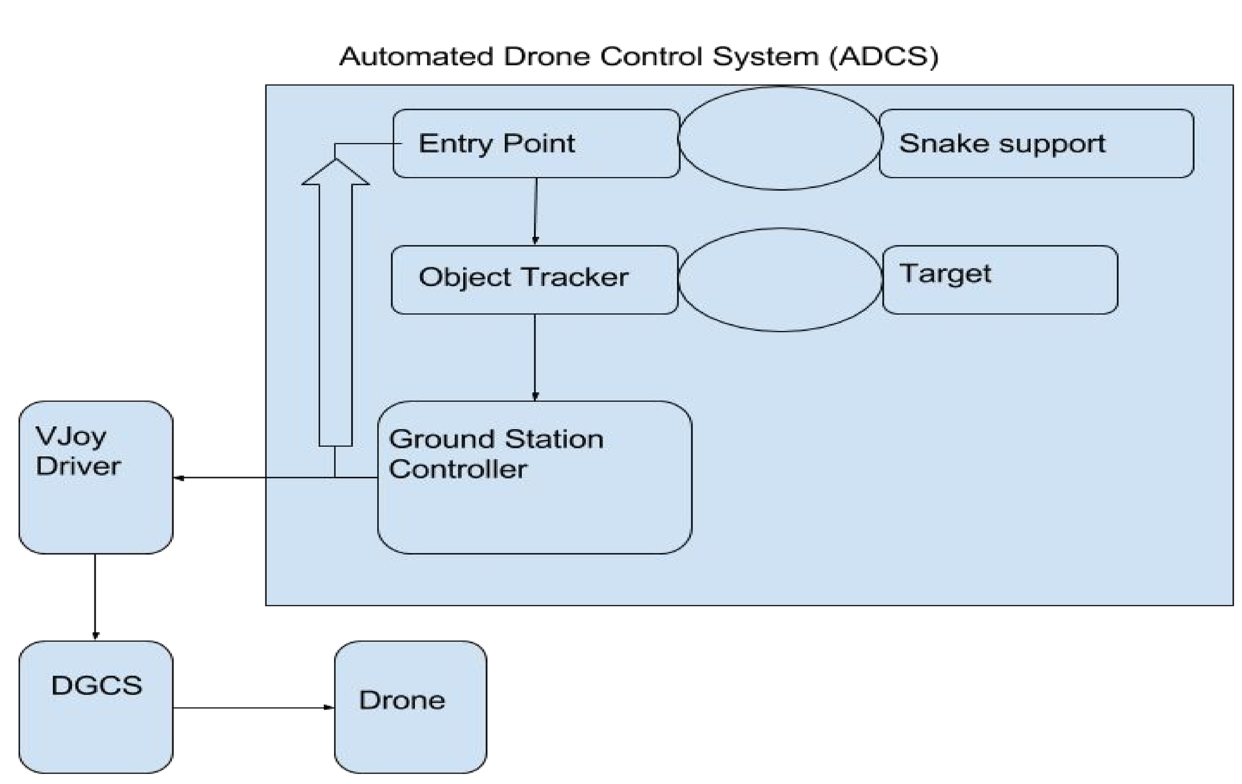
The software we implemented is based on prior research done on active contour models performed by Christopher E. Smith, Doug P. Perrin, and Hanspeter Schaub. This software creates a deformable model on a target, and then translates changes of the model directly into controls for the aerial vehicle, in the x y and z dimensions. The software designed has been called the Automated Drone Control System (ADCS for later reference).

ADCS

Using the Ground Station Controller from DJI to communicate commands to the Drone, our tracking implementation simulates joystick commands based on state changes of the deformable model.
The control algorithm in use is proportional. This means the further the object moves from its original position, the more power the system sends to the virtual joystick in the direction of the movement. The power is limited using Alpha, Beta and Gamma modifiers to the equation, so as to avoid full throttled and jerky movements.
Some issues arise from relying on video signals for input. To resolve these issues there is a default behavior for when the deformable model collapses or when the video signal is cut. This sets all axis throttles to 'neutral' values, holding the drone in place, allowing the system to reacquire the target.







ADCS Cont.

Additionally when the video signal is severed, there is a kill switch which throttles down the drone to prevent damage or crashes.
The ADCS interacts with an opensource software called VJoy, created by Shaul Eizikovich. Vjoy is a virtual joystick that can be used to programmatically interact with a joystick driver. We removed all features not used in programmatic control. After stitching these VJoy internals together with the control system, the result is a control software that will send commands to the drone.
Because we are using a virtual joystick the start up process is very specific, but still easy to use.
After being manually launched and in a hover position the user has to launch the DJI Ground Station program and go through a series of calibrations. Once the virtual joystick is calibrated, the controls are locked to specific channels and control is switched to the virtual joystick. Once set, the user only needs to select the target on the screen and hit the start button.
While we hit a road block with field testing due to a fault in the LiPo batteries used to stream the video feed from the drone to the command station, in lab we were able to do a multitude of tests on the proportional control law, and we were able to simulate the flight within the DJI ground control station. Once the issue with the video streaming technology is taken care of, only a few minor adjustments may be needed to ensure responsiveness and accuracy of movements translated from joystick to flight.

Learning Outcomes

This project has provided countless learning opportunities. To begin, the interaction and usage of deformable models for representing objects as well obstruction scenarios. Design of a proportional control system to work with tracking the object. Combining the control system with a virtual joystick to relay the commands to the drone. Usage of linear quadratic estimation to smooth errors in measurements. Communicating advanced topics with a client to discuss scope, requirements and general direction of project. Procurement of requirements documents, and research papers. Engaging people who may not have a software educational background to discuss the topics encountered. We learned very early the importance of documentation of both design and procedures which became very complex. As well as usage of various open source libraries such as OpenCV and VJoy.