Autonomous Aerial Vehicle Vision and Sensor Guided Landing

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Abstract

The use of autonomous landing of aerial vehicles is increasing in demand. Applications of this ability can range from simple drone delivery to unmanned military missions. To be able to land at a spot identified by local information, such as a visual marker, creates an efficient and versatile solution. This allows for a more user/consumer friendly device overall. To achieve this goal the use of computer vision and an array of ranging sensors will be explored. In our approach we utilized an April Tag as our location identifier and point of reference. MATLAB/Simulink interface was used to develop the platform environment.

Introduction

Unmanned Aerial Vehicles (UAV's) are on their way to becoming the primary source of delivery in many places. Companies such as Amazon, Walmart, and UPS are working toward being among the first companies to commercially fly drones full time [1]-[3]. Given the fact that society is in the midst of a global pandemic and has been advised to stay inside as much as possible, now seems like the perfect time for one of these companies to take that extra leap and further improve home delivery. For this project, we looked to expand on drone autonomy by utilizing the Quanser Autonomous Vehicle Research Studio, as well as AprilTag technology to develop a vision and ranging sensor based landing system to autonomously ground a drone.

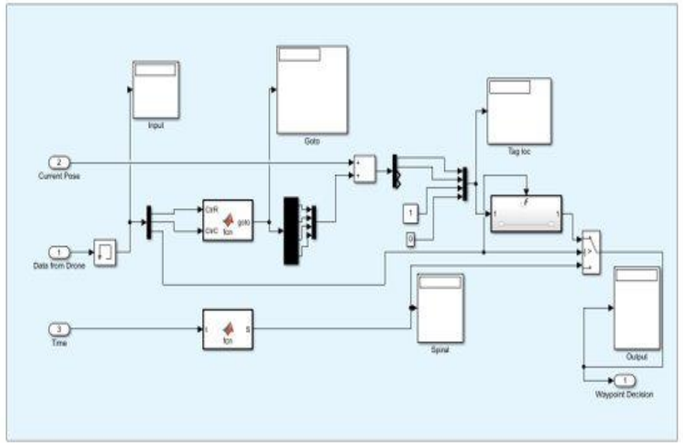
Methods and Materials

The project is based on using autonomous drone and a location marker. For the drone we used the QDrone controlled by the Quanser Autonomous Vehicle Research Studio (AVRS). The system consists of using 8 motion capture cameras to give the drone feedback as to where it is in 3D space and give it flight commands accordingly. The workspace acts as a replacement for GPS and controlled/safe environment for indoor testing.

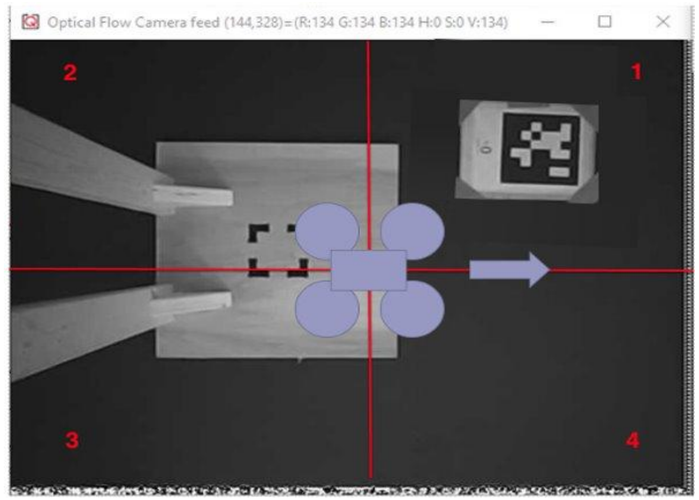
For the location marker we used a 2D QR-code like tag known as an April Tag. The tag is made up of many black/white squares which allow for distinction between different tags that hold different information. April Tags are convenient in that they do not need a special material to print them on a simple printer can do the trick.

In conjunction with the AVRS system we used an *ultrasonic* sensor and a *Time of Flight* sensor as an onboard way for the drone to know it's height and act accordingly during the landing procedure. An ultrasonic sensor sends a pulse of sound and calculate the time it takes to return similar to echolocation. A time of flight sensor follows a similar process however instead of emitting sound it emits light. The reason behind the use of two different sensors is to average two readings for a non-biased result.

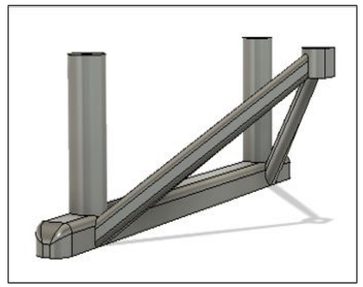
Subsystem for Decision Making



Drone Onboard Camera View



Stabilizing Landing Gear



Results

Initial testing consisted of solely gauging the drone's ability to spot and fly to the AprilTag. The tag was placed within a radius that we were entirely sure the drone's camera would be able to detect at one meter height. This way, if the drone did not fly to the tag, we could conclude the problem stemmed from our Simulink model. The drone successfully passed this test and allowed us to take the next step in our progression. In the next phase, we would implement the spiral search pattern, and randomly place the AprilTag somewhere in the workspace. The drone passed this test as well, confirming to us that we had successfully developed a model to send the drone on a search sequence and fly to the AprilTag when it was detected.

Conclusions

In closing, this project allowed us to further develop our coding abilities, specifically in MATLAB and Simulink. This project's concept and how it is rapidly coming to fruition in our society today made it all the more interesting. It has allowed us the opportunity to work with a highly complex system, and put our knowledge and computing skillset to the test.

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