Drone Precision: Altitude Relation

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*Abstract*

*Abstract*—Precision landing for drones uses a combination of hardware and software programming to land a drone as close as possible to a specified point. The Tello-EDU drone uses a bottom mounted infrared sensor to detect pads. The detection of the pad can be used to trigger events through software programming. The research done shows that with increased altitude the Tello-EDU drone will see the pad sooner and land prematurely. With decreased altitude, precision is increased, and results are more consistent.

# Introduction

Drone technology and the capabilities of the logic they employ is always evolving. Many commercial off the shelf drones have options that are under-utilized and misunderstood. For this paper we will cover a bit about the concept of precision landing. Using consumer-off-the-shelf (COTS) [1] software and devices research can be planned, executed, and replicated easily for other researchers wanting to try or expand on.

Precision landing uses many features of drone hardware coupled with programming concepts to fine tune the accuracy of the landing. This is important because a drone can only get so close to a precision point using global positioning system (GPS) satellites. The accuracy of the position using these GPS satellites can be marginal. The drone will see it is in the area but could be a meter away from the landing target. With access to a real-time bottom view, it could be possible to land the drone on a precise point instead of relying solely on the GPS to get the drone close enough.

The drone (Tello-EDU) used for this research has a forward-facing camera, bottom-facing infrared sensor (IR sensor), and a software development kit (SDK) that enables the user write code for the drones’ performance. The Tello-EDU comes with mission pads which work with the software as triggers for specific code to be ran when recognized. This research will explore the implications of altitude on the detection and advancement through code of the Tello-EDU. It was hypothesized that with increased altitude the vision system of the drone would be less accurate due to the field of vision being greater at increased altitudes.

# Testing of Tello-EDU

## Setup

The testing of the precision of Tello-EDU landings required a program to be coded that would take out any human error. Python [2] was the language chosen for the program. The DJITelloPy [3] SDK library was used for software functionality and operability with the drone. Once the program is launched the program will have total control of the drones’ actions. The program authored provides all data back to the user through the system console log. Measurement from center taken by tester using steel rule.

## Python Program Requirements

The Python Program has full control of the Tello-EDU from takeoff through to landing. Upon program launch the battery level is checked and reported. Mission pads must be enabled. Mission pad sensing must be set to the bottom facing infrared sensor. Takeoff will occur. Height adjustment (if required) occurred. The Tello-EDU will then sense if a pad is under the unit. If no pad is detected the Tello-EDU will move forward and sense again. This loop continues until 10 loops have been made or it senses a pad. If a pad is detected the Tello-EDU lands and exits the program. The python program is available on GitHub [4]

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# Testing Method

Testing consisted of a 1-meter straight-line flight from takeoff to landing. All flights occurred in the same environment with a minimum of two meters clear of obstructions. All time-of-flight data and code execution come from the PyCharm [5] console log. The precision measurement was measured with steel rule from the center of the target mission pad and the center of the drone body upon landing. The Tello-EDU was programmed to takeoff, adjust altitude, proceed forward sensing for mission pad, when mission pad is detected the Tello-EDU lands. While no mission pad is detected the Tello-EDU will proceed forward again in a loop until a pad is detected.

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# *III.* Findings

Table 1. Precision and Altitudes

The findings displayed in the Table 1, show the distance from the center of the mission pad to the center of the drone body. The data gathered shows that with increased altitude the drone lands farther from the center of the target. The cycles through code decreased by one cycle when the altitude was at 1.5 meters. The field of view of the IR sensor was increased in size with increased altitude, thus creating a detection of the mission pad sooner. Early detection farther from the center of the pad led to premature landing.

Figure 3 shows the relationship between detection range and altitude. Testing was conducted at 0.5m, 1.0m and 1.5m. A gain in altitude directly affects the detection range of the infrared sensors. The Tello-EDU did not detect mission pads consistently when the altitude was set above 1.5 meters.

Given the results of initial testing, modification was made to the program. The modified programming allows the Tello-EDU to fly at an altitude of 1.5 meters. When a mission pad is detected, instead of landing, the Tello-EDU decreases altitude to .5 meters and cycles through the loop an additional two iterations. The resulting precision was greatly improved.

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Figure 3. Tello-EDU detection range [6]

Table 2 displays the significant difference in results between the original programming and the modified programming. Both data sets were obtained from flights initially starting at 1.5 meters. With the modified program adjusting altitude and reassessing mission pad information a pattern emerged that displayed an increase in precision on the landing of the Tello-EDU.

Table 2. Effect of Decreasing Altitude (Modified Code)

# Limitations of Study

Occasionally the Tello-EDU unit would respond erratically. The inconsistencies in performance of the drone when this occurred nullified any possible data retrieved from the test. The results from these tests were not retained for presentation. Errors encountered during testing included:

* Tello-EDU stopped responding
* Tello-EDU poor IMU
* Tello-EDU instability in flight due to bent propellers

For easy repeatability of testing the Python code is available for download, use, and expansion at https://github.com/Gotterbote/TelloEDU.

# Possible Expansion on Study

Future research projects could include battery charge status effects on precision and methods to use OpenCV software to adjust landing automatically while in flight using the IR sensor display.

# References

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