Design and Flight Control to Variable Target Points of a Drone for Unmanned Delivery Service

Ho Jae Lee[1*], Seung Won Yeo[1], Hoseong Seo[1]
lhj2011611@snu.ac.kr*
Mechanical & Aerospace Engineering, Seoul National University[1]

Abstract

In this paper, we propose an unmanned delivery system using a drone. Gripper mechanism for holding an object is proposed via CAD and implemented with 3D printer and laser cutter. Algorithms for the drone's flying path exploit GPS and visual information. Drone flies to the several delivery destinations and comes back to the moving landing point using GPS coordinates and fine-tunes its position based on real-time visual information. The algorithms used ROS to communicate with the landing point and used MAVSDK to control the drone. During the flight test, we verified that our algorithm control the drone stable along predetermined locations. Due to the camera latency, vision-based control could not be tested.

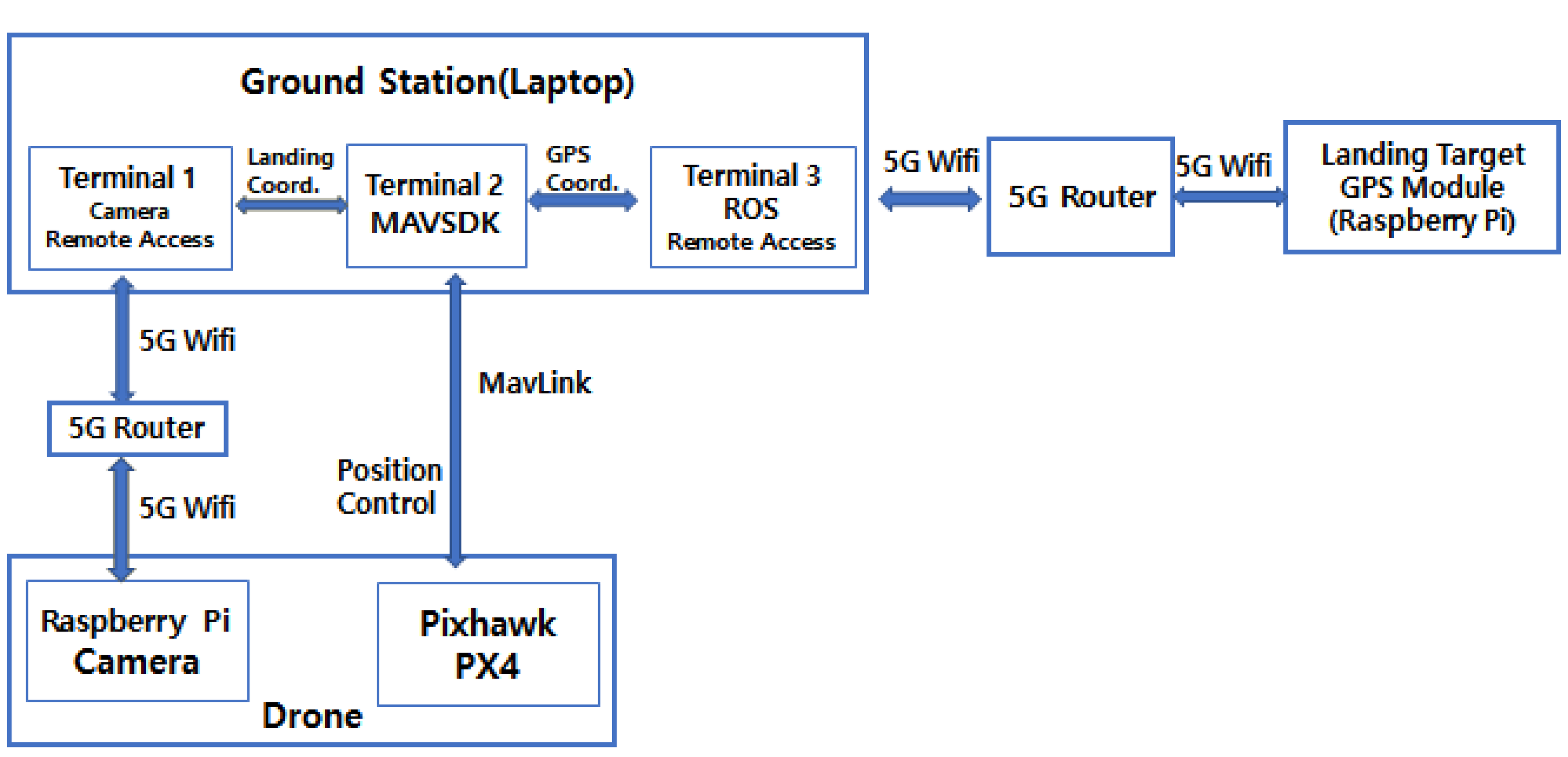
Objectives

- Design of a drone for unmanned aerial delivery service
- Autonomous flight control using visual information and GPS
- Vision-based automatic landing control

Drone Design & Control Algorithm

Drone Design

Flow chart of drone control



Drone control algorithm to waypoints and landing target

Algorithm: Drone Control to Several Waypoints to Target

```
Import MAVSDK
Import GPS and Camera info

Initilize ROS node
Subscribe GPS and Camera info

Connect to the Drone via MAVSDK
Set the waypoints in Mission items

// Drone starts flying
Start the Mission
Once the Mission is finished,
Repeat
    if target is not yet detected in Camera then
        Move the drone to target's GPS position
    else // target is detected in Camera
        Change to Offboard Mode if the drone is not Offboard Mode yet
        Move the drone based on Camera info to finetune drone's position
    end if
until manual landing
```

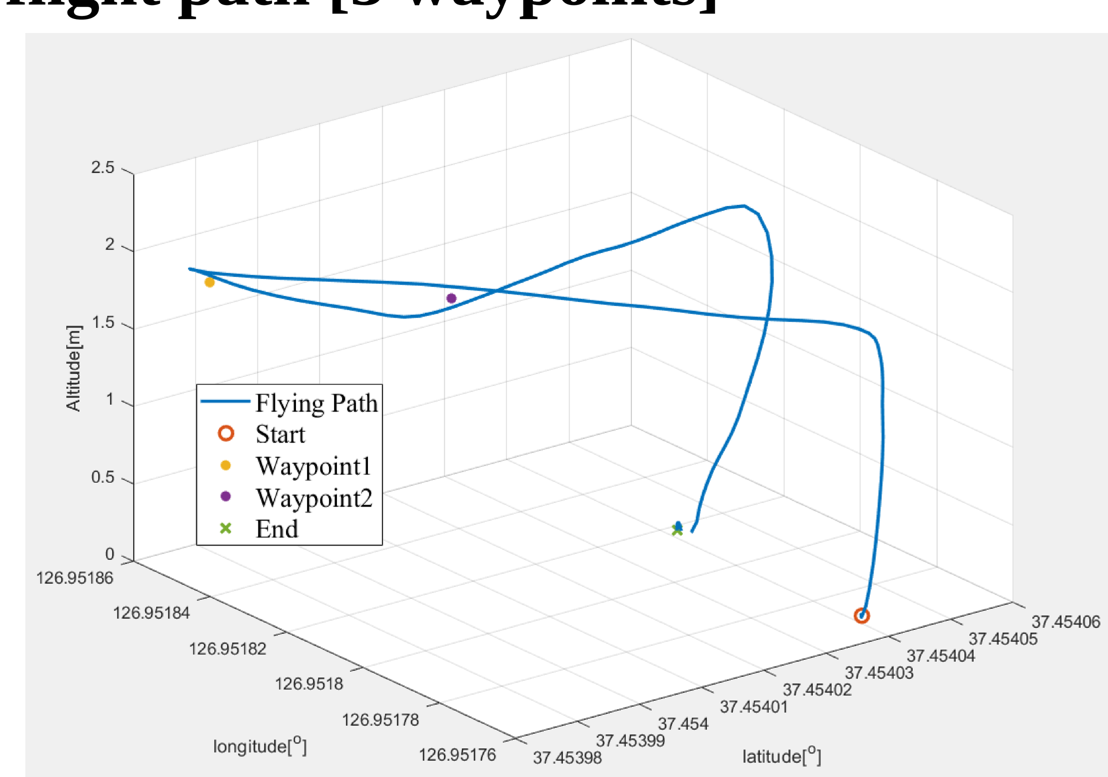
Marker recognition and drone control algorithm at target

Algorithm: Target Detection via Camera and Publish NED coordinate

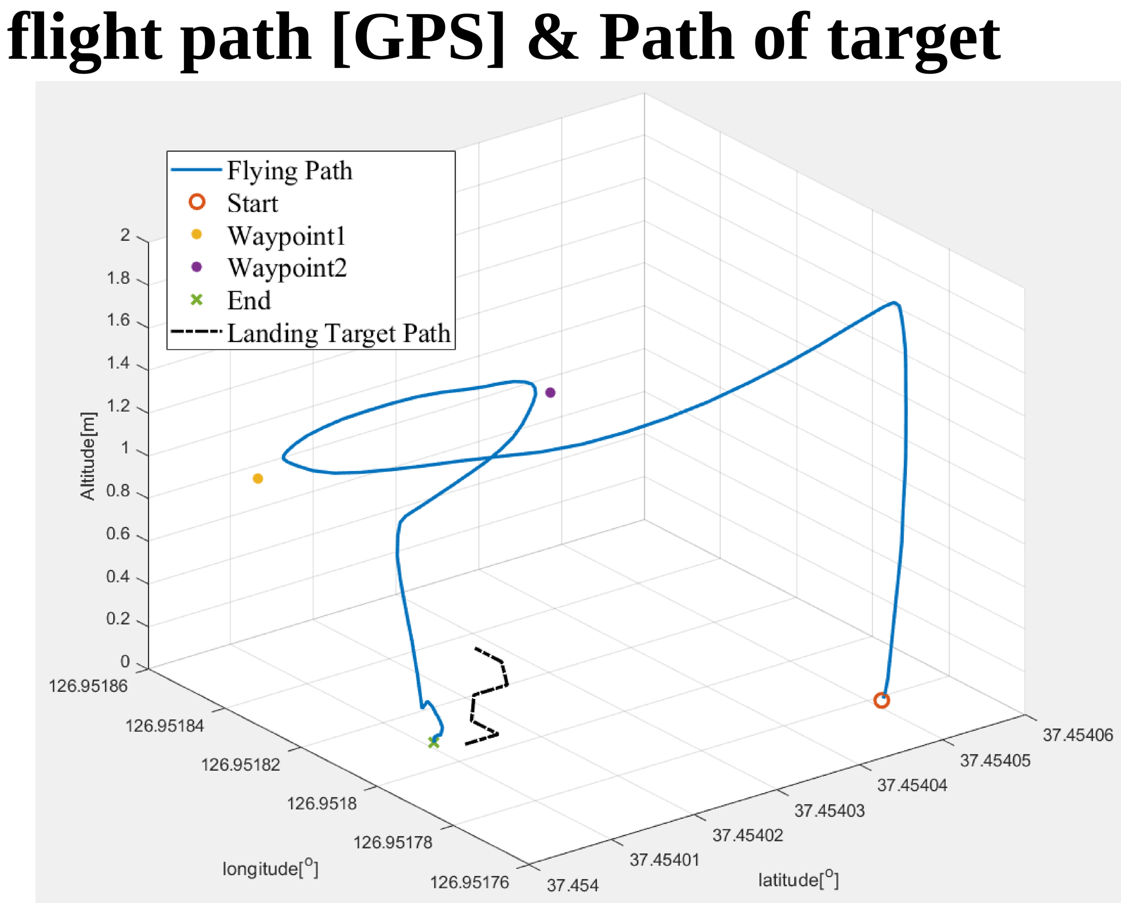
```
Import ROS, OpenCV

Initilize ROS node
Instantiate a Publisher for NED coordinate
Load Camera and Target image (Template)

// Feature Matching
Detect and Compute features in Target image
for each Camera frame do
    Detect and Compute features in the frame
    Match the features from the Target image and the frame using Brute-Force
    H ← Homography between matching features
    Find the Target in the frame by perspective tranform the Target image
    v ← pixel vector from the center of the frame to the center of the Target

    // Calculate NED coordinate to which the Drone should move
    scale ← What is the length of 1 pixel in meters?
    θ ← Angle between Camera front and North
    v ← Scale v in meters and rotate by θ counterclockwise
    Publish v
end for
```

Results

Drone flight path [3 waypoints]



Drone flight path [GPS] & Path of target



Conclusion

In this paper, we have presented the design of a drone for unmanned delivery service and proposed delivery platforms. Arduino Uno operates grippers made by 3D printer and laser cutter.
We used MAVSDK, OpenCV, and ROS to control drones. GPS and vision-based algorithms calculate the current position of the drone and its trajectory. We verified the accuracy of the GPS-based algorithm in the flight test while we were not able to test the vision-based algorithm due to the camera latency. We confirmed the feasibility of the unmanned delivery platform using drones.

Reference

1) Chang, Y.S., "Analysis of Cluster-based Truck- Drone Delivery Routing Models," Journal of Information Technology Applications and Management, Vol. 26, No. 1, 2019, pp. 53~64.

2) Johnson, A., Montgomery, J., and Matthies, L., "Vision Guided Landing of an Autonomous Helicopter in Hazardous Terrain," Proc. of the 2005 IEEE International Conference on Robotics and Automation, 2005, pp. 3966~3971.