# Collaboration Between Unmanned Aerial and Ground Vehicles (SSJ3-16)


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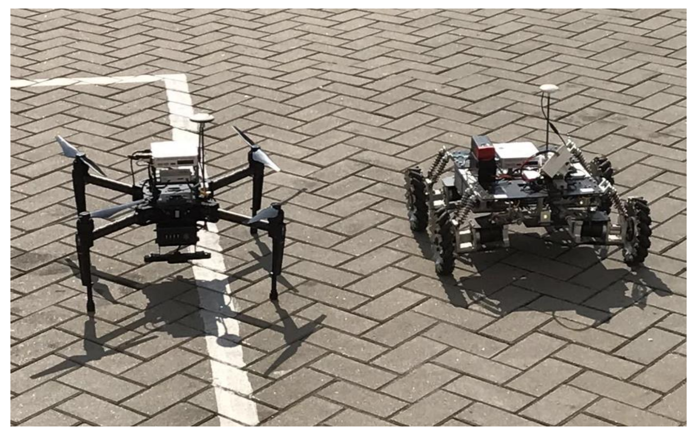
## Overview

Robots have been increasingly important to various industries given the improvement they can bring to both efficiency and quality. However most of the tasks are done by a single-robot or a centralized multi-robot system where there is no cooperation between individuals. In recent years, multi-robot cooperation has gain more and more attention, mainly because of the advantages it has over traditional single-robot system. Unmanned Aerial Vehicle (UAV) and Unmanned Ground Vehicle (UGV) are two kinds of most widely-used robots and the technologies are relatively mature as well. However, UAVs have two non-negligible disadvantages: small payload and short flight time. Similarly, UGVs also suffer from narrow view of field and the incapability to generate an optimal trajectory.

In order to overcome the above shortcomings, we introduce a method that can maximize the capability of each single robot and improve the overall situational awareness. The essential framework of our method is an Extended Kalman Filter (EKF) which fuses data from both UAV and UGV. The system outputs the position of two robots with respect to a local frame, and the robots will move together towards a target location following our path planning strategy. Our approach is independent of the terrain as long as GNSS signal is present.

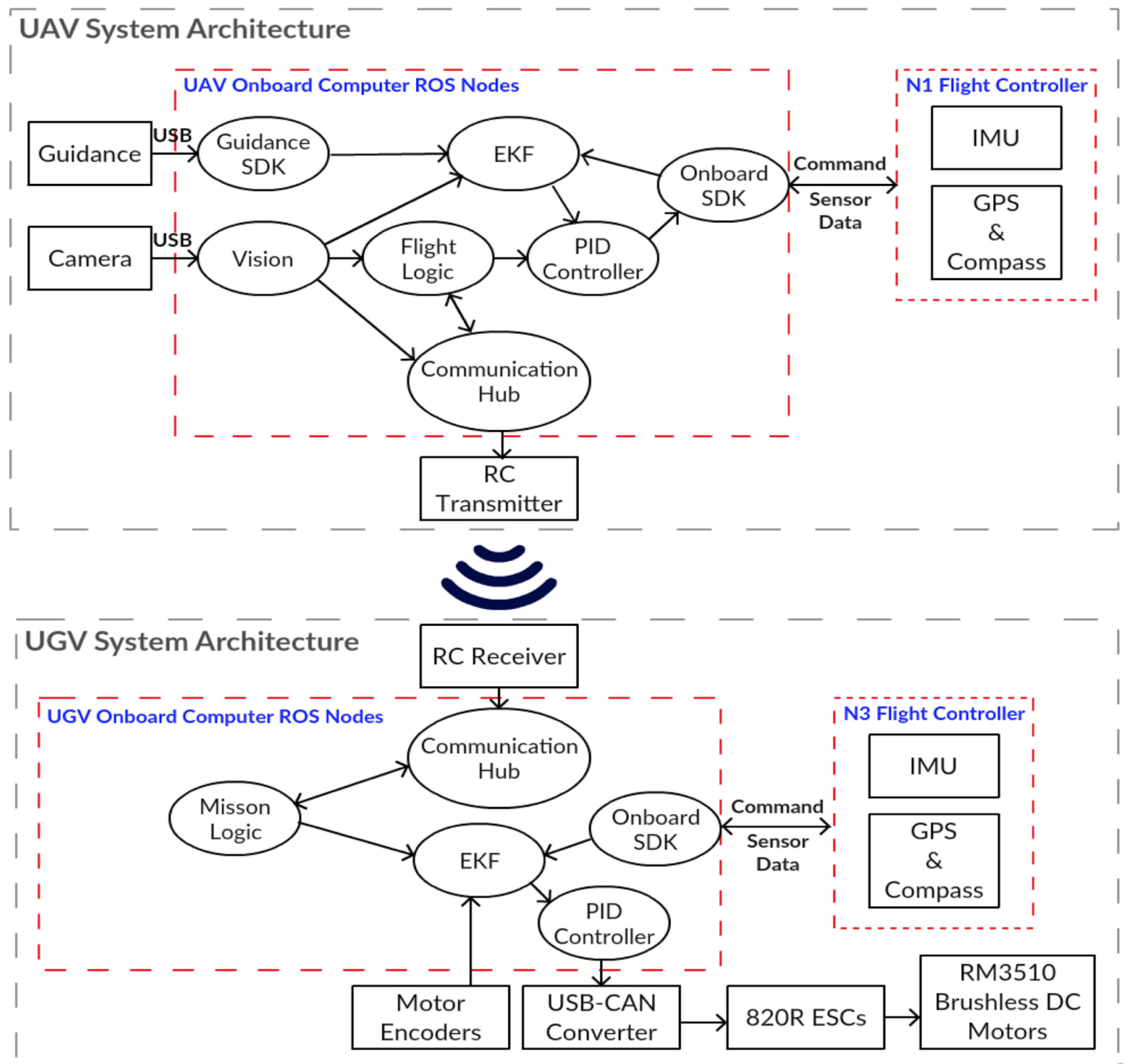
## Objectives

- Build durable and versatile UAV and UGV platforms
- Implement an EKF that correctly estimates robot states.
- Design a path planning strategy for robots to achieve maximum efficiency
- Modularize object detection methods for future improvement.



## Methodology

**System Flow Chart**

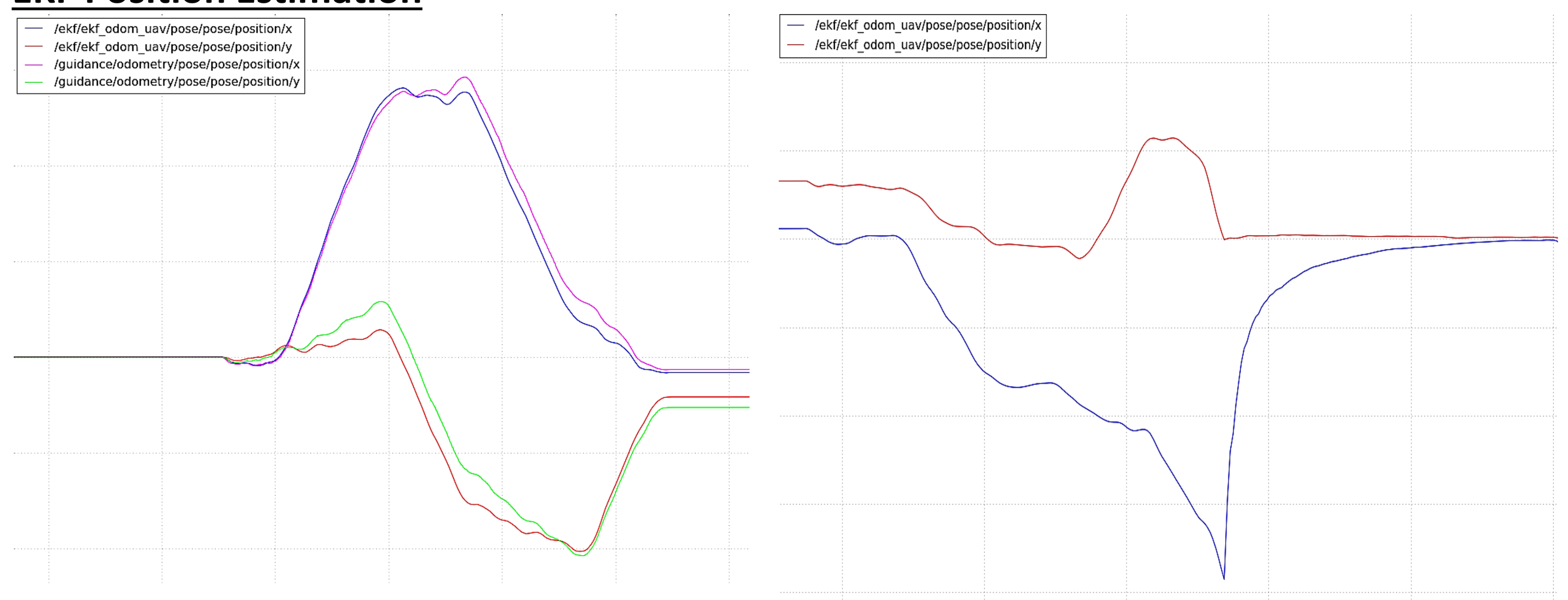



**System Components**

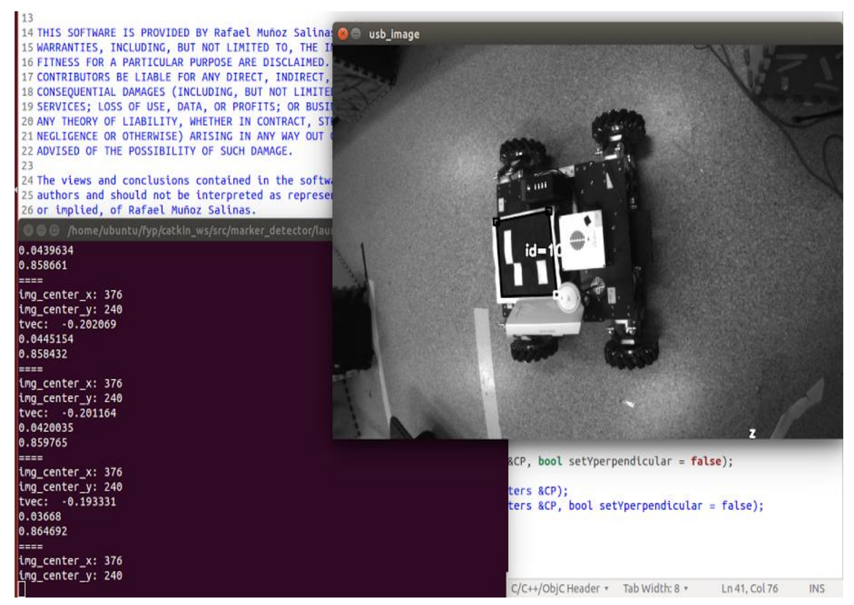
| Hardware | Software |
| --- | --- |
| •Matrice100<br>•Self-made Vehicle<br>•N3 Autopilot System<br>•Manifold Computer | •Ubuntu Linux<br>•ROS<br>•OpenCV<br>•ArUco API |

## Result

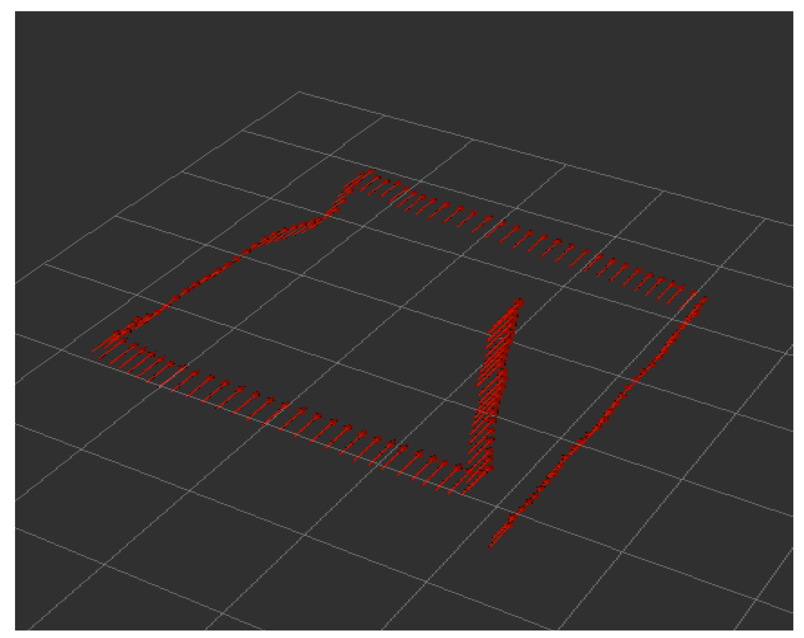
**EKF Position Estimation**



**UGV in UAV's Camera View**



**UAV's Flight Trajectory**



In joint testing, missions can be executed in order defined in flight logic. After taking-off, UAV was firstly sent out for target searching, and then UGV moves to the target automatically with UAV following it. Meanwhile, PID controller and EKF are running in the background. The EKF is able to propagate and update robot positions in relatively high accuracy (0.3m).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