Autonomous Drone Landing with Fiducial Markers and a Gimbal-Mounted Camera for Active Tracking

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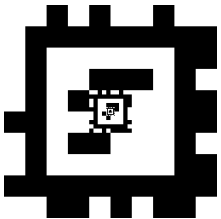
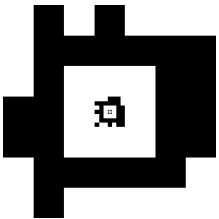
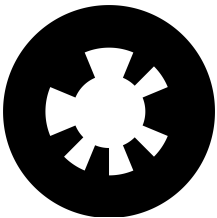
Fiducial Markers



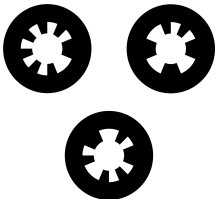
(a) April Tag 48h12



(b) April Tag 24h10



(c) WhyCode (Orig)



(d) WhyCode Multi

Orientation Ambiguity

- Marker *position* $\rightarrow$ accurate
- Marker *orientation* $\rightarrow$ ambiguous

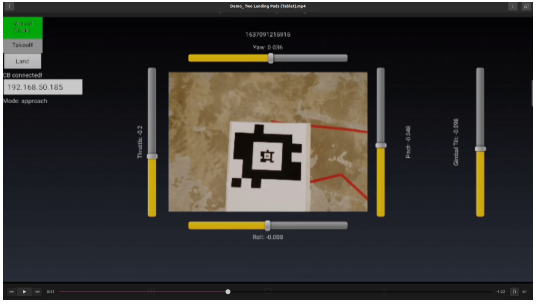
The Downward-facing Camera Axiom

Testing Platform: DJI Spark

- Small quadcopter
- Gimbal-mounted camera
- DJI Mobile SDK

Testing Platform: Software Side

- DJI Mobile SDK: App-style artchitecture
- Export video to Raspberry Pi 4 companion board
- Return control signals



Example Tracking Performance

Example Landing Trajectory

Example Control Outputs

Erroneous Control Outputs

Erroneous Landing Trajectory

Landing Radii

Future Work

- Use another drone platform
  - Phantom, Mavic
  - More gimbal tilt range
- Connect companion board directly to controller
- Test 3 separate methods for each fiducial system:
  - Raw/unfiltered marker pose
  - Filtered marker pose, e.g. KF
  - Marker *position* and gimbal *orientation* for pose transforms

Main Messages

- *Actuated*, gimbal-mounted camera → easier to search for the landing pad.
- Orientation ambiguity, discontinuities → pose estimation is harder.
- Autonomous precision landing still possible but can be improved.