



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

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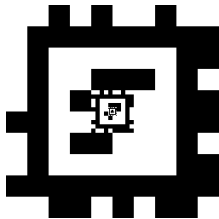
Joshua Springer

25 November 2022

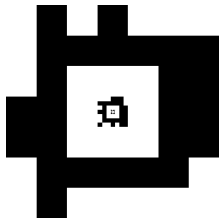
Reykjavik University

Department of Computer Science

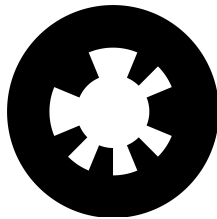
# Fiducial Markers



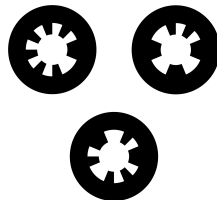
(a) April Tag 48h12



(b) April Tag 24h10



(c) WhyCode (Orig)

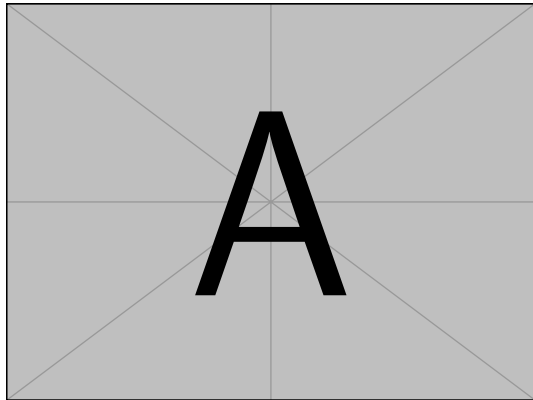


(d) WhyCode Multi

- ▶ Marker *position* → accurate
- ▶ Marker *orientation* → ambiguous

# The Downward-facing Camera Axiom

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



- ▶ App-style architecture
- ▶ Export video to companion board



## Example Landing Trajectory



## Example Control Outputs



# Erroneous Landing Trajectory



- ▶ 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

- ▶ *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.