



Autonomous Multirotor Landing on Landing Pads and Lava Flows

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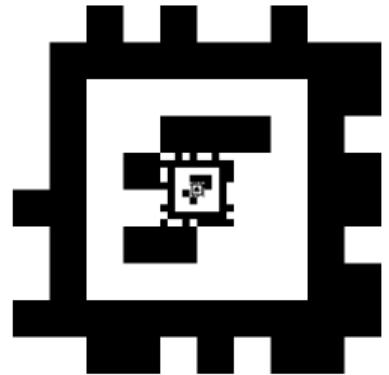
Department of Computer Science

Supervisor: Marcel Kyas

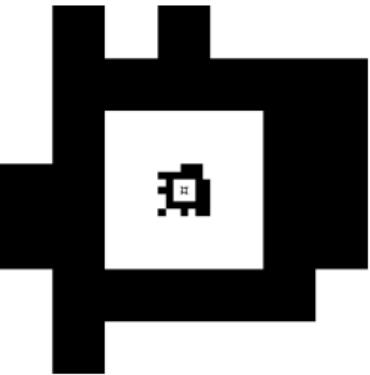
Topic Overview

- ▶ Autonomous drone landing: hard, needs to be precise
- ▶ Often depends on GPS, blind to obstacles
- ▶ Often needs to be more precise than GPS (or GPS-denied)
- ▶ Landing pads: fiducial markers
- ▶ Terrain relative navigation
- ▶ Aesthetics:
 - ▶ Embedded processing only → efficient, quick, dedicated hardware
 - ▶ No active ground infrastructure (e.g. ground stations with telemetry, computing hardware)
 - ▶ Prefer passive sensors (e.g. RGBD cameras instead of LIDAR/RADAR)

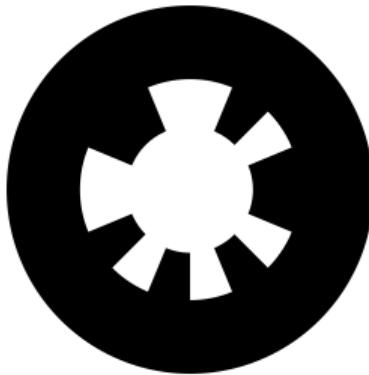
Fiducial Markers



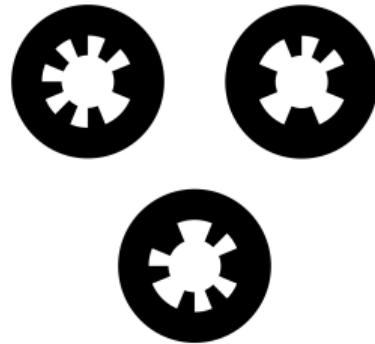
(a) April Tag 48h12 [2]



(b) April Tag 24h10 [1]

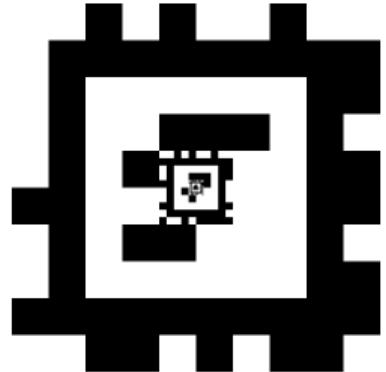


(c) WhyCode (Orig)[3]

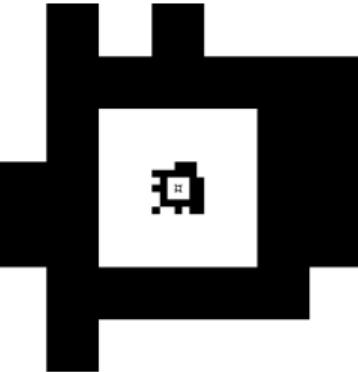


(d) WhyCode Multi [1]

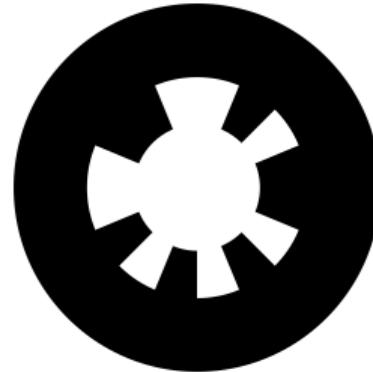
Fiducial Markers



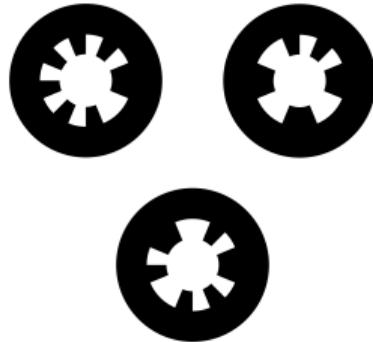
(a) April Tag 48h12 [2]



(b) April Tag 24h10 [1]



(c) WhyCode (Orig)[3]



(d) WhyCode Multi [1]

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

Landing Pads with Fiducial Markers

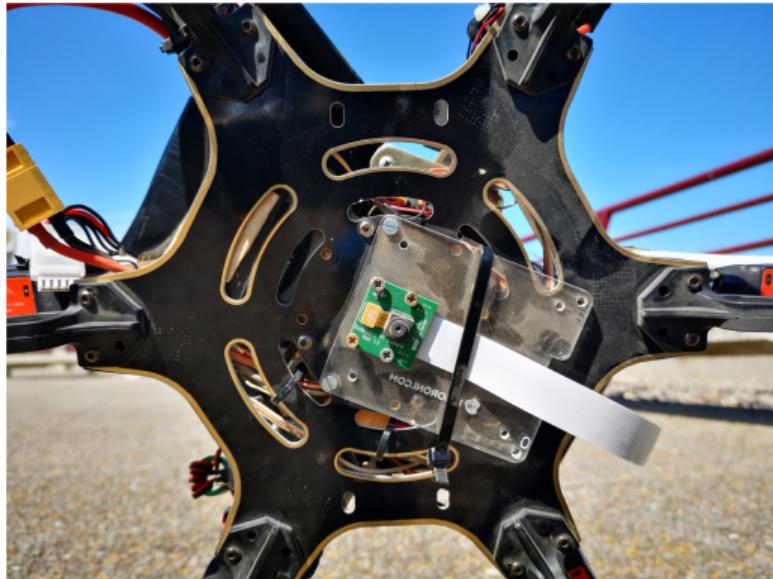
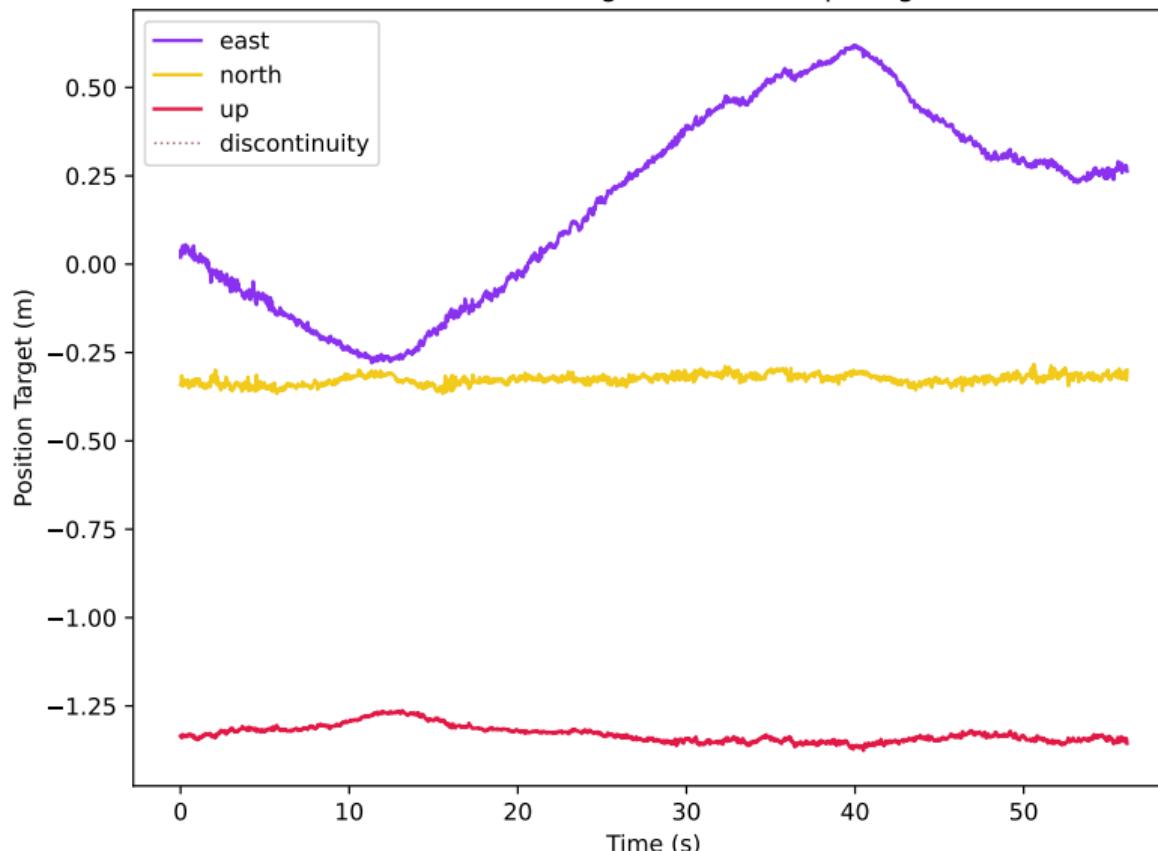


Figure 2: Classic, downward-facing, fixed camera. [4]

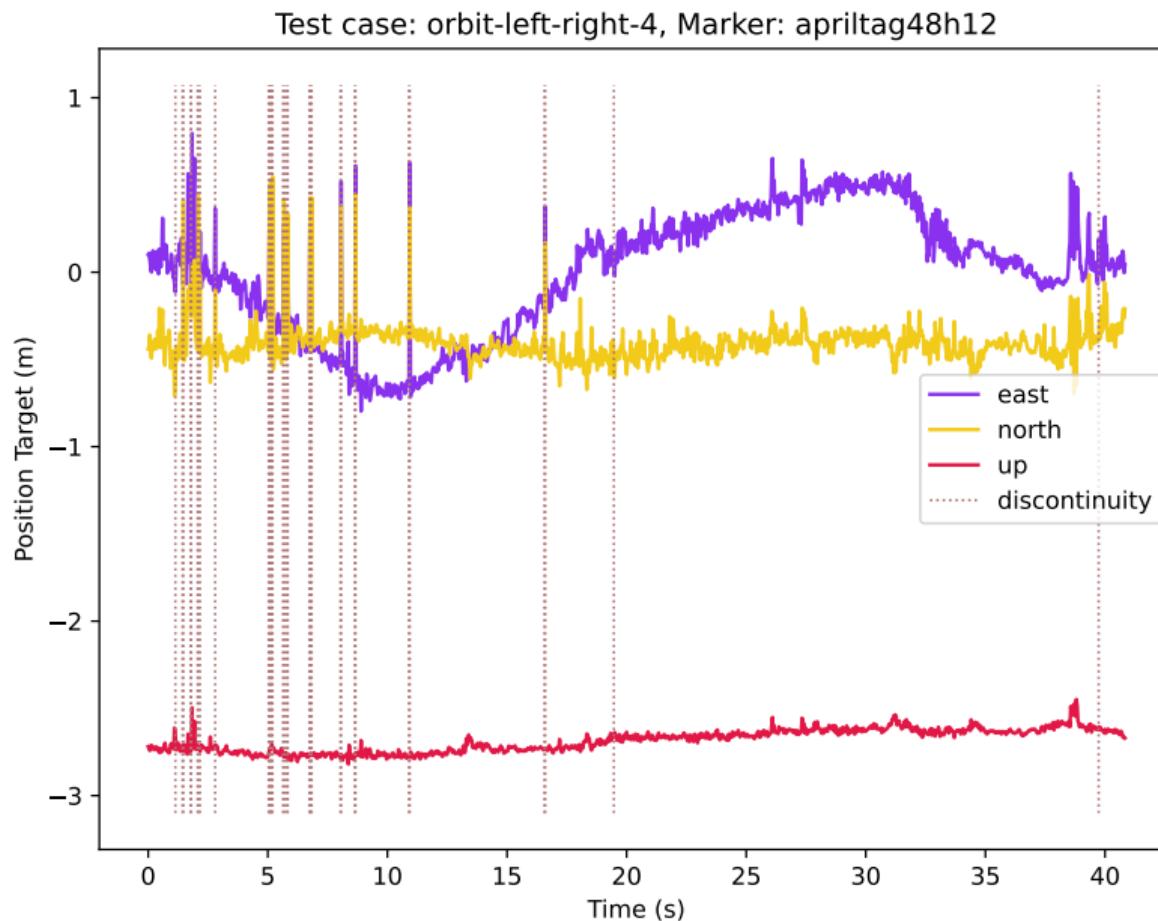
- ▶ Fixed, downward-facing camera paradigm
- ▶ Loses sight of the landing pad in adverse conditions (e.g. wind)

Example Test Case

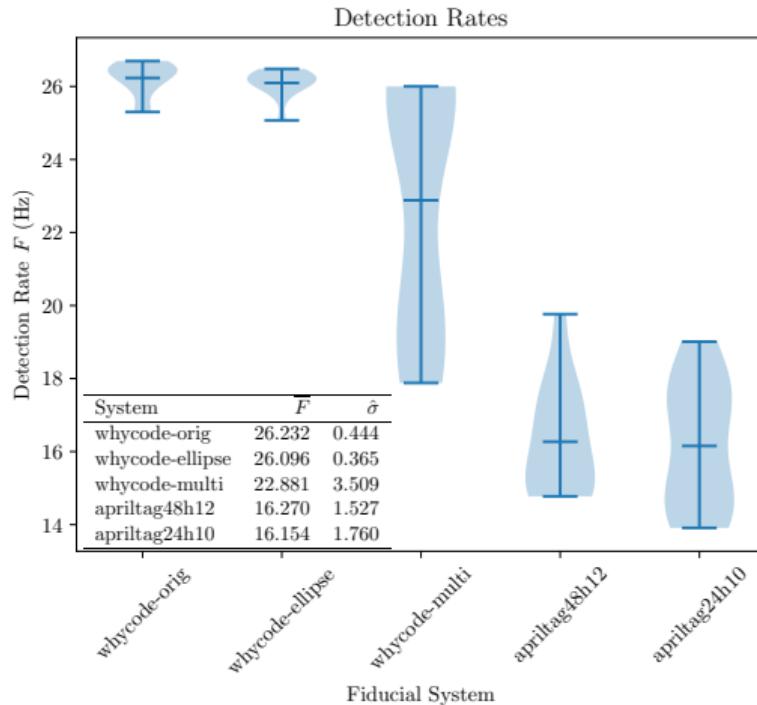
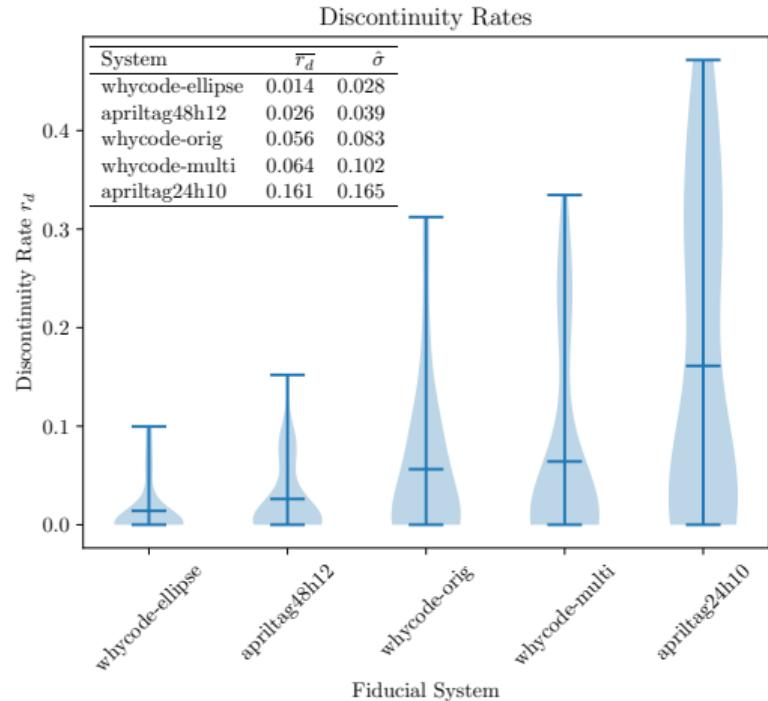
Test case: orbit-left-right-3, Marker: apriltag48h12



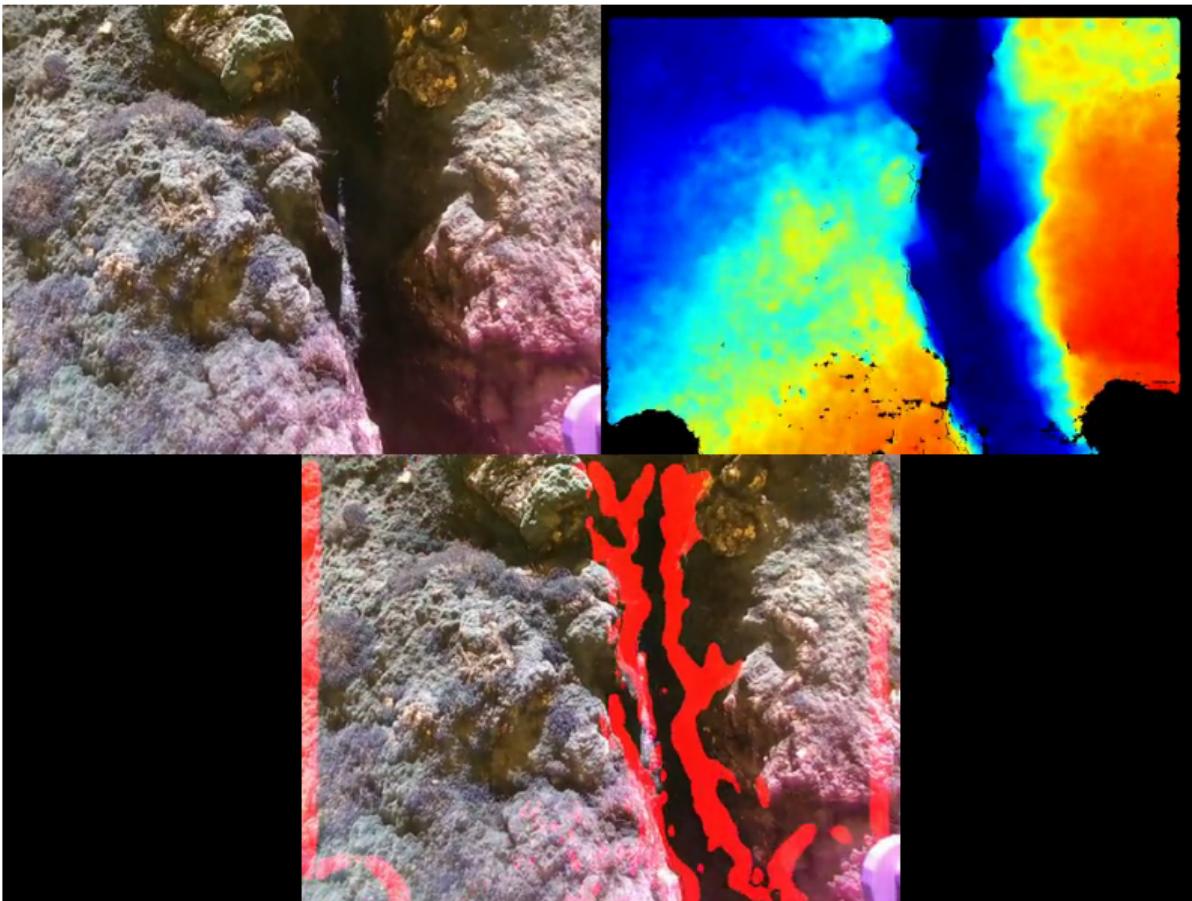
Example Test Case with Discontinuities



Results



Example Depth Image Processing



References

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- ▶ Peter Lightbody, Tomáš Krajník, and Marc Hanheide.
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