Vision-based Autonomous Landing in Catastrophe-Struck Environments

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Control Problems in Robotics: Modeling and control of multi-rotor UAVs
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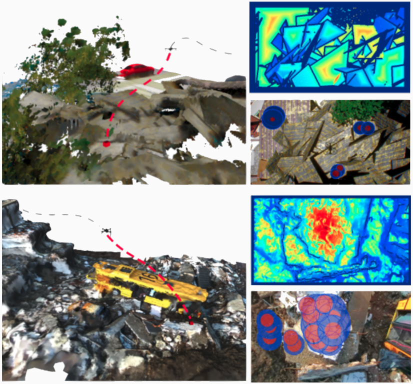
Intro.

- Why it's important (bioradiolocation, also emergency landing)
- previous work



Technical Approach

Brief introduction to ch. 3, describe approach and then discuss details.

- State Estimation
- Landing Site Detection
- 3D Volumetric Mapping
- Landing Trajectory Estimation

Technical Approach: State Estimation

ORB-SLAM2 + IMU + barometer + GPS (EKF multi-sensor fusion).

Technical Approach: Landing Site Detection

Cost functions + clustering.

$$J = c_1 J_{DE} + c_2 J_{FL} + c_3 J_N + c_4 J_{EC}$$

with $c_i \in [0,1]$ weighting parameters such that $\sum_i c_i = 1$.

Technical Approach: Landing Site Detection

Confidence in **Depth Information** J_{DE}:

$$J_{DE}(p) = 1 - \frac{D(p)^2 - min\{D^2\}}{max\{D^2\}}$$

Technical Approach: Landing Site Detection

Flatness Information J_{FL}:

$$di(B, p) = min\Big\{\|p - q\| \Big| B(q) = 1\Big\}$$

$$J_{FL}(p) = di(Canny(D), p)$$

STEEPNESS INFORMATION J_N:

$$\theta = cos^{-1}(\hat{n}_z)$$

$$n(p) = exp\left\{-\frac{\theta^2}{2\theta_{th}^2}\right\}$$

description $\theta_{th} = \pi/12$.

Energy Consumption Information J_{EC}:

$$J_{EC}(p) = \int_{t_0}^{t_f} P(t)dt$$

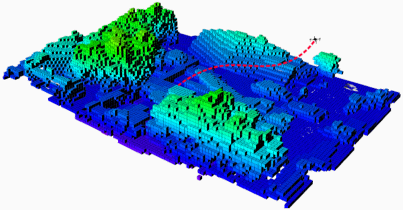
Technical Approach: 3D Volumetric Mapping

OctoMaps and Voxblox

Technical Approach: Landing Trajectory Estimation

RRT* and minimum-jerk trajectory.

- First.
- Second.



Experimental Evaluation

Description:

- Hyperrealistic Simulation
- Real-World Outdoor (Training Center for Rescue, Germany)

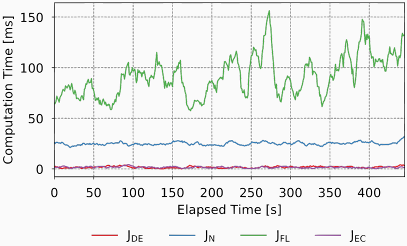
+ computation costs

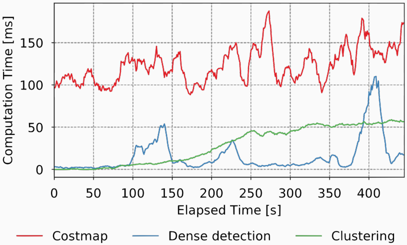
Hyperrealistic Simulation Experiments

Real-World Outdoor Experiments

Experimental Evaluation: Computation Costs

Computation costs





Conclusion.

Q&A

References

M. Mittal, A. Valada, and W. Burgard, “Vision-based autonomous landing in catastrophe-struck environments,” *CoRR*, vol. abs/1809.05700, 2018.