Implementation of Low Cost Drone and Feasibility of 3D Outdoor Mapping

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Abstract

A robot can loosely be defined as any mechanical system that can observe and physically interact with its environment with some degree of autonomy. To do so, it requires sensors (which perceive its environment), actuators (which produce the necessary motions to carry out some physical task), and some method of computation (to act according to prior and/or learned knowledge), all of which must be integrated into a cohesive system. This poster gives a high level overview of these core concepts in general robotics and how they are implemented in the Duckiedrone, a quadcopter kit produced by the Duckietown Project.[1] It also touches on some open-source mapping algorithms and discusses their applicability for outdoor mapping with the Duckiedrone.

Hardware/Software Considerations

Efficacy vs. Efficiency

- Ideal: multiple sensors of different types, deterministic algorithms [1]
- Restrictions: budget, power consumption, physical space, time sensitivity [1]
- Result: sparser system, probabilistic algorithms

Bayesian State Estimation

Process by which state estimates are recursively updated by incoming observations via Bayes Rule [2]:

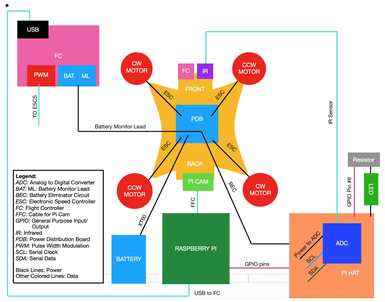
$$P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}$$

where

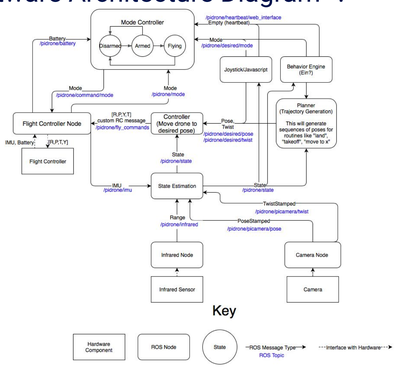
- A is state in question
- B is most recent observation

Duckiedrone

Wiring Diagram [3]:

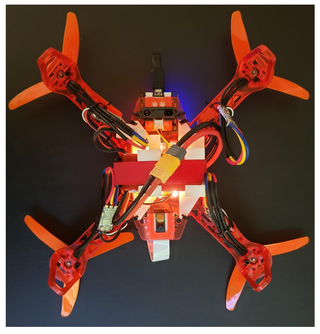


ROS-based Software Architecture Diagram [3]:



Top View:

Bottom View:



Mapping Algorithms

SLAM

- ORB SLAM can be run with monocular camera but produces sparse point clouds
- LiDAR produces much denser map but is orders of magnitude more expensive

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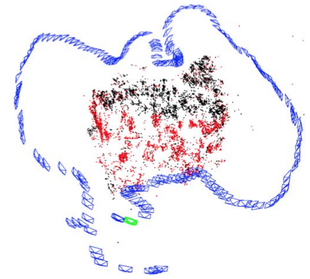

REMODE

- Can be run with monocular camera and produces dense depth maps but requires GPU for CUDA

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References

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4. Mur-Artal et al., ORB-SLAM: a Versatile and Accurate Monocular SLAM System, http://webdiis.unizar.es/~raulmur/MurMontielTardosTRO15.pdf
5. Pizzoli et al., REMODE: Probabilistic, Monocular Dense Reconstruction in Real Time, http://rpg.ifi.uzh.ch/docs/ICRA14_Pizzoli.pdf