Sensor Fusion on a mini Unmanned Vehicle

Integrating vision-based algorithms on an Asctec Pelican to autonomously follow linear shaped structures in a landscape.

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2 Research Question

What vision-based algorithms perform successful in autonomously following linear shaped structures in a landscape with an Asctec Pelican?

3 Research Goal

The goal of this research project is to develop an algorithm on an Unmanned Aerial Vehichle that in the end can navigate autonomously over infrastructure (ie. power lines, railways and roads).

4 Research Plan

1. Research relevant literature.
2. Define tasks.
   Starting with an easily recognizable model and then gradually fade the preconditions away. This gives the following set of tasks:
   (a) Follow a bright orange clothesline laying on the ground.
   (b) Follow a bright orange clothesline hanging in the air.
   (c) Follow a lighter orange clothesline hanging in the air.
   (d) Follow a white clothesline hanging in the air.

   Extra tasks:

   (a) Follow a white clothesline hanging in the air, while moving spirals around it.
   (b) Follow linear shaped structures in a landscape such as, highways, rivers and fences.
3. Create a dataset of tasks (a), (b), (c) and (d), to test the vision-based algorithms in simulation.
4. Design vision-based algorithms.
   - Prior knowledge techniques.
   - Machine learning techniques.
5. Test vision-based algorithms in simulation experiments (above described tasks).

6. Test vision-based algorithms on the Asctec Pelican in experiments (above described tasks).
7. Based on the results either increase the difficulty of the task or improve the algorithms.
8. Compare algorithms.
9. Write research paper.

5 Integration Plan

In short the integration plan is:

1. Initial design, determine the camera application that should be integrated (ie. Optical or Multispectral).
2. Structural integration, attach the camera application to the Asctec Pelican.
3. Algorithm and Data processing, determine the algorithm that should process the visual information. By experimenting in simulation and on the Asctec Pelican platform.
4. Intergrating software with the Flight Control System, integrate the algorithm with the Flight Control System and fly autonomously.
5. Interfacing with the Ground Control System, create a interface for the new algorithm on the Ground Control System.

6 Relevant Literature

6.1 [Bosch et al., 2006]

This paper describes an approach to detect safe landing areas for a flying robot, on the basis of a sequence of monocular images. The approach does not require precise position and altitude sensors as it exploits the relations between 2D image homographies and 3D planes.

6.2 [Caballero et al., 2006]

This paper describes a vision-based position estimation method for Unmanned Aerial Vehicles. The method assumes a planar scene, approximation that usually holds when a vehicle is flying at a relatively high altitude. Furthermore the method uses monocular images to estimate the vehicle motion, but accumulative errors can make diverge the estimated position. The method uses an online-built mosaic to correct the drift associated to the planar motion estimation algorithm. Due to the mosaic the researchers can use previously recorded information for localization.

6.3 [Feil et al., 2008]

This paper describes a compact Broadband 78 GHz Sensor, which is high sensitive, has simultaneous detection capabilities and can see small objects (ie. nuts).

6.4 [Frew et al., 2004]

This paper describes the vision-based control of a small autonomous aircraft following a road. The computer vision system detects natural features of the scene and tracks the roadway in order to determine relative yaw and lateral displacement between the aircraft and the road. The method uses only vision measurements and onboard inertial sensors to make a control strategy to stabilize the aircraft and follow the road.

6.5 [Katrasnik et al., 2010]

This paper discusses the most important achievement in power line inspection by mobile robots. The paper focuses on helicopter inspection, inspection with flying robots and inspection with climbing robots. The paper discusses the benefits and drawbacks in power line inspection.

6.6 More to come...

References

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