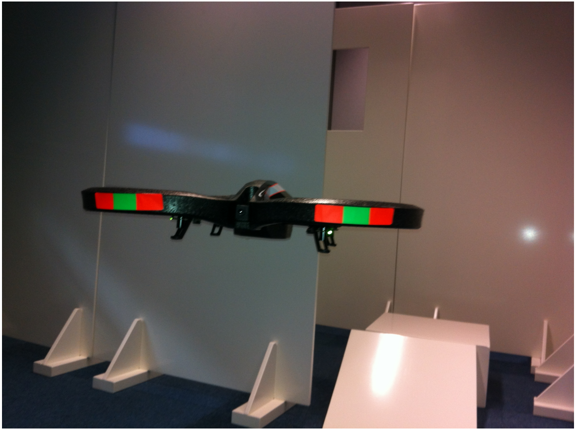
Sensor Fusion on a mini Unmanned Vehicle

Integrating vision-based algorithms on an Parrot AR.Drone to autonomously follow linear shaped structures in a landscape.



A Bachelor Thesis by Camiel R. Verschoor

Sensor Fusion on a mini Unmanned Vehicle

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July 26, 2012

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National Aerospace Lab NLR

NLR is the main knowledge enterprise in the Netherlands in the field of aviation and aerospace.

Outline

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Motivation

- Autonomous Robots require navigation.
- GPS is unreliable in indoor and urban environments.
- **Possible alternative:** vision-based line-following.

Motivation

- Various approaches of vision-based line-following.
- Edge and motion detection suitable candidates [Bills et al., 2011, Gerke et al., 2011], but have weaknesses.
- **Solution:** combine them to strengthen each others weaknesses.

Research Question

- To examine how edge and motion detection can be combined to strengthen each other in a line-following task.
  - What is the optimal camera configuration?
  - What are the experimental settings that demonstrate the strength and weaknesses of these algorithms?
  - What is the performance and robustness of these vision-based methods to navigation?

Platform and Framework

Platform Parrot AR.Drone.

- Top and bottom camera.

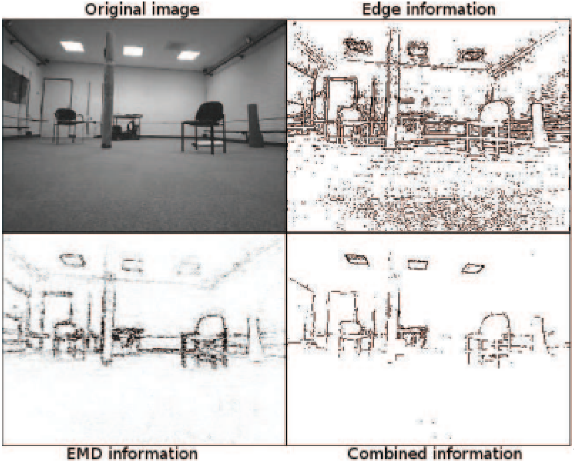
Framework AR.Drone SLAM[1] a development framework

[1] [Dijkshoorn, 2012]

Related Work

- Corridor and Stair Following [Bills et al., 2011]
- Power Line Detection [Golightly and Jones, 2005, Li et al., 2008, Katrasnik et al., 2010]
- Obstacle Avoidance [Jurriaans, 2011]
- Elementary Motion Detectors [Gerke et al., 2011]

Related Work



[2]

[2] [Gerke et al., 2011]

Related Work

- Nearly all proposed methods use Hough Transform for feature extraction.
- Edge and Motion detection have been suitable techniques for navigation
- Combination of Edge and Motion detection gave promising results.

Outline

Main Approach

$$
\begin{tikzcd}
\mathit{Camera} \arrow[r, "\mathit{Frame}"'] & \mathit{Pre-processing} \arrow[d, "\mathit{Binary\ image}"'] \\
\mathit{World} \arrow[u, "\mathit{Input}"] & \mathit{Feature\ extraction} \arrow[d, "\mathit{Line\ segments}"'] \\
\mathit{Flight\ controller} \arrow[u, "\mathit{Flying}"] & \mathit{Navigation} \arrow[l, "\mathit{Controls}"']
\end{tikzcd}
$$

Main Approach

- Pre-processing
  - Canny edge detector (Brightness changes)
  - Monocular stereo vision (Apparent motion)
- Feature extraction
  - Probabilistic Hough Transform
- Navigation

Pre-processing

- Canny edge detector (Brightness changes)
- Monocular stereo vision (Apparent motion)

Feature extraction

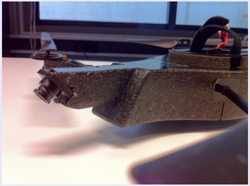
- To be written

Evaluation

- To be written

Outline

Camera Configuration



Experiments

Evaluation Criteria

To be written.

Outline

Camera Configuration

To be written.

Experiment 1

Edge detection

Performance	True	False
Detected	528 (97.8%)	12 (2.2%)
Direction	503 (93.1%)	37 (6.9%)

Motion Detection

Performance	True	False
Detected	53 (9.8%)	487 (90.2%)
Direction	37 (6.9%)	503 (93.1%)

Conclusion Experiment 1

To be written.

Experiment 2

Edge Detection

Performance	True	False
Detected	69 (29.0%)	169 (71.0%)
Direction	58 (24.4%)	180 (85.6%)

Motion Detection

Performance	True	False
Detected	96 (40.3%)	142 (59.7%)
Direction	87 (36.6%)	137 (63.4%)

Conclusion Experiment 2

To be written.

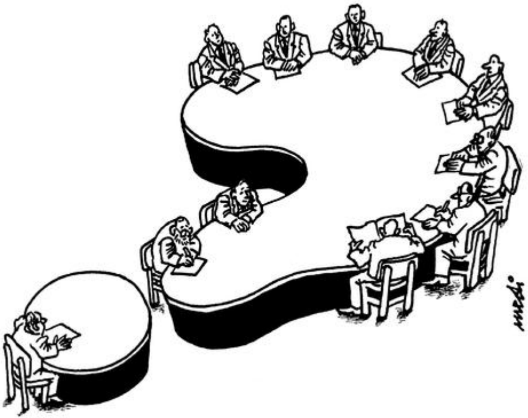
Outline

Conclusion

- To be written

Outline

Questions?



Acknowledgements

I would like to thank for their guidance and support :

- Arnoud Visser
- Gerald Poppinga

Outline

Relevant videos

- Corridor following
- Various tasks

Relevant Literature I

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