Autonomous Navigation for Flying Robots

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metaio GmbH

Teaser Video

Motivation

- Imagine you have a flying camera
- What would you use it for?

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http://gopro.com/camera-mounts/chest-mount-harness

Applications

■ Building inspections after earth quakes

http://www.nifti.eu/news/photo-album-of-mirandola-mission-on-facebook

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Applications

- Roof inspection
- Bridge inspection
- Precision agriculture/remote farming

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http://flickr.com/photos/wsdot/3379758425/

European Commssion, http://ec.europa.eu/enterprise/flipbook/rpas/files/
assets/common/downloads/publication.pdf

Applications

- Transportation

Amazon

Domino's

Course Goal

- **How can we enable a quadrocopter to fly autonomously?**
- How can we estimate its state from its sensor readings?
- How can we generate control commands to move it towards its goal?

http://www.seeedstudio.com/depot/
Crazyflie-Nano-Quadcopter-Kit-6DOF-with-Crazyradio-BCCFK01B-p-1364.html

https://www.mikrocontroller.com/

Course Content by Week

1. Introduction, state-of-the-art
2. Linear algebra, 2D geometry
3. 3D geometry and sensors
4. Motors and motor controllers (PID)
5. Probabilistic state estimation
6. Bayes and Kalman filters
7. Visual odometry
8. Cutting edge research results

Course Organization

- Course duration: 8 weeks, starts on 5.5.2015 (next Tuesday)
- Video lectures
  - 45 minutes per week
- Interactive exercises
  - Quizzes, arithmetic problems
  - Hands-on programming exercises in Python
  - Need to complete >60%
- Final exam (for TUM students) on 30.6.2015 (oral)

EdX Platform

- Demo

Camera-based Navigation
[Engel, Sturm, Cremers; IROS 2012, RAS 2014]

J. Engel, J. Sturm, D. Cremers : Camera-Based Navigation of a Low-Cost Quadrocopter, In Proc. of the International Conference on Intelligent Robot Systems (IROS), 2012.
Computer Vision Group, Technical University of Munich;, http://youtu.be/tZxlDly7lno

Camera-based Navigation
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Computer Vision Group, Technical University of Munich; http://youtu.be/eznMokFQmpc

Visual Navigation for a 25g Nano-Quadrotor
[Dunkley, Engel, Sturm, Cremers]

Visual-Inertial Navigation for a Camera-Equipped 25g Nano-Quadrotor (O. Dunkley, J. Engel, J. Sturm, D. Cremers), *In IROS2014 Aerial Open Source Robotics Workshop*, 2014.

3D Reconstruction with a Quadrotor
## [Bylow, Sturm, Kahl, Cremers; RSS 2013, UAV-g 2013]

E. Bylow, J. Sturm, C. Kerl, F. Kahl, D. Cremers : Real-Time Camera Tracking and 3D Reconstruction Using Signed Distance Functions, In Robotics: Science and Systems Conference (RSS), 2013.
Computer Vision Group, Technical University of Munich; http://youtu.be/MzLdRFSrtuI

Large-Scale 3D Reconstruction
[Steinbrücker, Kerl, Sturm, Cremers; ICCV 2013, ICRA 2014]
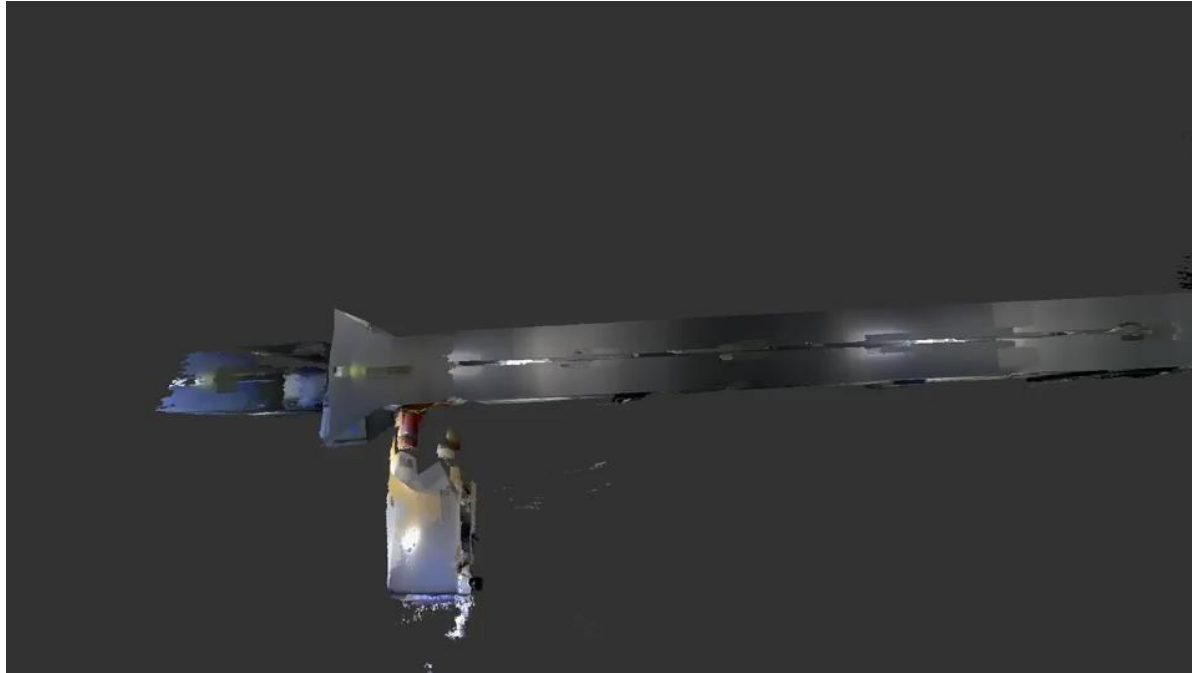
F. Steinbruecker, C. Kerl, J. Sturm, D. Cremers : Large-Scale Multi-Resolution Surface Reconstruction from RGB-D Sequences, In IEEE International Conference on Computer Vision (ICCV), 2013.
Computer Vision Group, Technical University of Munich, http://youtu.be/RZckDPvGmyI

Metaio: The Augmented Reality Company

The New IKEA Catalog App: Create Your Space
IKEA USA

Summary

- TODO:
  - Sign up on EdX https://www.edx.org/course/autonomous-navigation-flying-robots-tumx-autonavx-0
  - Check TUM website for updates https://vision.in.tum.de/teaching/ss2015/autonavx
- Contact info
  - For general questions, use the EdX discussion forum
  - TUM related questions, send email to juergen.sturm@in.tum.de
- Any questions?