# Practical Course: Vision-based Navigation Winter term 2015/2016

## Welcome

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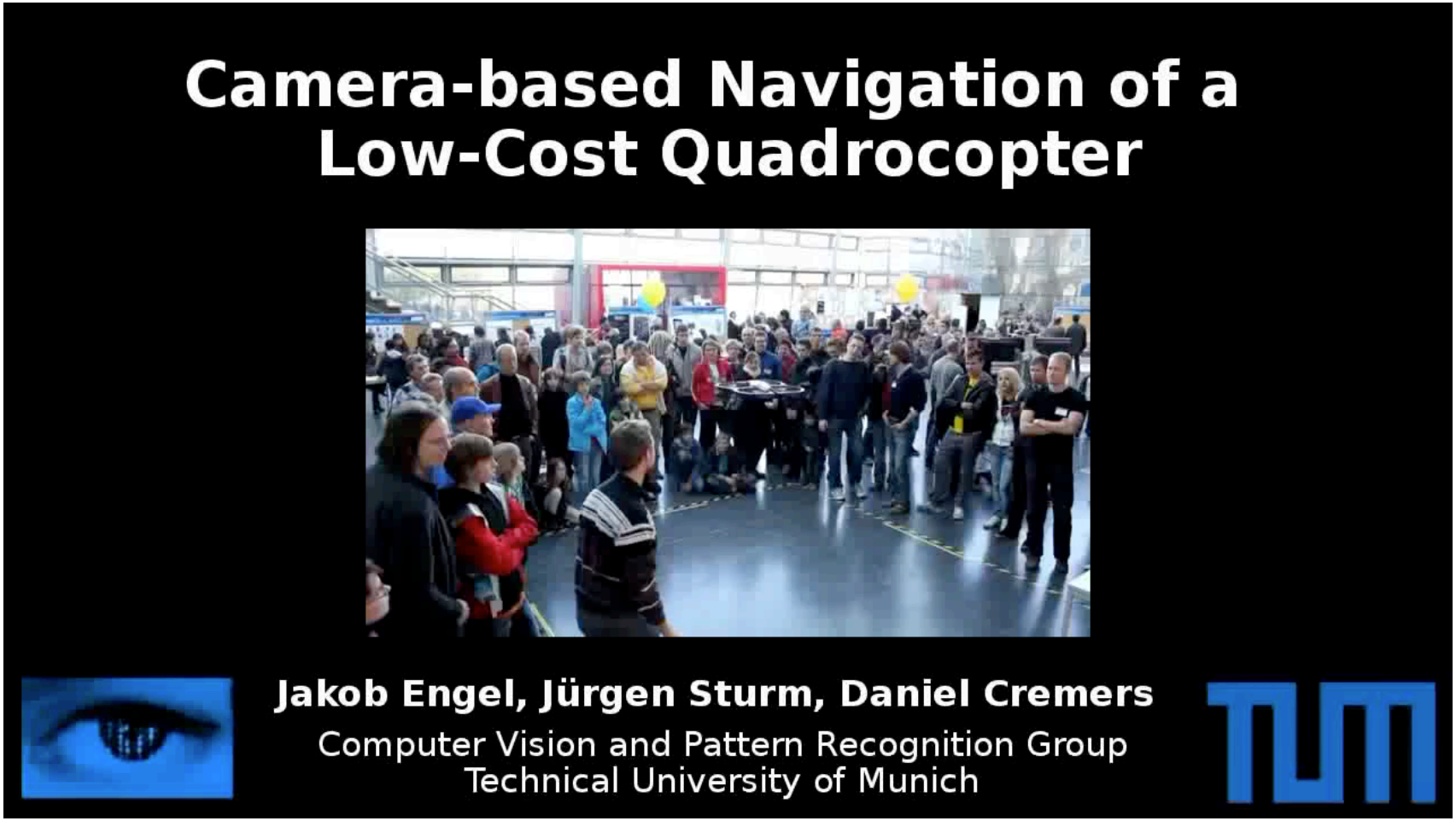
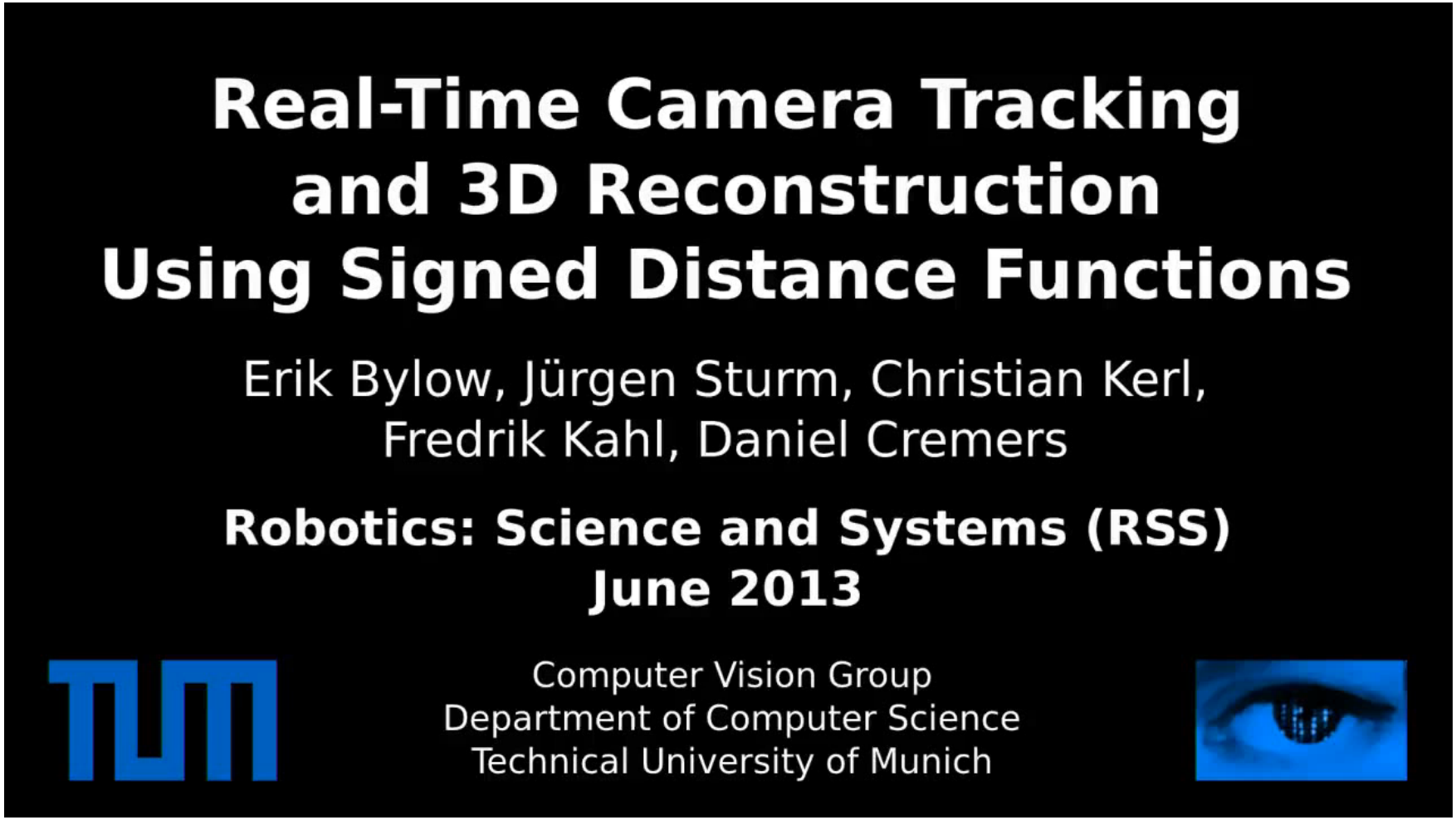
# Fork Lift Robots (2010)

# Vision-based Quadrotor Navigation (2011)

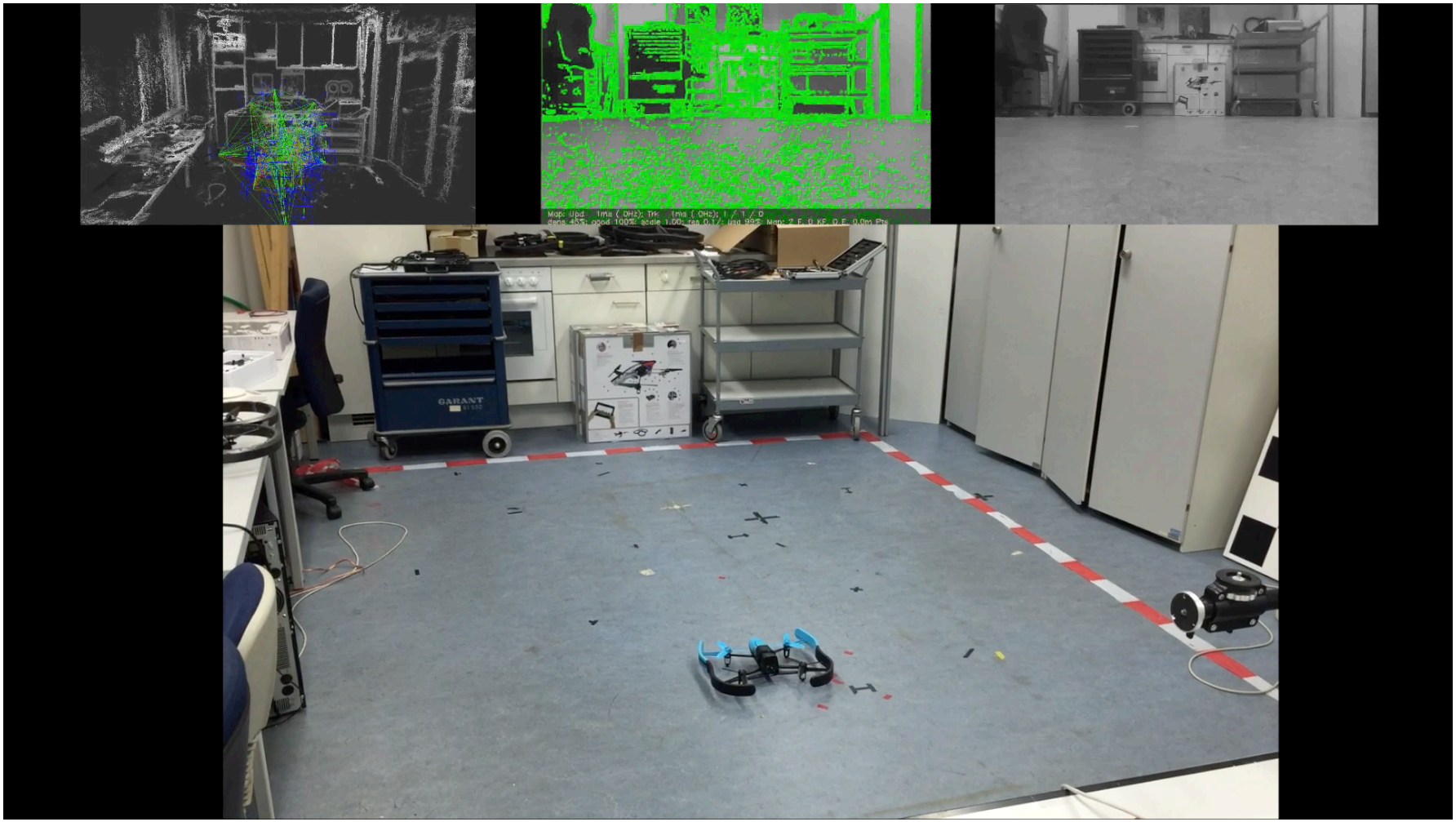


# Autonomous Construction (2011)

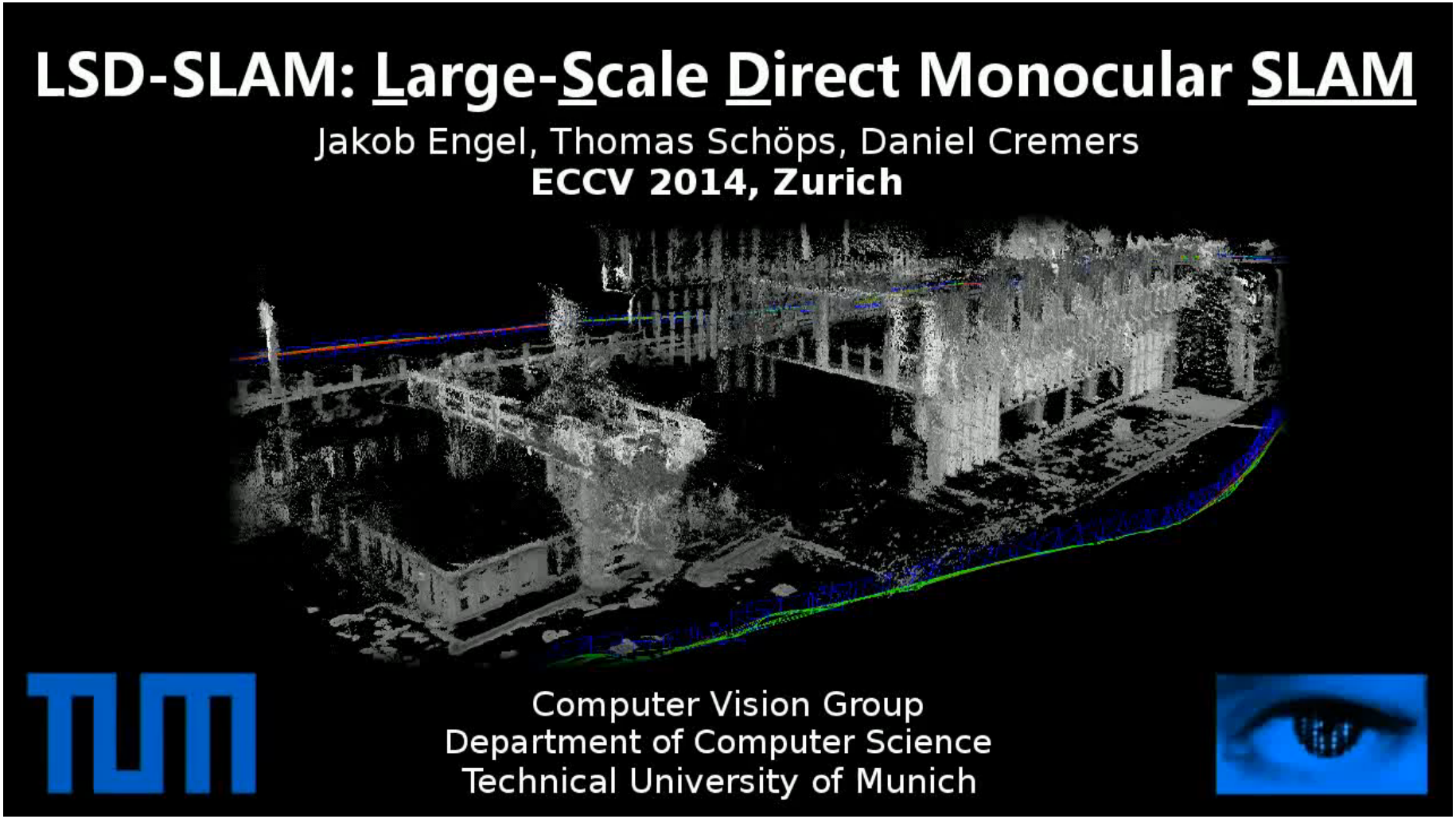
# Real-Time RGB-D SLAM with Quadrotors (2013)



# Monocular SLAM with Quadrotors (2015)



# Real-Time SLAM with a Single Camera (2014)



# Current Trends in Robotics

- Robot technology becomes increasingly mature for applications
- Beyond preprogrammed motions of static robot arms

- Novel application domains
  - Shop floor logistics
  - Human-robot collaboration in industrial settings
  - Domestic service robots
  - Autonomous cars
  - Aerial inspection/maintenance

- Vision sensors provide rich information
  - How to make use of it for robots?

# Content of this Course

- You can gain practical experience with
  - Visual odometry and localization/state estimation
  - Vision-based Simultaneous Localization and Mapping (SLAM)
  - Vision-based control of quadrocopters or wheeled robots
- Implementation of algorithms
- Benefits/drawbacks of specific methods when applied to concrete, relevant problems
- Learn how to work in teams/on projects
- Improve your presentation skills

# Available Robots in this Course


Kobuki Turtlebot 2 (2x)

Parrot AR Drone 2 (4x)

Crazyflie2 Nanocopters (2x)


Parrot Bebop (1x)

# Course Organisation

- Course takes place during the lecture period
- Registration in TUM Online (by matched/accepted students)

- Initial phase (first 4 weeks): Lectures & Exercises
  - Lectures: Mondays 9am to 11am in seminar room 02.09.023
  - Tutored exercises: Mondays 11am to 1pm in lab 02.05.014
  - Programming assignments will be handed out every week and checked/graded by the tutors
  - Small groups, each participant should be able to explain solution
  - Attendance to lecture & exercise sessions mandatory

- Second phase (remainder): Project
  - Work in small groups (2-3 people) on a project
  - Lab 02.05.014 available; tutors available Mondays 9am-1pm
  - Implement a specific algorithm, which one tbd.
  - Present project outcome in talk&demo session (15min per group)
  - Written report on project outcome (10-12 pages, single column, single-spaced lines, 11 pt)

# Course Requirements

- Good knowledge of the C/C++ language and basic mathematics such as linear algebra, analysis, stochastics, and numerics is required
- Prior practical knowledge in CUDA programming, robotics, and computer vision topics is a plus
- Participation in at least one of the following lectures of the TUM Computer Vision Group: Variational Methods for Computer Vision, Multiple View Geometry, Autonomous Navigation for Flying Robots. Similar lectures can also be accepted

# Warning

- Micro Aerial Vehicles (MAVs) are dangerous objects
- Read the instructions carefully before you start
- Always use the protective hull
- If somebody gets injured, report to us so that we can improve safety guidelines
- If something gets damaged, report it to us so that we can fix it
- Don't fly MAVs outdoors or above persons
- **NEVER TOUCH THE PROPELLORS**
- **DO NOT TRY TO CATCH THE QUADROCOPTER WHEN IT FAILS – LET IT FALL/CRASH!**

Questions ?