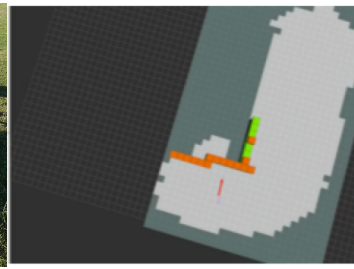
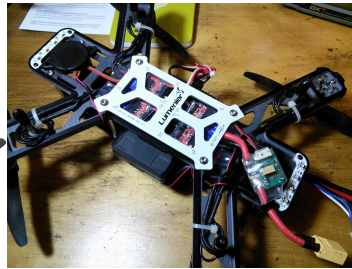


TOWARDS OBSTACLE AVOIDANCE ON OPEN SOURCE DRONES



Lorenz Meier / <http://px4.io>

PERSONAL CONTRIBUTION TIMELINE



pixhawk



 **QGROUNDCONTROL**
GROUND CONTROL STATION FOR SMALL AIR - LAND - WATER AUTONOMOUS UNMANNED SYSTEMS

 **MAVLINK**
MICRO AIR VEHICLE COMMUNICATION PROTOCOL



**AVOIDANCE
LOCALIZATION**



2008

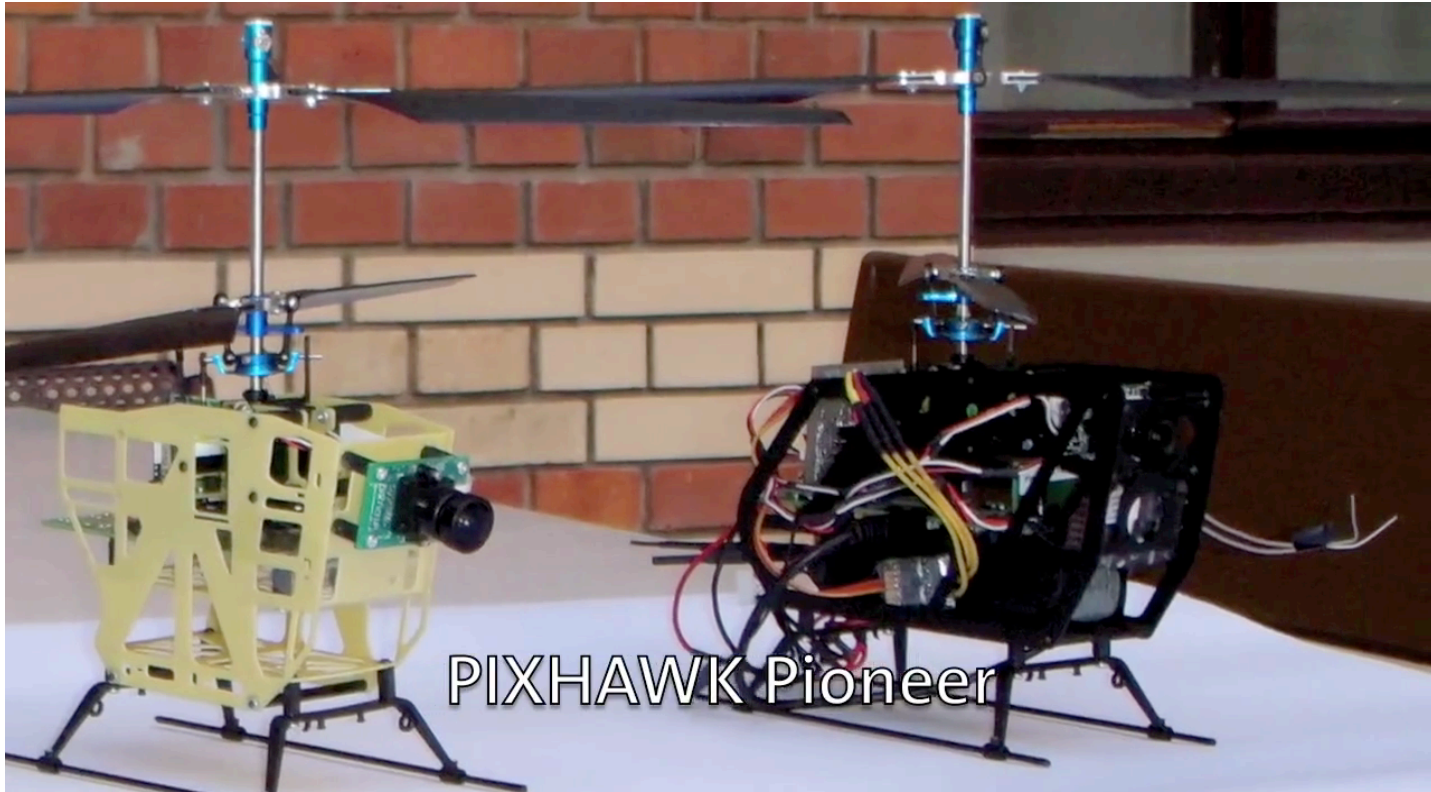
2010

2011

2013

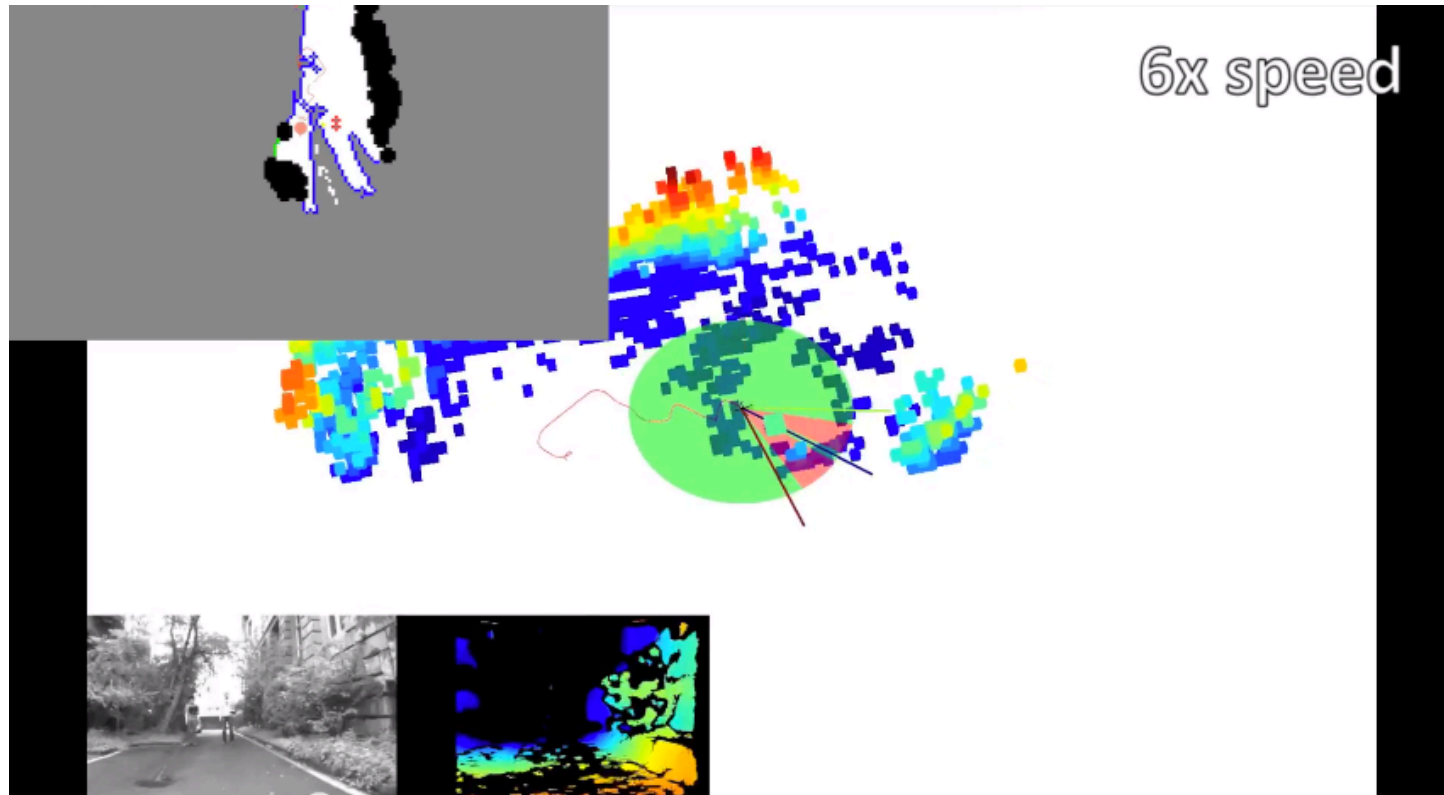
2016

LINUX ON DRONES IN 2008



PIXHAWK Pioneer

LINUX ON DRONES IN 2012



IROS 2012, Friedrich Fraundorfer, Lionel Heng, Dominik Honegger,
Gim Hee Lee, Lorenz Meier, Petri Tanskanen, and Marc Pollefeys



Computer Vision
and Geometry Lab



PX4 PROGRESS UPDATE



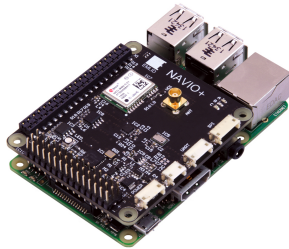
- VTOL (Tiltrotor / Tailsitters / Quad Planes)
- Hardware support
- Dronekit – first steps
- MAVLink based Simulationkit
- Building a complete stack:
 - Simulation in 3D including cameras / flow
 - High speed computer vision
 - Obstacle avoidance



HARDWARE SUPPORT



Autopilot Hardware



Operating Systems

- Linux (user space)
- QuRT (kernel)
- NuttX (kernel)
- OS X (user space)

VTOL CONTROL



SNAPDRAGON ON OPEN SOURCE DRIVERS



DRONEKIT SUPPORT



- Basic support in Dronekit upstream (community-contributed)
- Mode setting, missions, arming
- Still work in progress (unpolished)

Try it:

<http://dev.px4.io/dronekit-example.html>



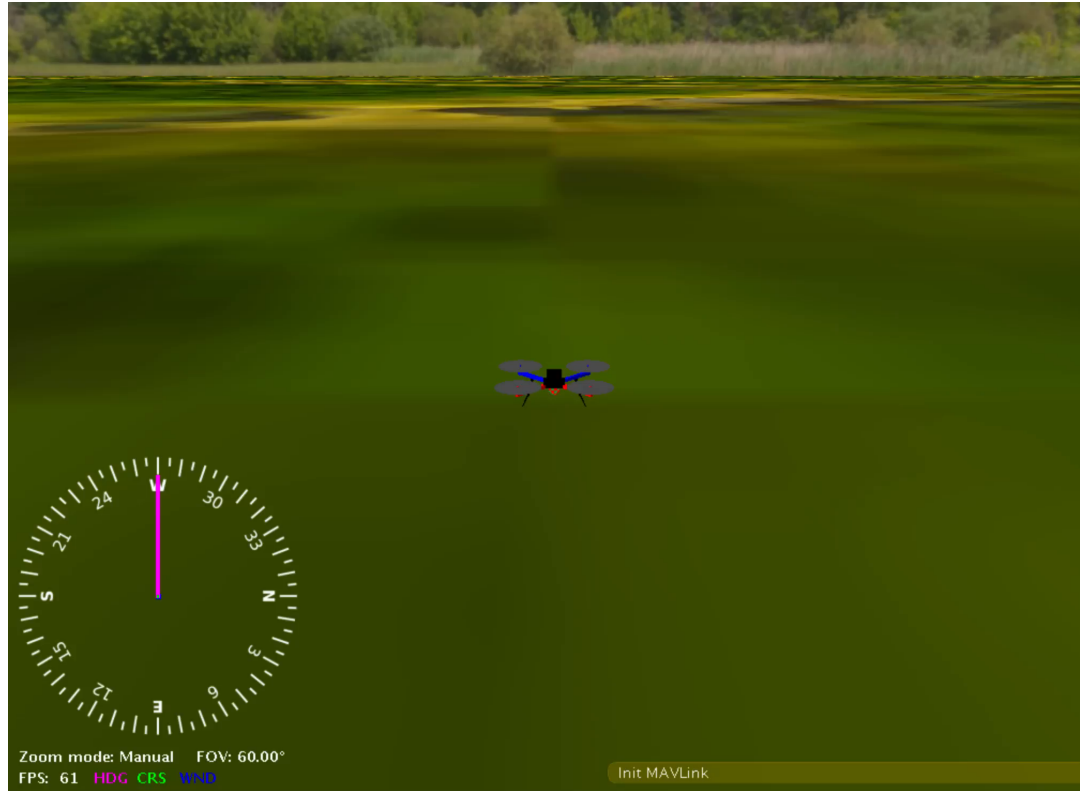
Dronecode



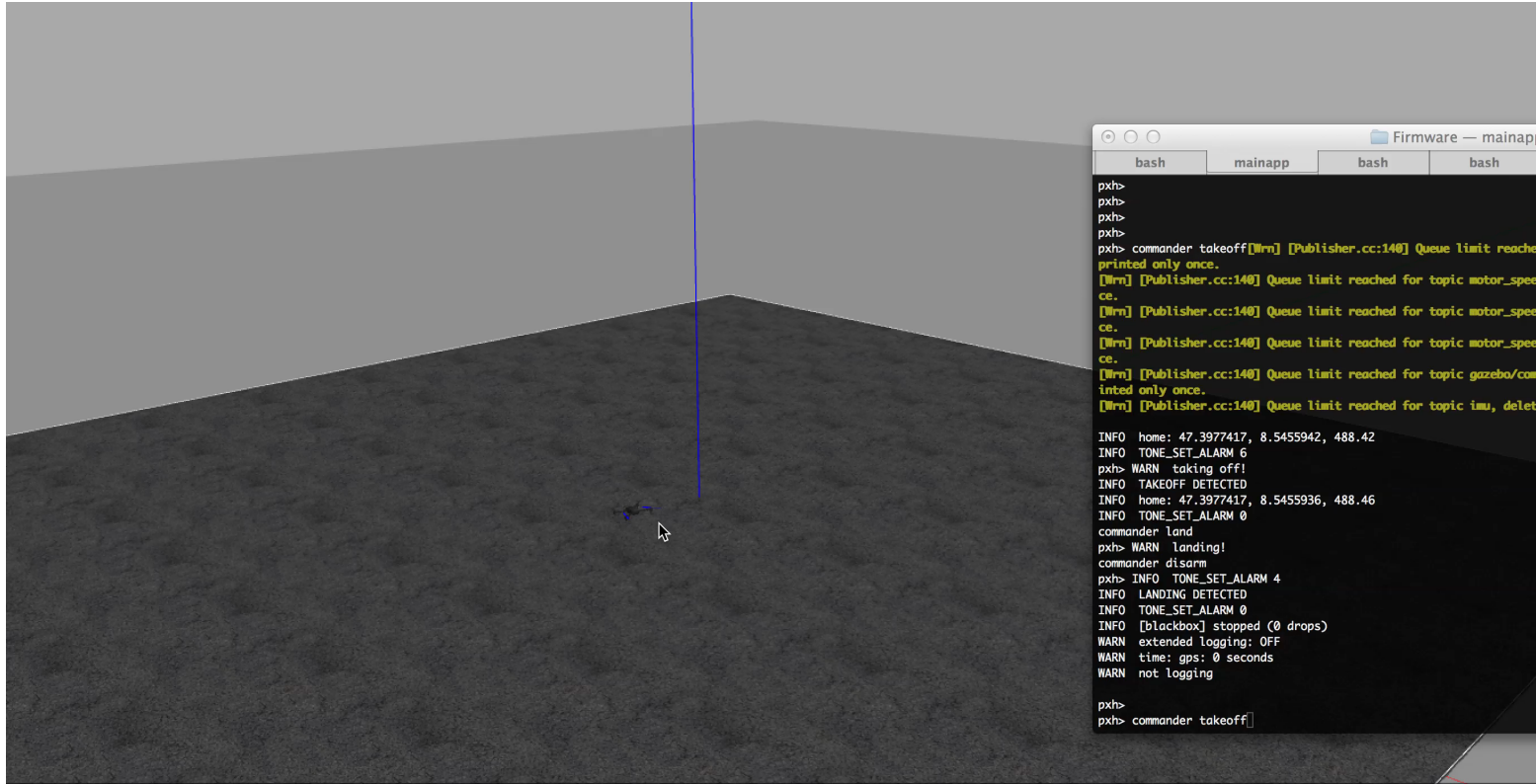
Computer Vision
and Geometry Lab

ETH zürich

SIMULATIONKIT (MAVLINK API)



SIMULATIONKIT (MAVLINK API)



SIMULATIONKIT (MAVLINK API)



BUILDING A COMPLETE STACK?



- Dronecode flight stack (PX4 / APM)
- Simulationkit
- High speed stereo
- AIT-Visual Inertial Odometry
- Local avoidance planner (VFH+ 3D)
- Global path planner (Octomap + graph)



OPTICAL FLOW SIMULATION

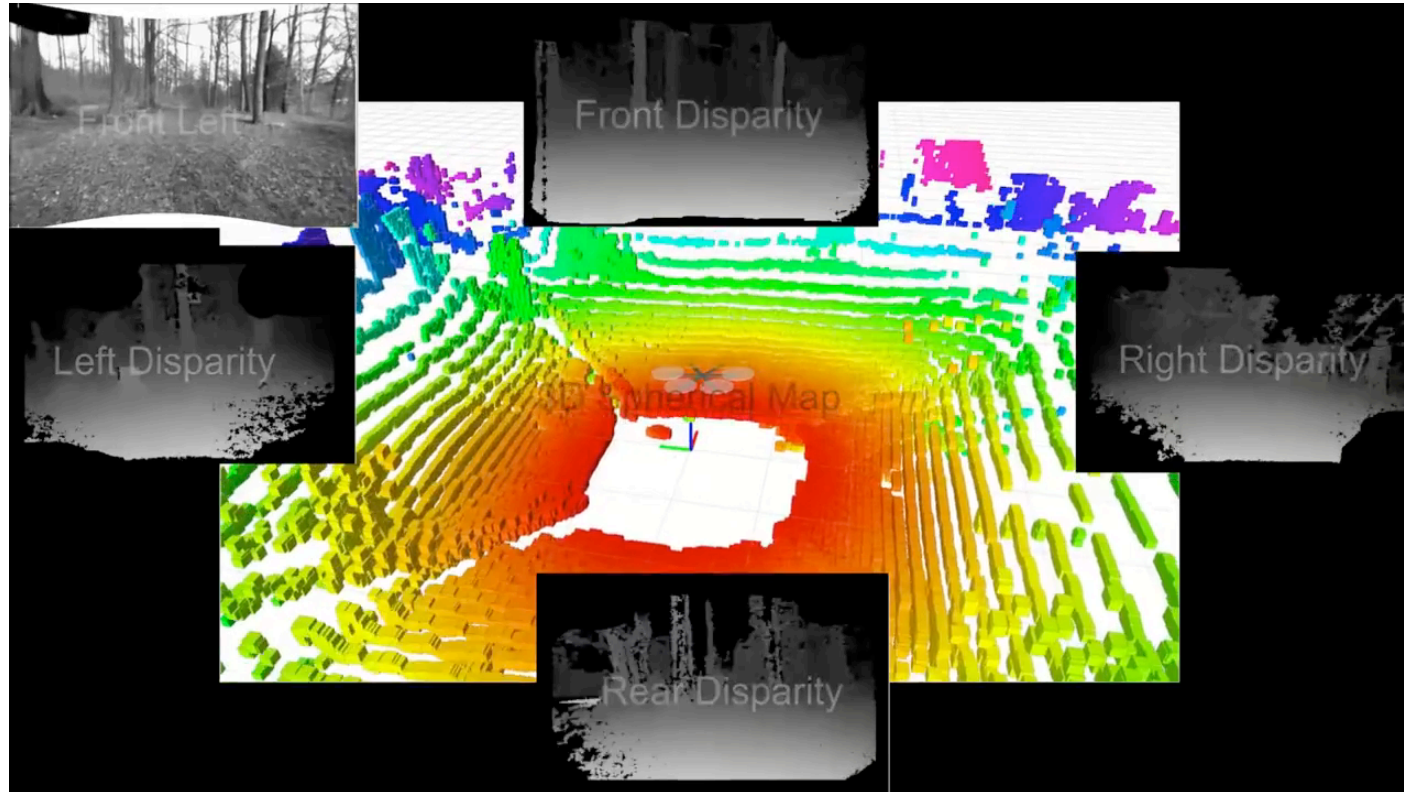


The screenshot displays a Gazebo simulation environment. On the left, a scene tree lists objects like 'ground_plane', 'asphalt_plane', and 'House 1'. A 'Gazebo: Image View' window shows a camera feed of the asphalt ground with a frame rate of 30.12 Hz and a bandwidth of 5.67 MB/s. Below this, a 'Property' table shows details for the 'asphalt_plane' link.

Property	Value
name	asphalt_plane
is_static	<input checked="" type="checkbox"/> True
self_collide	<input type="checkbox"/> False
pose	
link	asphalt_plane-link

An 'Analyze' window in the bottom left shows a graph of 'M1:LOCAL_POSITION_NED.x' and 'M1:POSITION_TARGET_LOCAL_NED.x' over time. The graph shows a constant value around 2.85 until approximately 13:44:08, after which it rises sharply to about 3.35. The interface also includes controls for 'Short names', 'Show units', 'Recolor', 'Start Logging', and 'Ground Time Time axis'.

REALTIME VISION



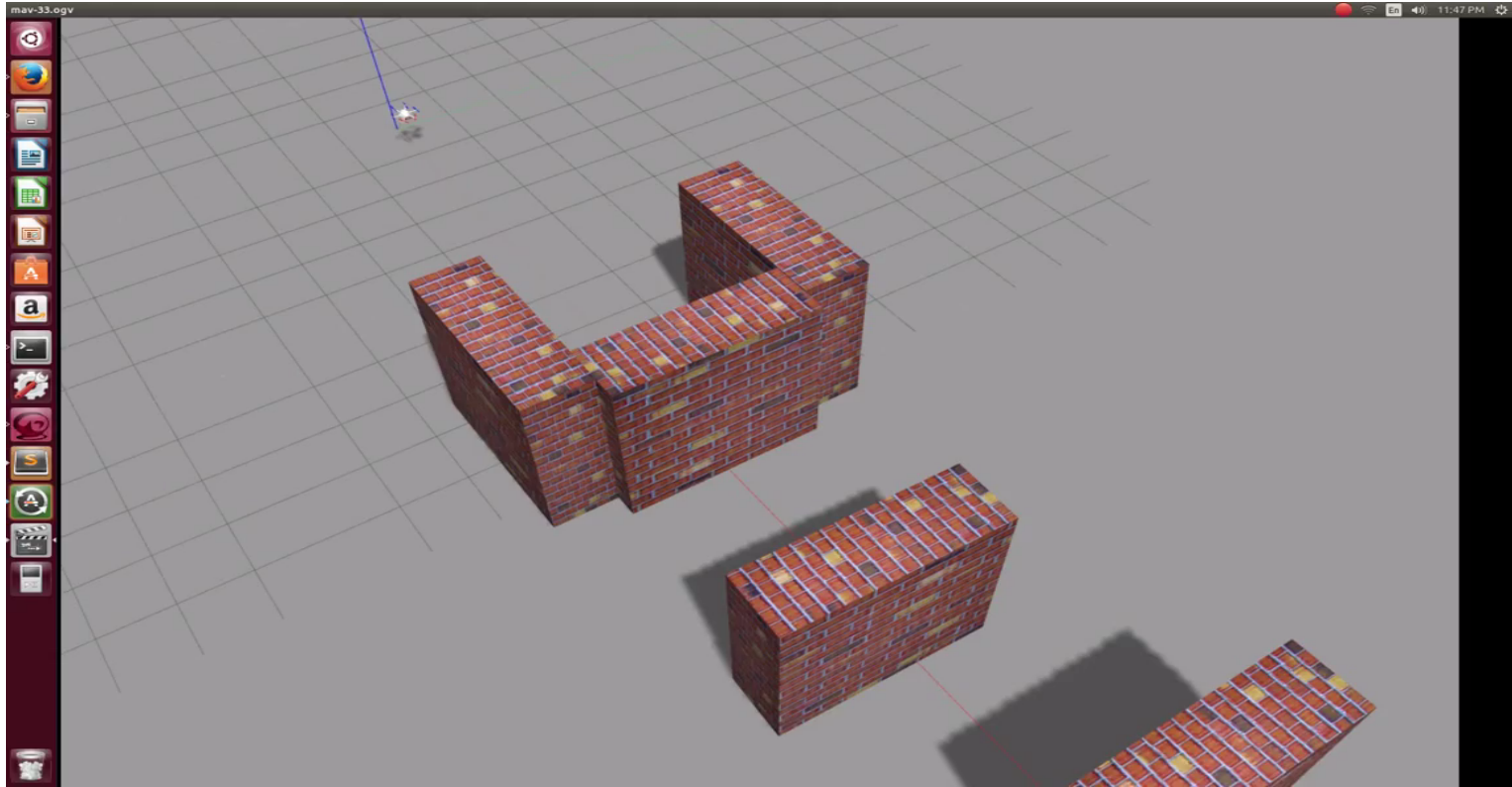
Pascal Gohl, Dominik Honegger, Sammy Omari, Markus Achtelik, Marc Pollefeys and Roland Siegwart. **Omnidirectional Visual Obstacle Detection using Embedded FPGA.** Proc. IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS), 2015



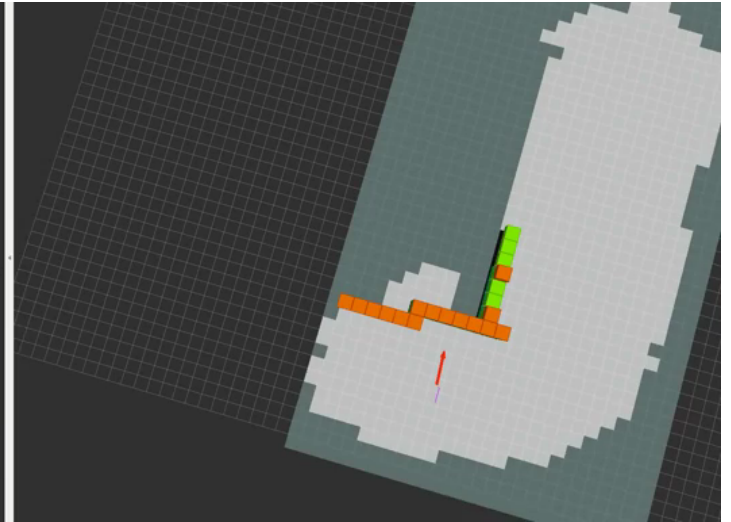
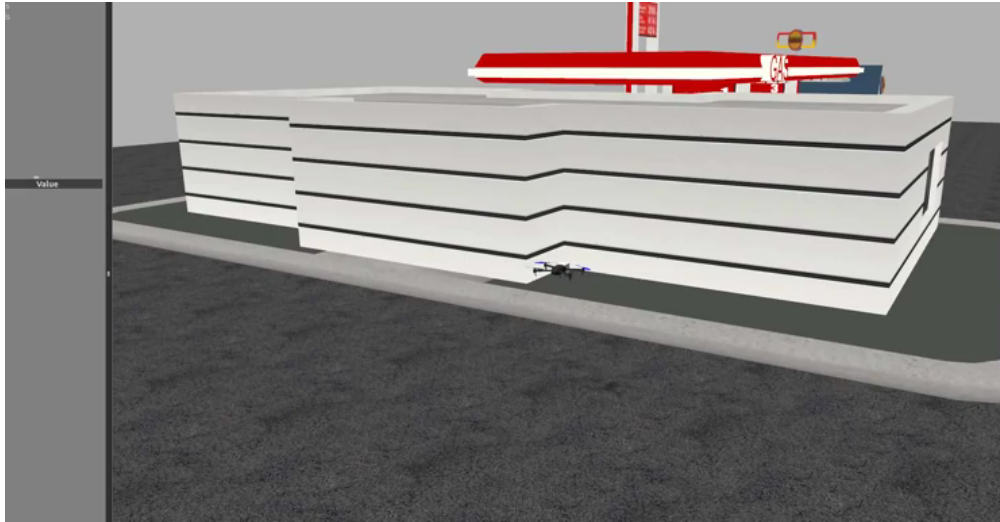
Computer Vision
and Geometry Lab



AVOIDANCE



GLOBAL PLANNING



ACKNOWLEDGEMENTS / THANKS!



- ETH Zurich, CVG Lab
- Master students of ETH Zurich
- APM Dev team on middleware
- OSRF / ETH Zurich on Gazebo Simulator
- Paul Riseborough on EKF Fusion framework
- Pavel Kirienko on UAVCAN