



Aerial Robotics Working Group

November 22th 2023
Discussion/Developer meeting

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The Agenda

- Introduction topic **3D planning**
- Discussion
- Conclusion
- Announcements
- Next meeting

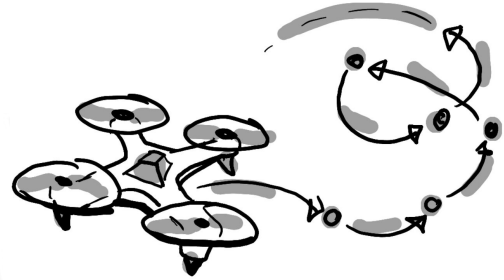
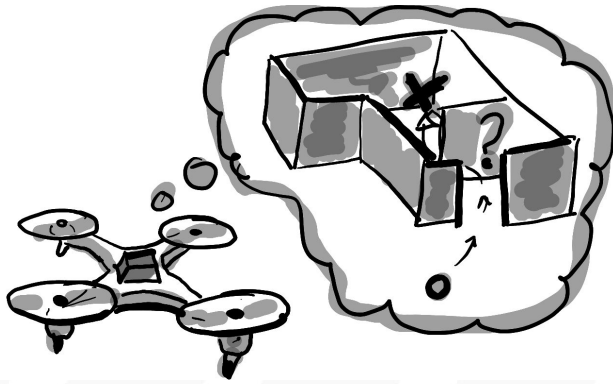
Announcements

- Ramon's ROScon talk is out!
 - Up, Up, and Away: Adventures in Aerial Robotics
 - <https://vimeo.com/879001926/02a07b8277>
- Also checkout the Aerostack2 talk
 - Aerostack2: A framework for developing Multi-Robot Aerial Systems
 - <https://vimeo.com/879000655/24398f48ef>
- Anyone like to share an event :) ?
 - Mayank: Join roscon India! I have a presentation :)
 - Kim: don't forget about roscon germany!



Introduction topic 3D planning

- 2D navigation is not enough, which many ROS packages are based on
- 3D planning is especially important for outdoor navigation
- Current planning packages simply won't do!



3D planning current work

- **Head-start by**
 - Ryan Friedman (Ardupilot)
 - Jaeyoung Lim (ETHZ, PX4)
 - Rhys Mainwaring (Maritime group)
 - Mayank Joneja (Vimaan)
- **Autonomous System Lab (ETH Zurich)**
 - Terrain Navigation <https://github.com/ethz-asl/terrain-navigation>
 - MAV comm https://github.com/ethz-asl/mav_comm
 - Gridmap geo https://github.com/ethz-asl/grid_map_geo (relies on Anybotics' Gridmap https://github.com/ANYbotics/grid_map)

3D planning

- On github.com/ros-aerial















ROS-Aerial / Projects / 3D Planning

3D Planning

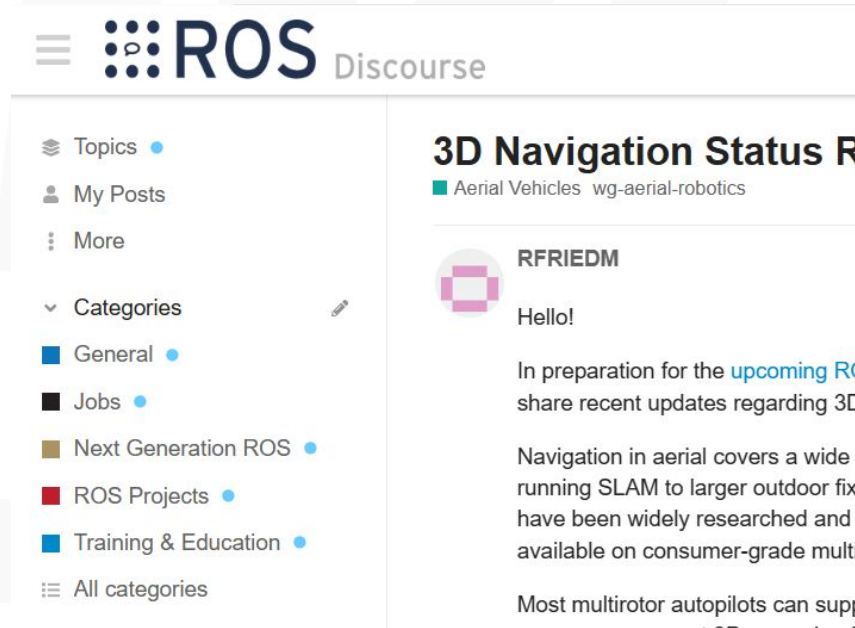
List View | Kanban | View 3 | + New View

Filter by keyword or by field

	Title	...	Status	...
1	 Distro name fix for rolling #405		In Progress	▼
2	 Update ament to latest recommendations #404		In Progress	▼
3	 Port to humble #24		Done	▼
4	 Add ROS1 dockerfile #8		Done	▼
5	 Depend on gdal where it's used with rosd... #10		Done	▼
6	 Docker support #6		In Progress	▼
7	 Port mav_msgs to ROS 2 #90		Done	▼
8	 Updates to cmake and launch files to sup... #26		Done	▼
9	 Port terrain-navigation to ROS 2 Humble #20		In Progress	▼
10	 Update rviz config #27		Done	▼
11	 ompl missing dependency #7		Done	▼
12	 Add missing ompl dependency #9		Done	▼

Issues from status report

- Lot of navigation solutions not possible for fixed wings:
 - Cannot stop midflight and fewer DOF
 - Flight longer distance, curvature of earth become important
 - Stricter airspace regulations
- Big planning burden on the operator or the autopilot suite
- Current issues with GPS for navigation:
 - <https://discourse.ros.org/t/future-of-ros-2-gps-support/33297> has 38 responses!
- Current work
 - Porting to ROS2
 - Standardization
 - Fix compatibility issues
 - Make ROS binaries



The screenshot shows the ROS Discourse forum interface. At the top, the ROS logo and 'Discourse' text are visible. A navigation sidebar on the left lists various categories such as 'Topics', 'My Posts', 'More', 'Categories', 'General', 'Jobs', 'Next Generation ROS', 'ROS Projects', 'Training & Education', and 'All categories'. The main content area displays a thread titled '3D Navigation Status Report' by user 'RFRIEDM'. The thread content includes a greeting 'Hello!' and a paragraph discussing the preparation for upcoming ROS updates regarding 3D navigation, mentioning SLAM and consumer-grade multirotor autopilots.

Discussion topics

- Existing 3D planning algorithms
- The state of the 3D planning implementation for UAVs
- Indoor versus outdoor navigation
- Burden of autopilot suites (what belongs where?)
- What needs standardization for planning?

Existing 3D planning packages for ROS1

- ROS1 3D navigation (Still from willow garage era):
https://github.com/ros-planning/3d_navigation
- MoveIt! (Maintained by picknick robotics) <https://moveit.ros.org/>
 - Latet uses octomap (<http://octomap.github.io/>)
 - Mostly for arms, useful for drones?
- Hector quadrotor
 - ROS1
- Nav and Nav2
 - Focus on indoor navigation mostly (actually the previous one are too)
- Terrain navigation (by ETHZ)
- Anymore??

The state of the 3D planning implementation for UAVs

- Ryan: Local cart. Planning is more of a solved problem. More packages example. TF2 cart coordinates only
- Kim REP 105. Has a suggestion.
- Any maritime packages that handle geos?
- Rhys: based for locally coordinate systems
- TF2 has a suggestion, but switching between coordinate frames is not great. (maps).
- There is no packages that handles geo great
- Rhys: arduplot dds support. Better maritime simulation. Quadplans landing on ships.
- Planning over larger distance, curvature, switching between global and local map.
- Kim When need to use geo coord. Or local?
- Rhys: terrain database needs to be accurate. Shifting happens between navigation.

Current state.

- Shift from one frame to another, coordinate transformation is important.
- This is handled manually, tf2 doesn't use this automatically.
- Ryan: GPS receivers now report WGS-84 as frame id. Not accurate for the earth, other use the gravitational field..
- Some other GPS receivers use different frames, and then datum conversion is complicated.
- Rhys, why is it so difficult?
- Ryan: This could be something the autopilot could do, the autopilot need to know where it is. Difficult to rely companion computer.
- Kim: Regulation is difficult if not fool proof

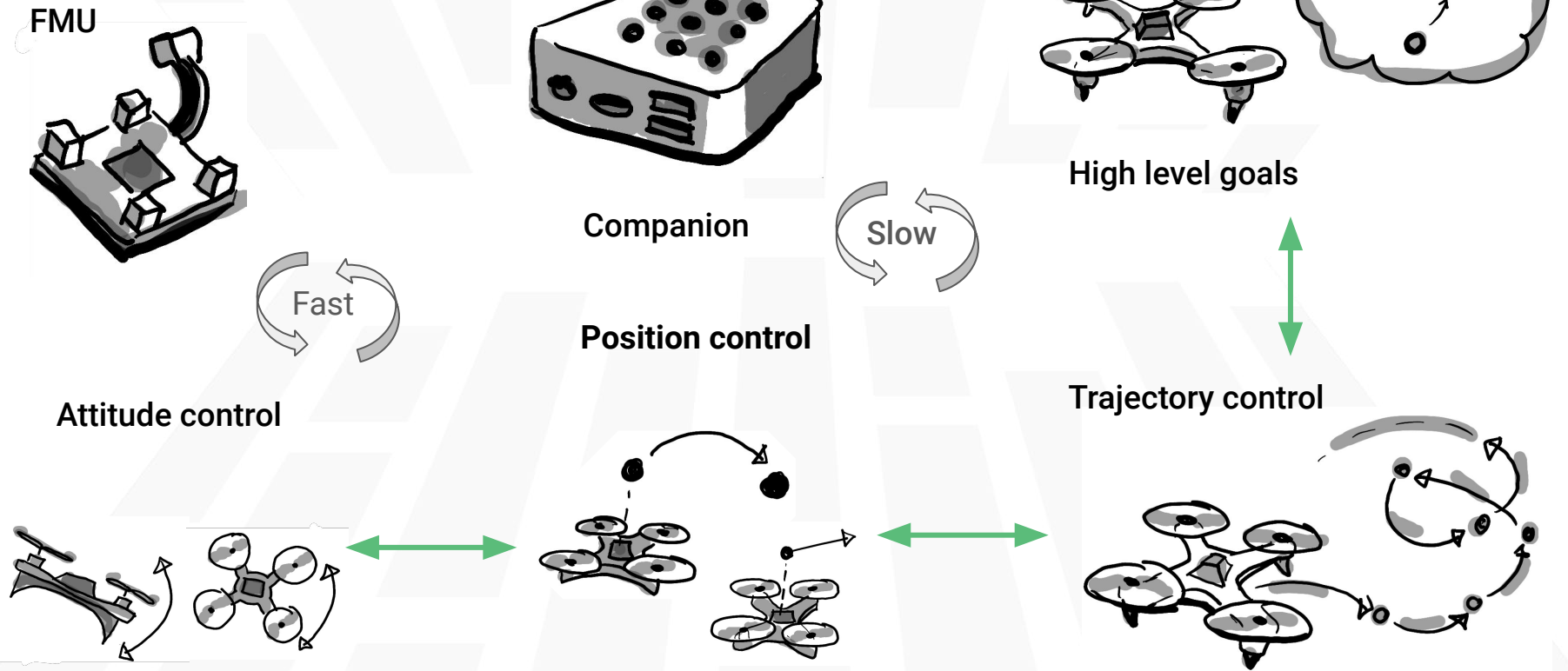
Current state

- Trimble PS1, WGS84 EGM96, only supports two. Terrain data can be in different formats.
- Mayank, Specify the platform as well. Fixed wing has limited dof.
- Mayank, would be important to specify at which distance the curvature becomes important.
- Ryan: relative to home attitude is on most autopilot suites. Kind of solves the problem
- Concrete usecase would be drone delivery. Maybe for dropping packages
- 400 feet that you can be from the ground (gps 40 meters inaccuracy). Then it really becomes problem. Especially with varied terrain, this is too difficult for the autopilot. (mountain issue...)
- Mayank: see cool video
<https://www.youtube.com/watch?v=EJWyGSqaKb4>

Burden of autopilot suites

- For navigation, what should autopilots handle and what should ROS packages handle (on a companion computer or offboard).
- **Companion:**
 - Complex flight manouvers to avoid airspace or obstacles
 - Perception, camera data (slower)
 - FMU does not have RAM
- **FMU**
 - Faster loops (altitude control/ attitude control / position control)
 - Safety
- **Both**
 - Operation space constraints: terrain, geofence, airspace constraints, max velocity
 - Localization in space
- **Interfering systems.**
 - Which overrides the other?
- **Unknown**
 - Where does the datum translation happen. GPS, Autopilot, companion or all three?

Mary breaks down levels of control



Indoor versus outdoor navigation

- Who consider themselves indoor or outdoor?
- Indoor doesn't worry about the curvature of the earth
- Outdoor have GPS RTK
- Outdoor more natural features
- Indoor have to use mocap, slam etc..
- Indoor Can't always put a system in place.
- Outdoor have to handle with wind.
- Outdoor more strict regulation
- Indoor are around people usually
- Outdoor usually less people
- Indoor more obstacles static and dynamic
- Outdoor: risk of fly aways need a lot of redundancy in safety.
- Outdoor more static obstacle

Standardization

- Difficult to coordinate autopilots for ROS
- Where to apply standardization? What needs attention.
- Goal.
- Goal vs waypoint: goal is end location you want to be at and a vector you want to
- In Rviz only 2d goal in nav2
- Assumption of datums. MAVlink messages doesn't say which format. WGS84 is the assumption but it is not great also not mentioned.

Anything else?



Topics

- *Autonomy stacks for UAVs (Done)*
- Autopilot suites for UAVs
- *Aerial robotics simulation (Done)*
- *Message standards for UAV (Done)*
- *Communication for swarms of UAVs (done)*
- Safety and management systems
- *Tutorials and education (done)*
- Legality and airspace access
- *Hardware, Components, and Dev Kits (done)*
- Aerial Vehicle Types
- *Planning in 3D (Done)*
- Any more... ?

Upcoming meetings



Next meeting

Presentation meeting about **Ardupilot and ROS** by Ryan Friedman!

- Wednesday **6th of December** at **3 pm UTC**

Github organization for this working group: <https://github.com/ROS-Aerial>

- Aerial robotics landscape: Add a info page if you like
- Community: Add yourself as member

Wanna do a presentation? Email to kimberly@bitcraze.io & rroche@linuxfoundation.com