auterion

Frontier of Computer Vision

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DISCUSSION

Who has done CV development?

(even toy projects)

Computer Vision - Motivation

- Enables autonomy
- Rich, high bandwidth sensor data
- Easy for humans to understand the raw data

Computer Vision - Current Industry Status

On drones, CV functionality is limited to roughly:

- Collision Prevention
- VIO
- Follow-me tracking or other use-case specific applications

Computer Vision - Current Industry Status

On drones, CV functionality is limited to roughly:

	The cheap, lightweight (sometimes more reliable) solution
• Collision Prevention	SONAR / laser distance sensors
• VIO	On-chip Optical Flow (think optical mouse)
• Follow-me tracking	Target GPS tracking

Computer Vision - Current PX4 Status

On drones, CV functionality is limited to roughly:

- Collision Prevention ✓
- VIO ✓
- Follow-me tracking

The cheap, lightweight (sometimes more reliable) solution

- SONAR / laser distance sensors ✓
- On-chip Optical Flow (think optical mouse) ✓
- Target GPS tracking ✓

Computer Vision - What can it do

- Human use of vision
  - Localization
  - Recognition and object tracking
  - Environment awareness & map building
  - Minimum risk path planning
  - Safe stopping locations
  - Facial expressions, body language

Computer Vision - What can it do

- Academic projects, but not industry:
  - SLAM - build maps and localize the robot dynamically via the robot's movement
  - Safety analysis beyond simple landing systems
  - Object classification
  - Playback of exact flight paths based on visual markers
  - Learned safe flight patterns from dashcam videos
  - Accurate landings on dynamic platform
  - Many many more

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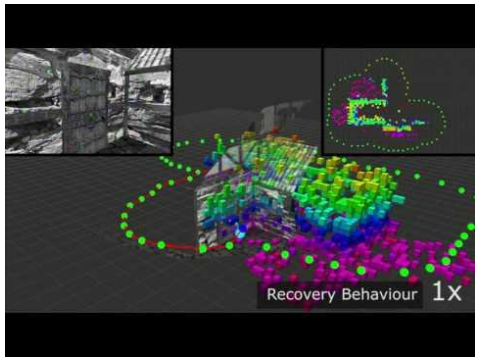

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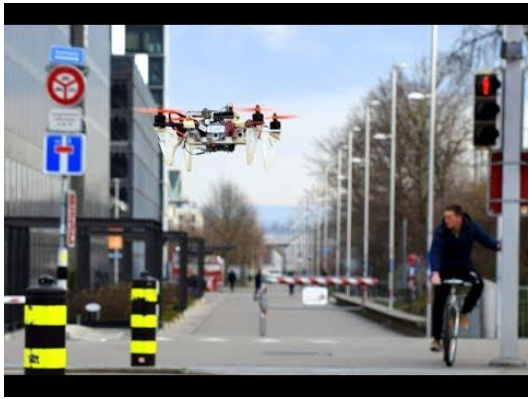


Computer Vision - Why isn’t it everywhere

Expensive

- Weight
- Power
- Hardware prices

These are being solved in newer hardware generations

Computer Vision - Why isn’t it everywhere

Reliability

- Depends on lighting conditions

Historical deployments of CV/ML systems are in controlled environment

- Eg. factory assembly lines for component alignment and QA

Partially solved with better cameras - industrial still catching up with consumer

- Active sensors - IR pattern projectors

Computer Vision - Why isn’t it everywhere

Other problems:

- Concentrated R&D Costs
- Systems are complex and require large upfront investment, with risk of failure
- Customers and regulators don’t trust black boxes

Open Source solves these problems

Computer Vision - So what are we waiting for

- Purpose designed hardware
  - Higher bandwidth between FCU and companion computer — WIP
  - Cheap enough to deploy in scale — Depending on platform
  - Widely available — Depending on platform
- The frameworks to effectively re-use libraries
  - Reliable PX4 ← → ROS[2] communication — ROS1 works, ROS2 WIP
  - Integration of vision interfaces into PX4 architecture — Works, but extensions missing
  - Making vision components with better integration — WIP

DISCUSSION

Who has ideas for CV projects they’d like to see integrated into or created for the PX4 ecosystem?

Computer Vision - Features I’d like to see

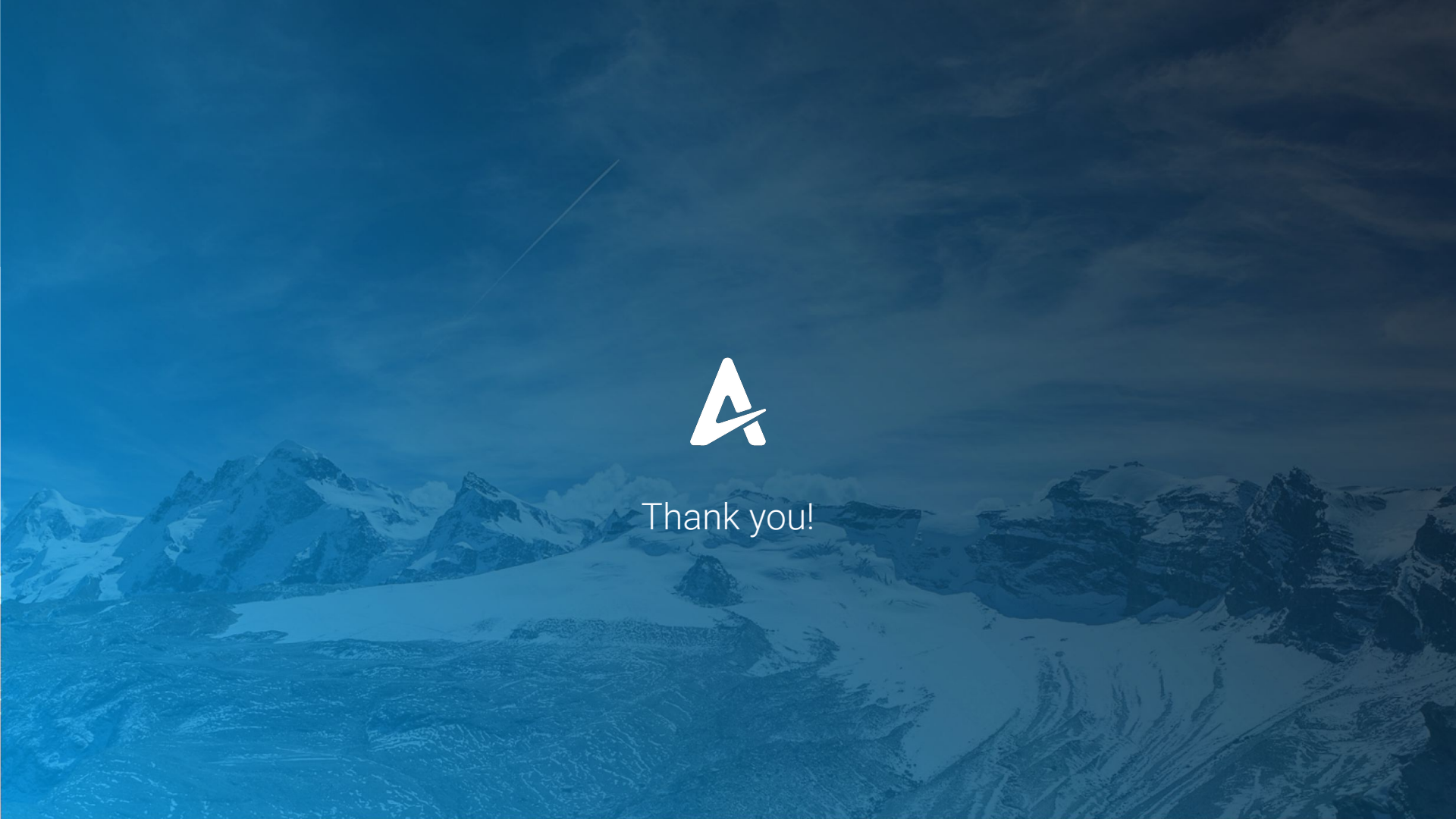
- Minimum risk path planning
- Full SLAM with collision prevention in position mode
  - Give pilot additional environmental awareness based on generated map
- RTL following visual landmarks if GPS is lost, including precision landing
- Structure following for inspection
- Full integration of compatible ROS[2] packages with PX4

Computer Vision - Integrating with the FCU

- Offboard mode - great for research, poor for end users
- As of 1.9 we can inject trajectories while in *auto* modes
- Integrating more fully requires PX4 flight mode awareness
    - Make a standard ROS[2] node to do this

Conclusions

- Computer vision is hard, but the community can help
- Hardware is finally good enough for (some) drones
- We still need to customize things, the software isn’t just ‘plug and play’


Thank you!