NVIDIA GPUs and Drones

A PRIMER ON INTEGRATION WITH PX4 AUTOPILOT

NVIDIA Jetson Orin GPU-accelerated Stereo VIO in PX4 EKF2 using Isaac ROS2 & uXRCE-DDS

PX4 autopilot + ROS 2 +

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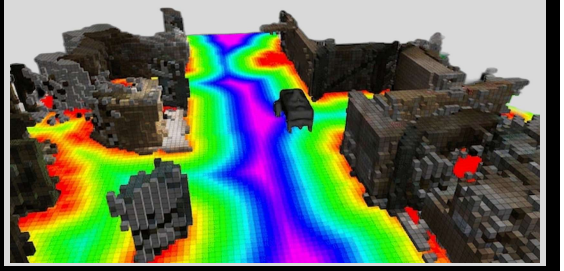
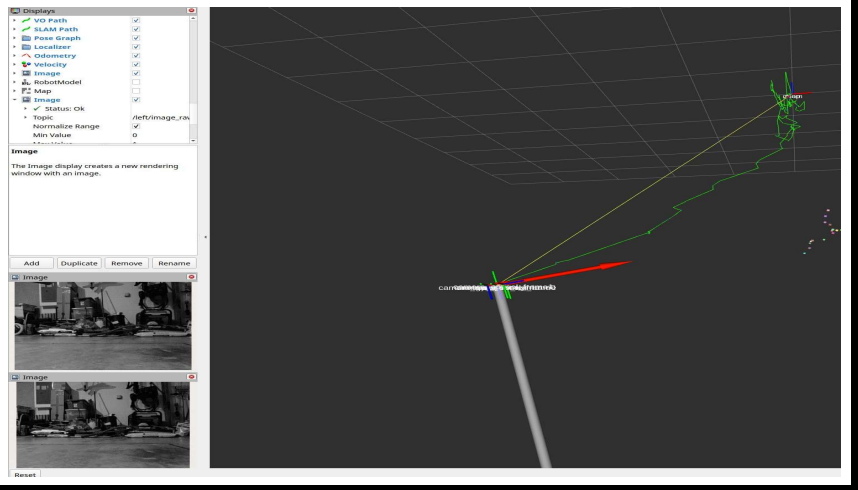
Principle Engineer
Ascend Engineering

Why a **NVIDIA** Jetson for my PX4 drone?

Real Time Mapping



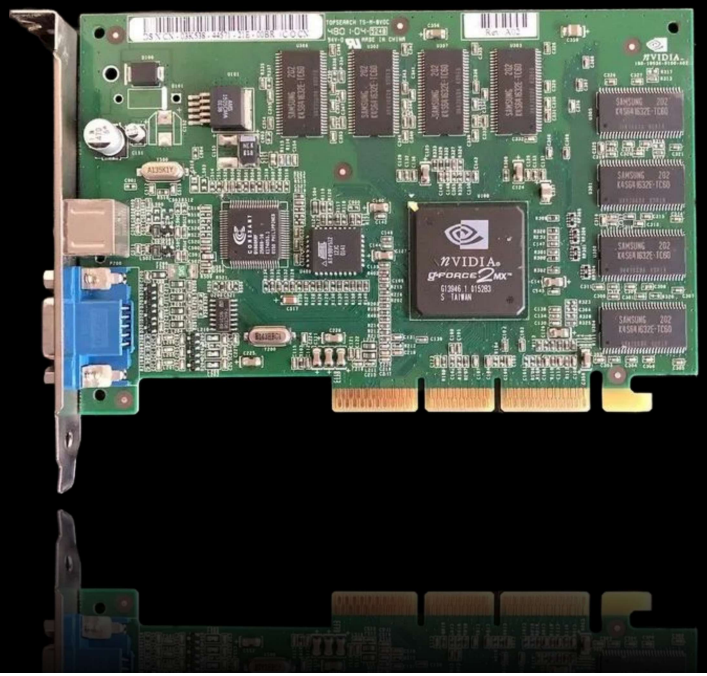
Odometry (VIO)



Fiducial Marker

My First **NVIDIA** GPU

- NVIDIA GeForce2 MX 200
- Graphics cards/3d accelerators for PC gaming



NVIDIA History

GPGPU FOR ROBOTICS

From Data Centers to Physical Robots

1993 — NVIDIA is Founded

1999 — The First GPU GeForce 256

2018 — Jetson AGX Xavier

2019 — Jetson Nano

2021 — NVIDIA GPGPU Powers Robotics

2022 — Jetson Nano Orin / NX

2023 — Isaac ROS Announced

2024+ — Toward General Robotics

1993 — 1999 — 2018 — 2019 — 2021 — 2022 — 2023 — 2024+

ISAAC ROS MILESTONES

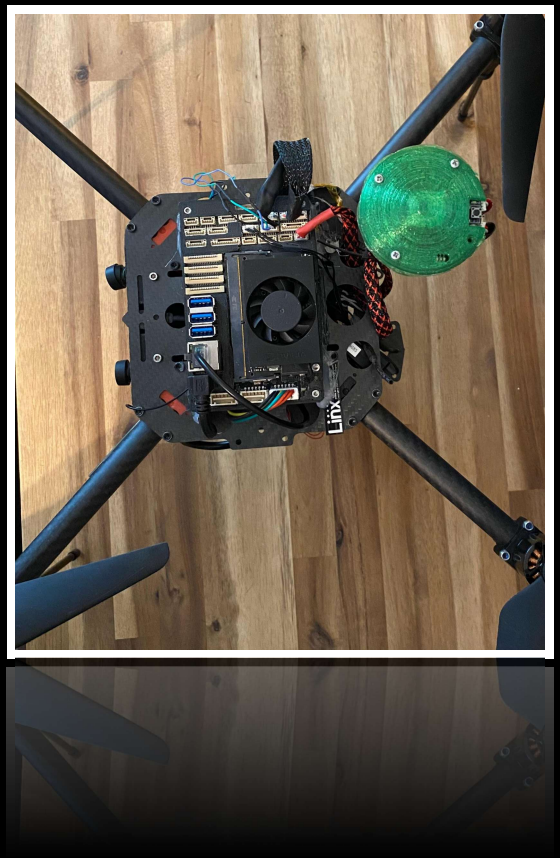
2023 — Isaac ROS 1.0

2024 — Expanding Ecosystem

Future — Open. Accelerated. Robotics.

Why PX4 Autopilot?

- uORB Pub-sub internally
- uXRCE-DDS Pub-sub externally (ROS2)
- DDS Topics YAML
- PX4 MSGS



Hardware

- Ark Jetson PAB: with ARK FMU V6X, NVME SSD, and Wifi M.2 module , Jetson Orin
- Intel Realsense D455/D435i or other similar stereo camera
- 450-650mm wheelbase drone (capable carrying 500g payload)
- 7x9 or 6x8 checkerboard pattern for camera calibration (if not using realsense)

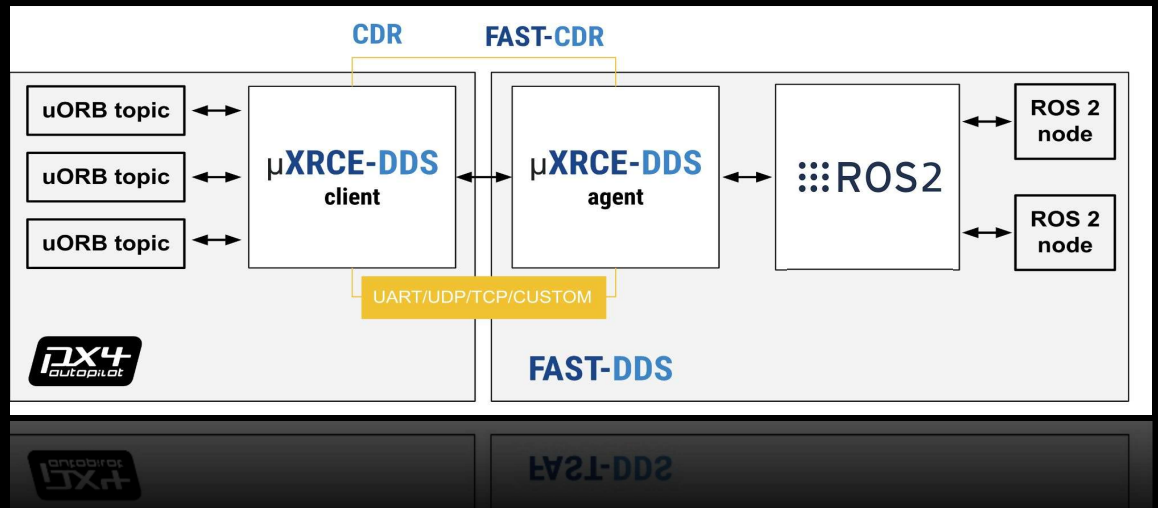
Software (VIO)

- Jetpack 6.2 (cuVSLAM will not work with < 6.2)
- Isaac ROS common release 3.2*
- Isaac ROS visual slam release 3.2*
- Isaac ROS Nitros release 3.2*
- PX4 msgs*
- Magic enum* (if isaac ros docker has issues finding magic enum dependencies)
- RVIZ 2/Foxglove for visualization

**NVIDIA Isaac ROS overlay workspace*

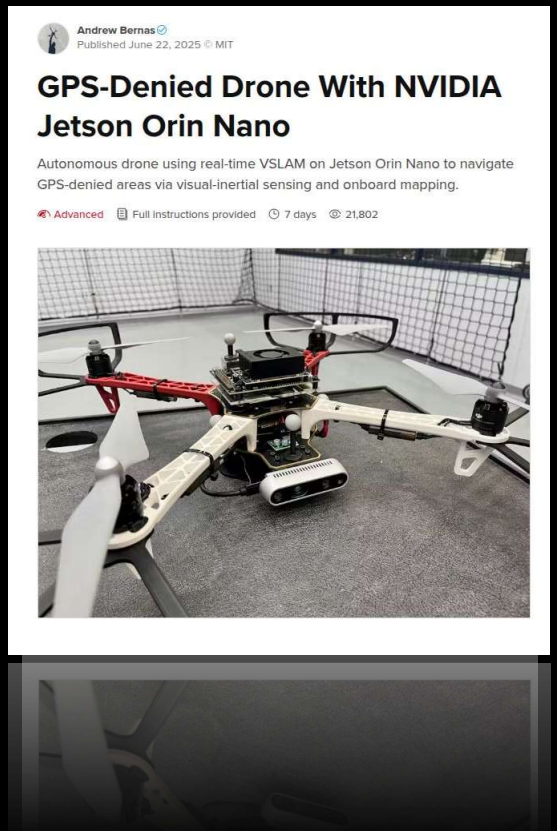
Software (VIO) *continued...*

- Nvidia container toolkit (for docker)
- ARK OS (needed for **uxrce dds agent**)
- Allan ROS2 for determining IMU noise parameters
- PX4-Isaac-VIO-Bridge (courtesy of Jacob Dahl from ARK Electronics)



This Has Been Done, But it is Not Easy

- Bernas uses MAVROS
- Realsense D435i
- Standalone Jetson



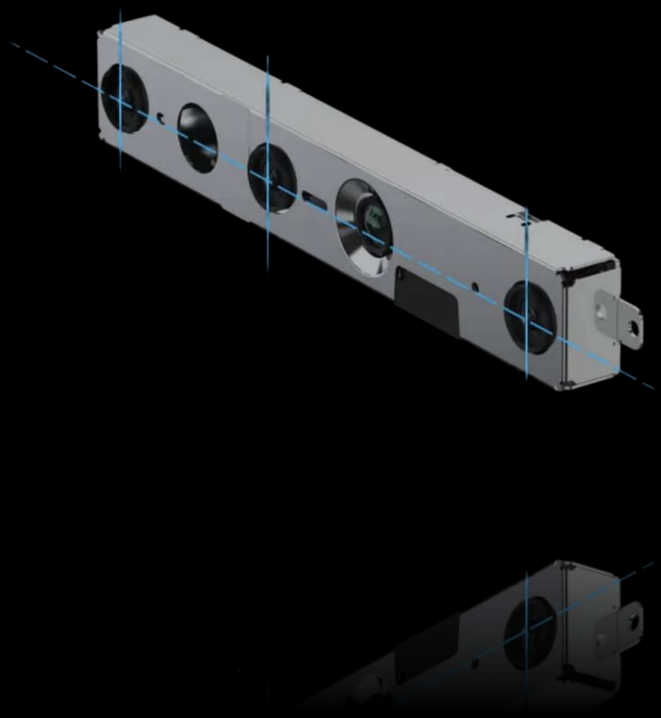
Andrew Bernas

Hackster.io

Common Issues with Isaac ROS Visual SLAM

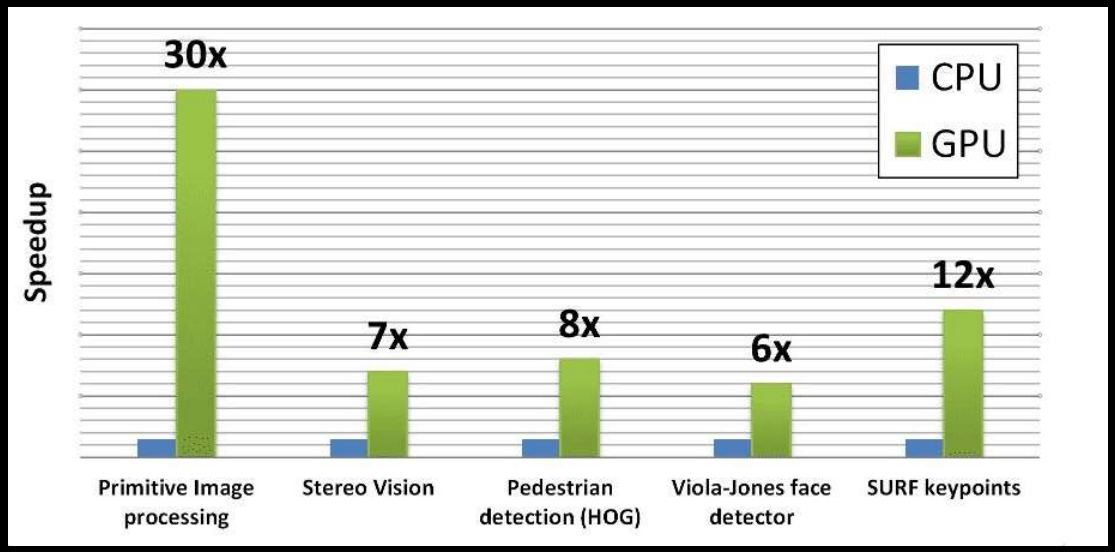
Headaches

- Nvidia proprietary libraries
- Release 3.2 does not support RGBD, mono-inertial, only stereo pairs
- Gravity vector not correct due to transform issue (imu frame)
- Building issues due to Isaac ROS dependencies (over 70 packages) -Isaac ROS Nitros!
- Camera calibration and IMU noise param issues
- PX4 VIO parameters not set correctly
- Running RVIZ 2/FoxGlove during flight!



Other VIO Stacks try to on the Jetson

- ORBS AM3 mono-inertial, stereo-inertial, or RGB-D
- Kimera-VIO-ROS2
- These stacks aren't GPU dependent, but you can accelerate using OpenCV CUDA or CV-CUDA
- Pycu SLAM (can use RGBD!)



Thank You

Questions?

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NVIDIA.

A TIMELINE OF INNOVATION

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NVIDIA. ONE ARCHITECTURE. ENDLESS POSSIBILITIES. FROM PIXELS TO INTELLIGENCE.