NORTHROP GRUMMAN

GAME OF DRONES

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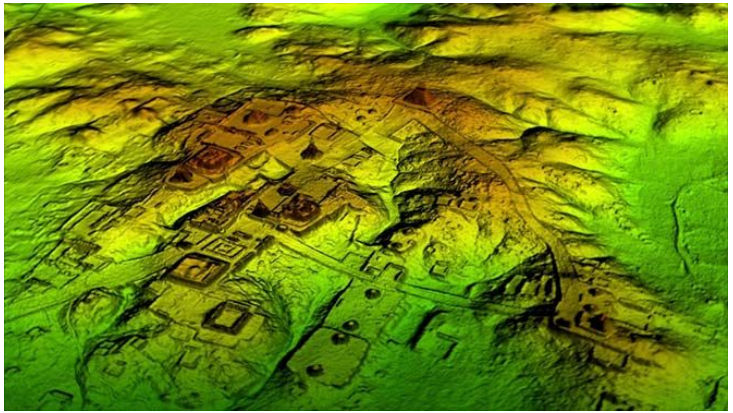
Motivation

- Easily create a 3D map of an unknown area in a cost efficient manner
- Current solutions are expensive or have limited precision

Global Application

- Drone with LiDAR (Light Detection and Ranging) used to uncover Mayan city below Guatemalan jungle

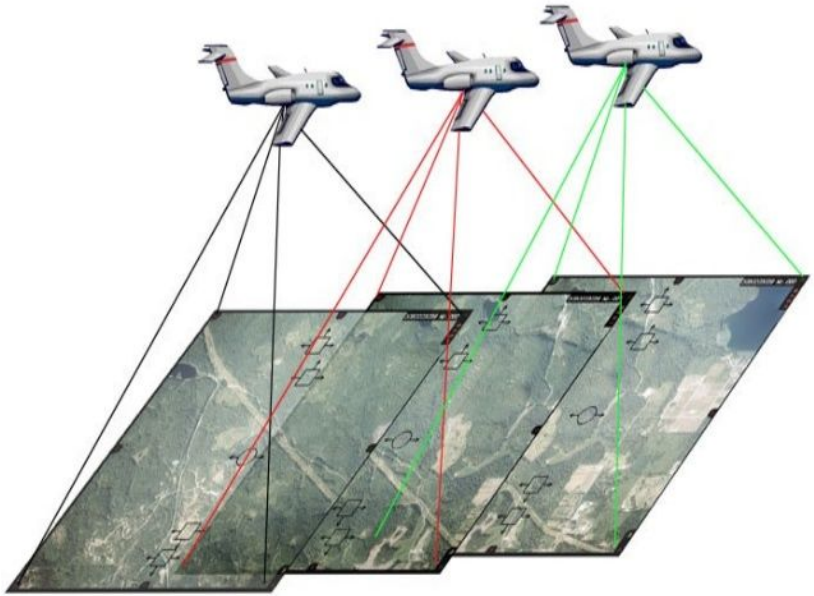


http://gpsworld.com/lidar-and-uav-reveal-maya-megalopolis-below-guatemalan-jungle/

Local Application

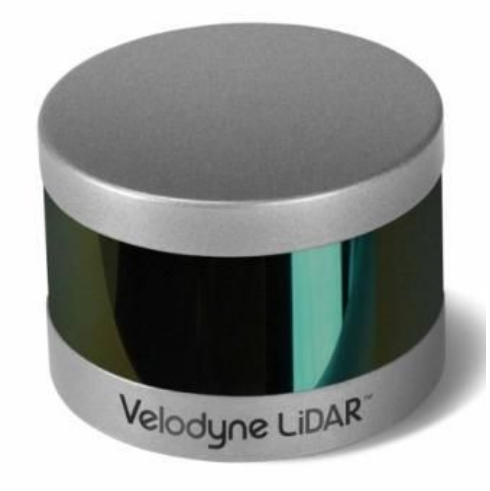
- Cliff erosion in Isla Vista
- Mudslide damage in Montecito

Current Solutions: Photogrammetry



- Makes measurements using photographs
- Can overlay map with best attempt at 3D model
- Lacks accurate terrain features like height of a hill

Current Solutions: LiDAR

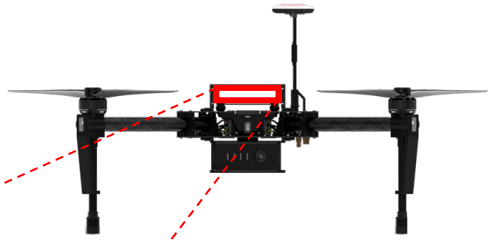


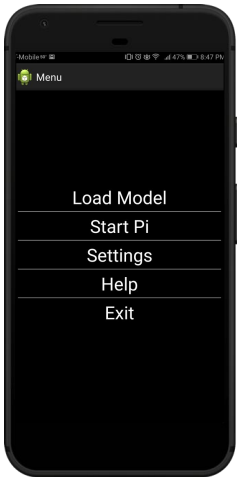
- $4,000 for Velodyne LiDAR
- Standalone piece of hardware
- Highly accurate
- Outputs 3D map without need for any other equipment

Our Solution

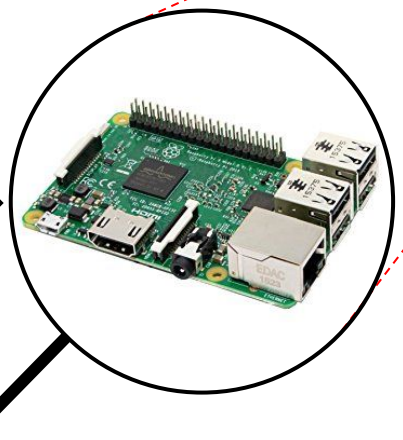
- Uses a $350 LiDAR sensor with limited functionality
- Builds 3D map from 2D LiDAR data
- Integrates with Raspberry Pi and DJI Matrice 100 drone
- Cost efficient solution with many applications

System Architecture



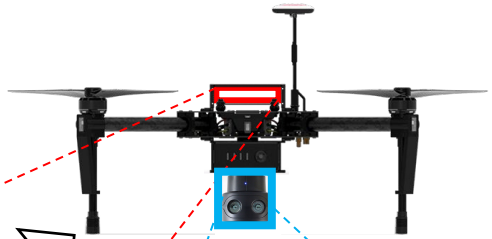


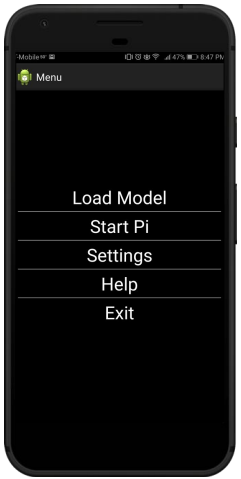
Start System



Send start command to Pi

System Architecture





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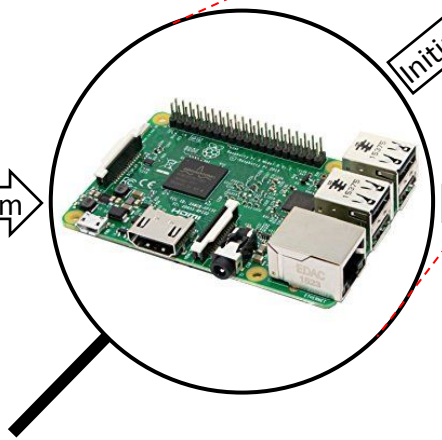


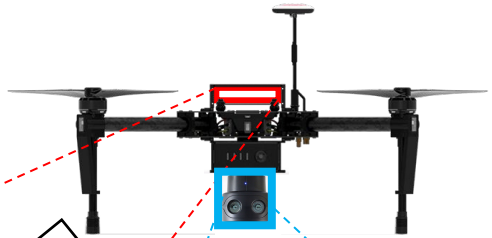
Initiate Telemetry

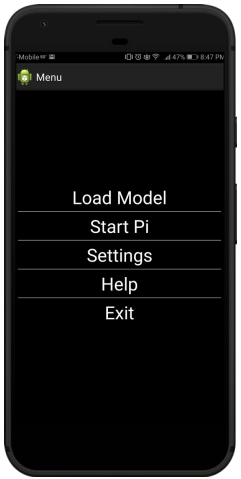
Initiate LiDAR

Send start command to Pi

Initiate LiDAR and telemetry data collection

System Architecture





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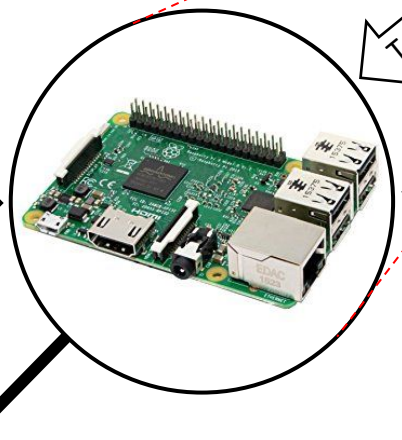


Telemetry Data

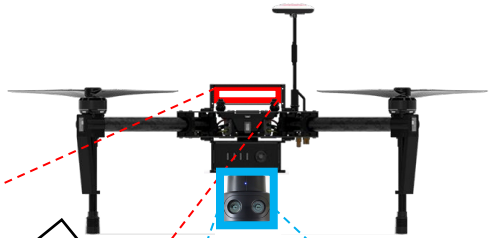
LiDAR Data

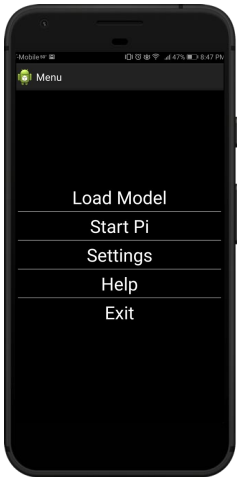
Send start command to Pi

Initiate LiDAR and telemetry data collection

Combine and transform data into coordinates

System Architecture





Telemetry Data

Coordinates

LiDAR Data

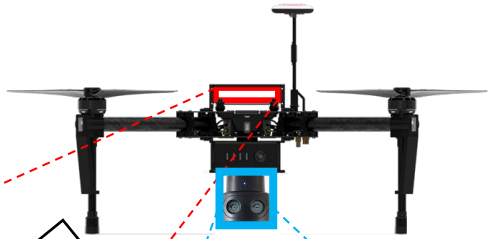
Send start command to Pi

Initiate LiDAR and telemetry data collection

Combine and transform data into coordinates

Send batch of coordinates to Android

System Architecture



Telemetry Data

Coordinates

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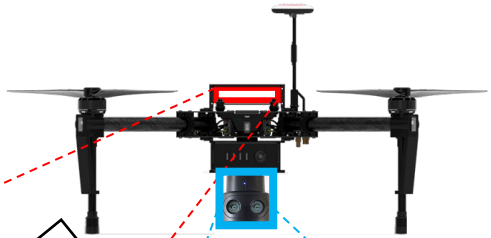
Refresh viewer

System Architecture



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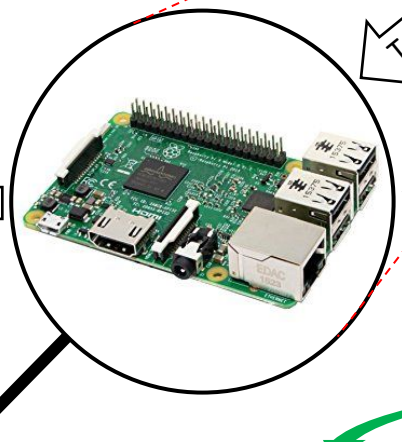

LiDAR Data

Send start command to Pi

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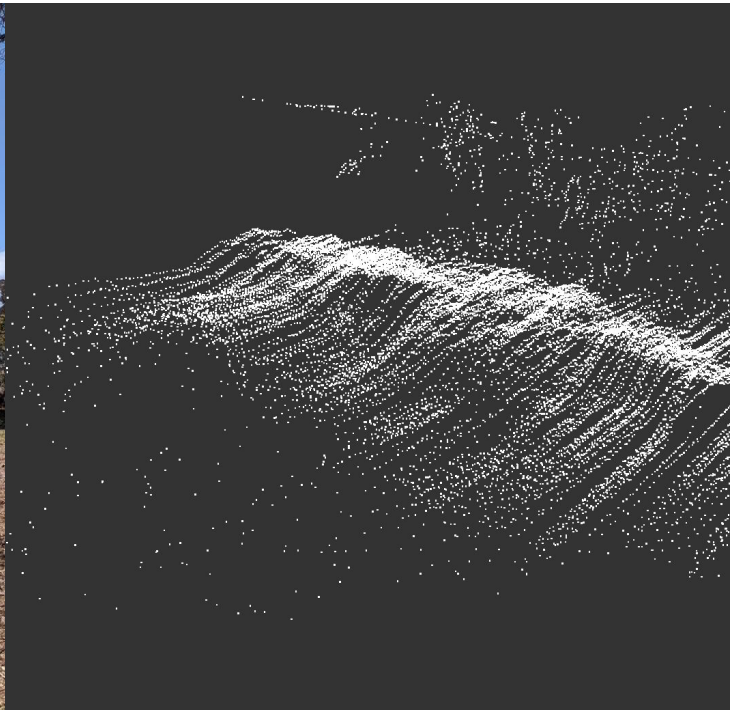
Refresh viewer

Demo - Mapping Mounds

Demo - Results



The Process

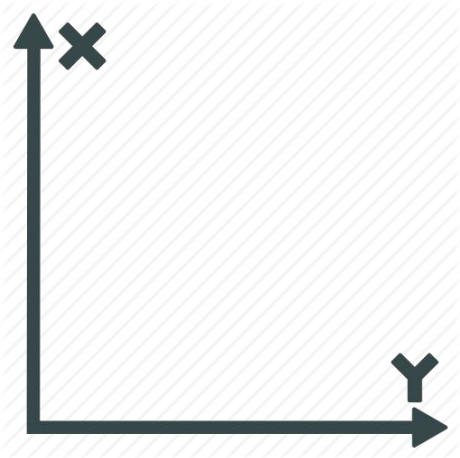
How it’s all possible

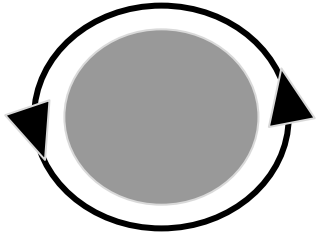
Three Coordinate Systems

- LiDAR - Relative to the LiDAR Sensor
- Drone - Relative to the Drone itself
- World - Relative to the Drone’s launch position

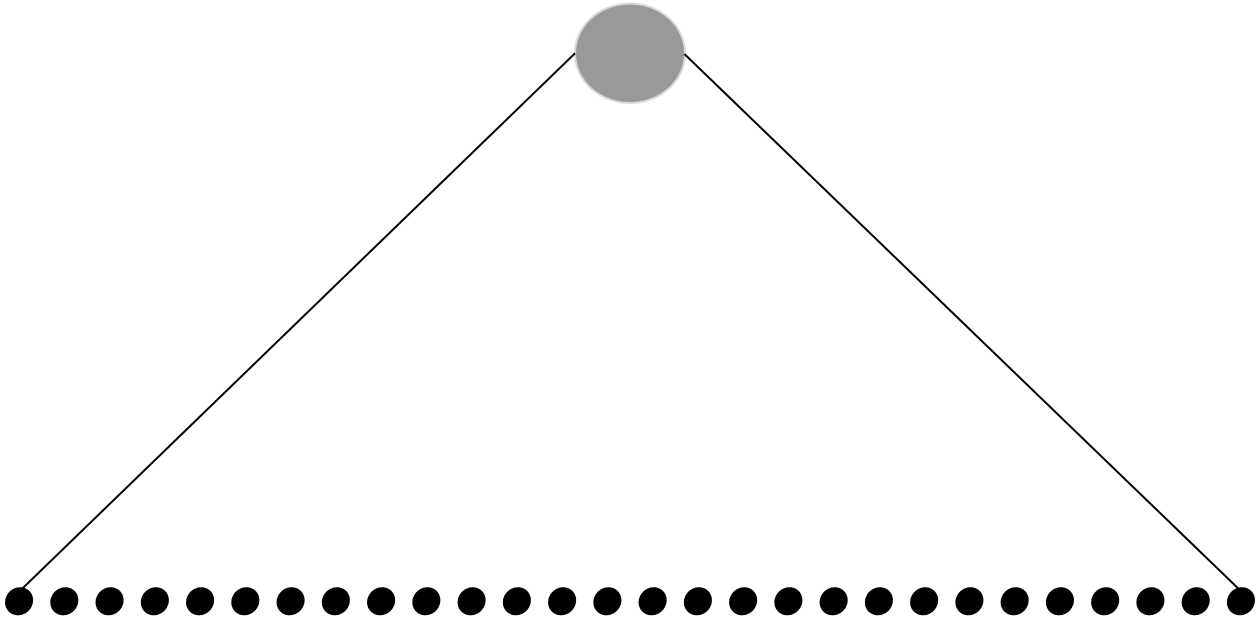
The LiDAR

A two dimensional sweep





The LiDAR



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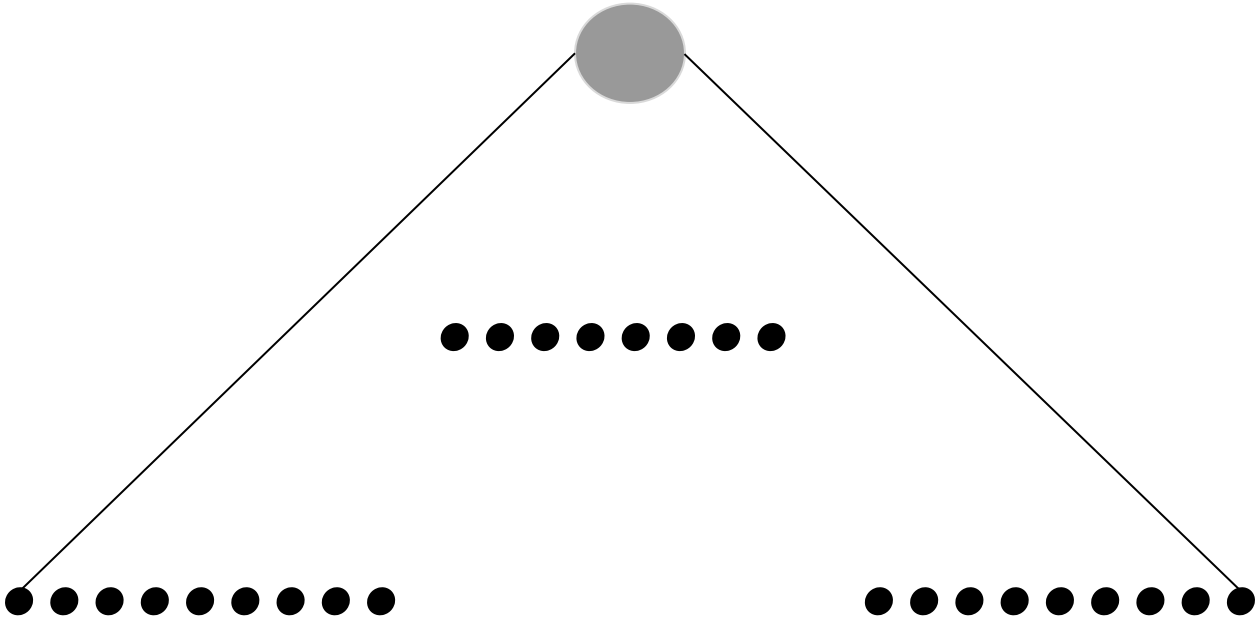
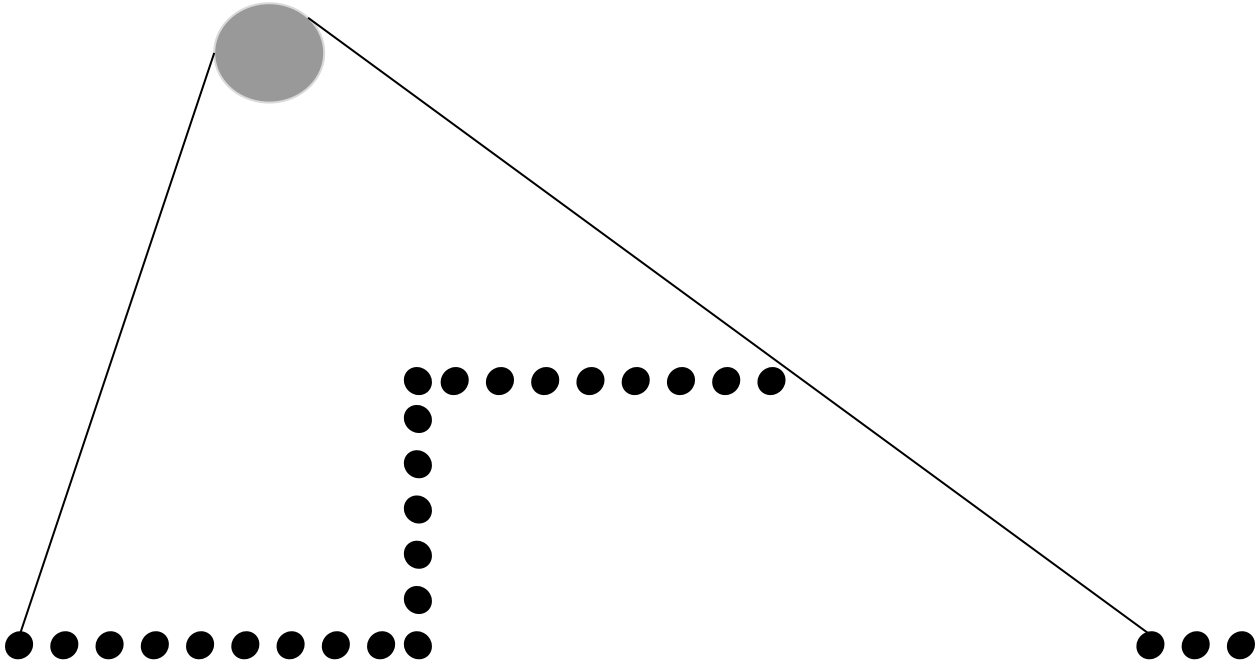


The LiDAR



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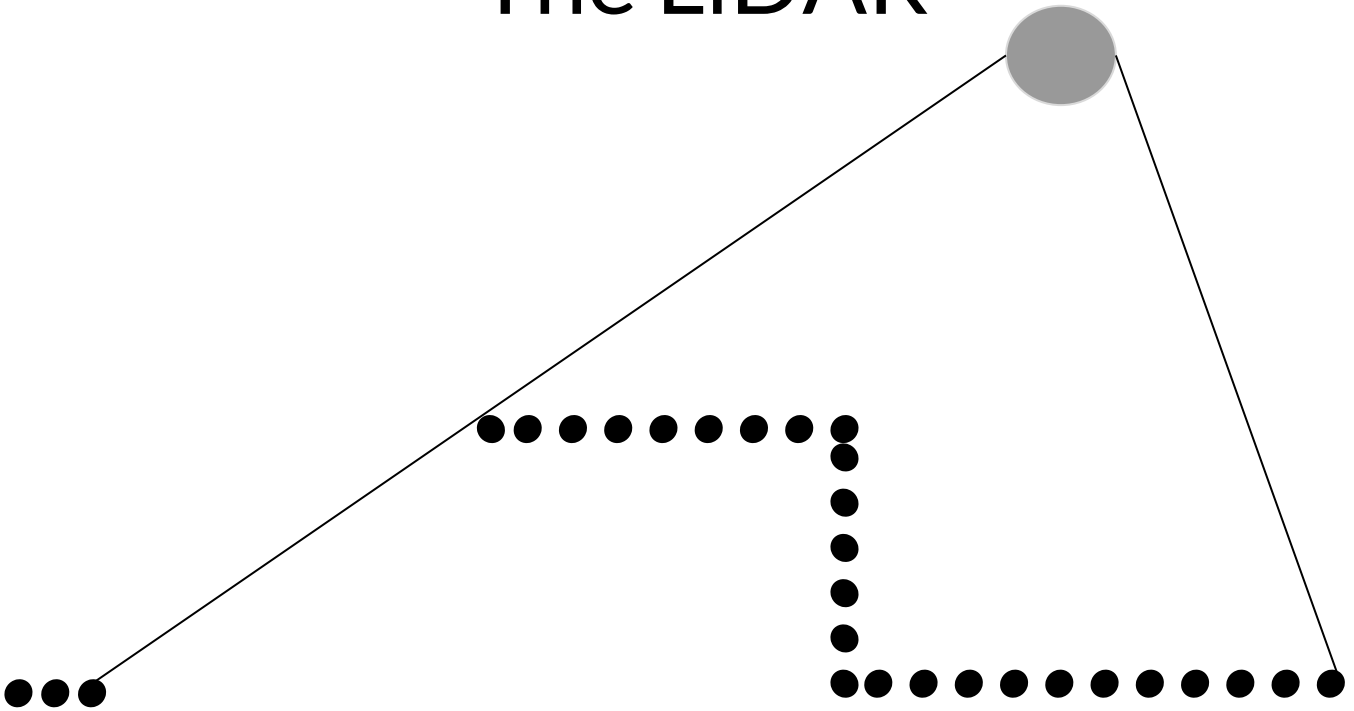
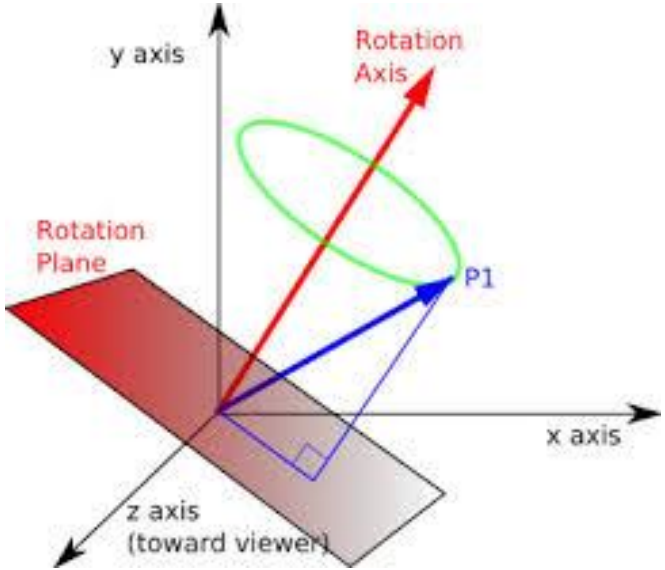


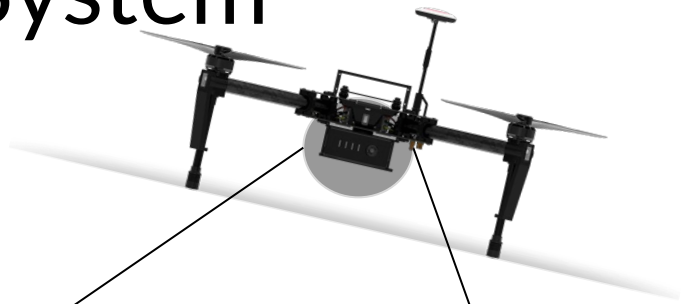
The LiDAR

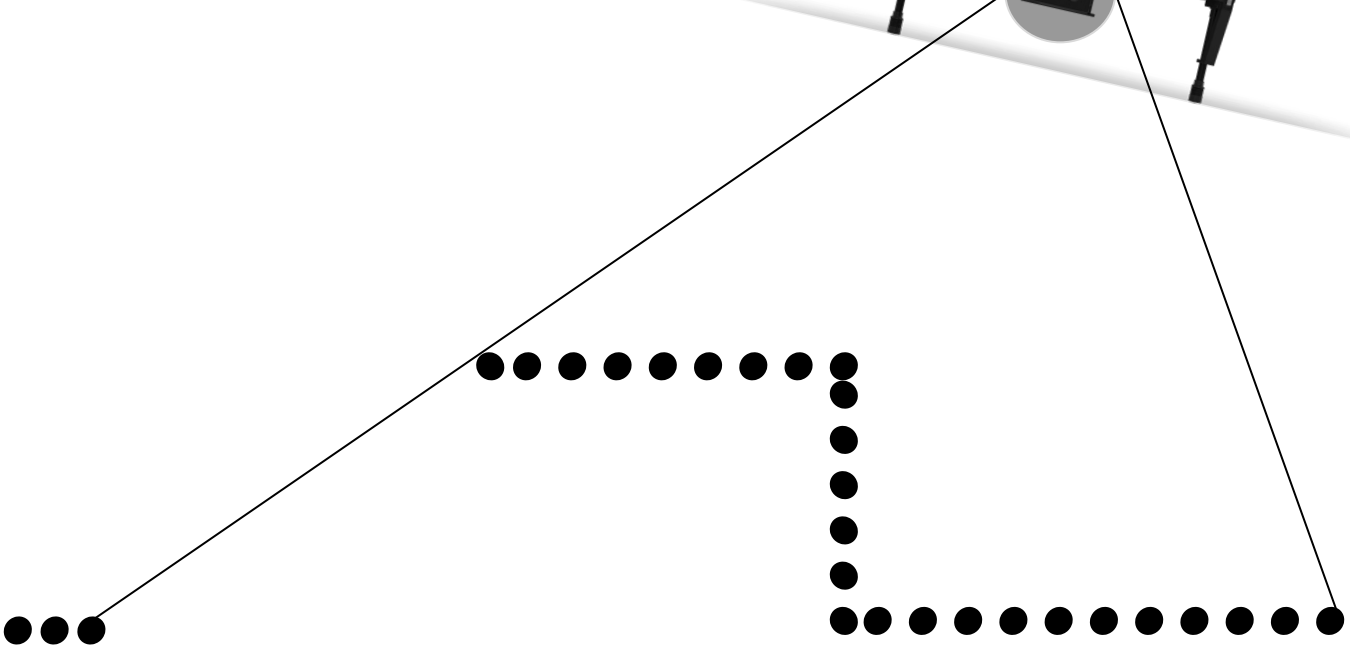
Drone System

Roll, Pitch, and Yaw

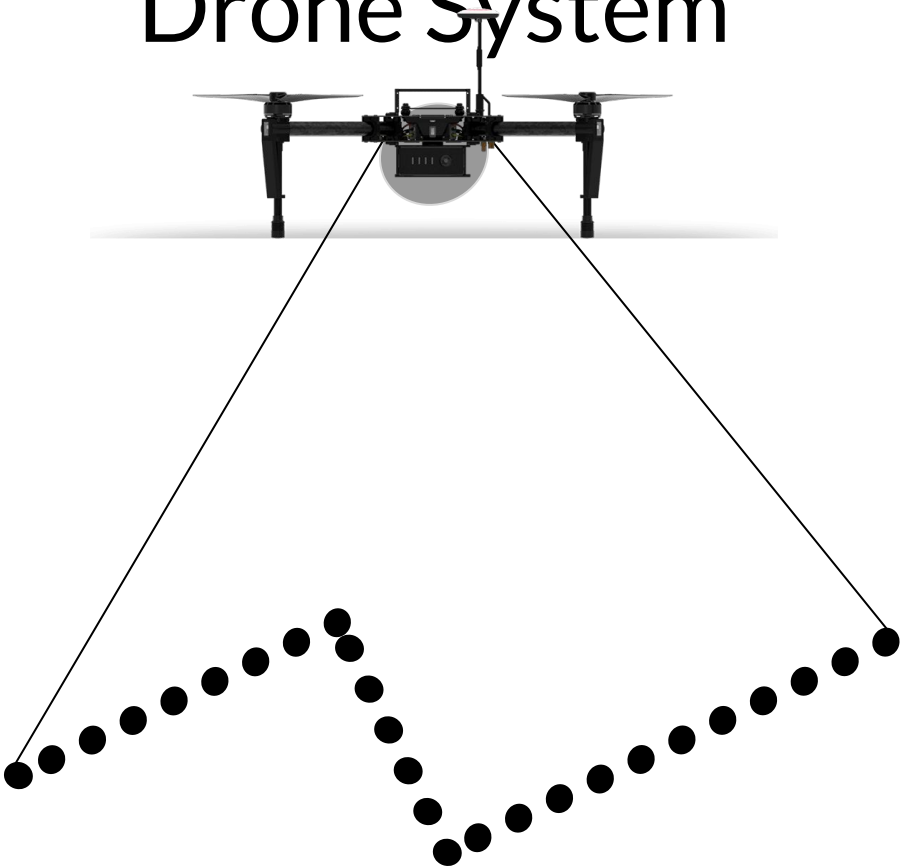


Drone System





Drone System



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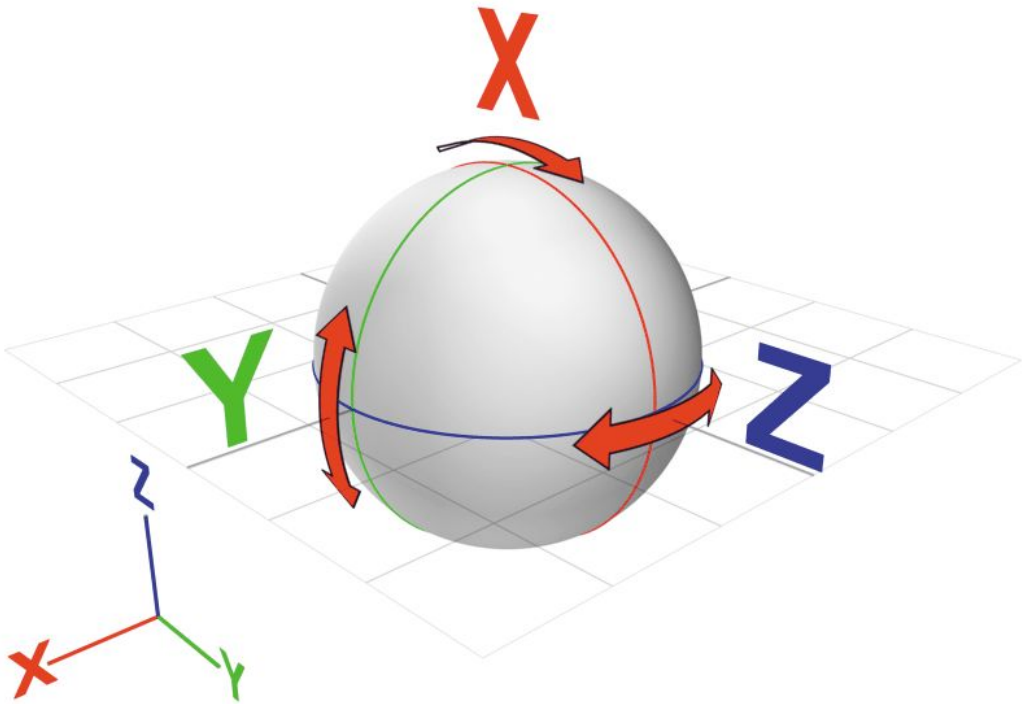
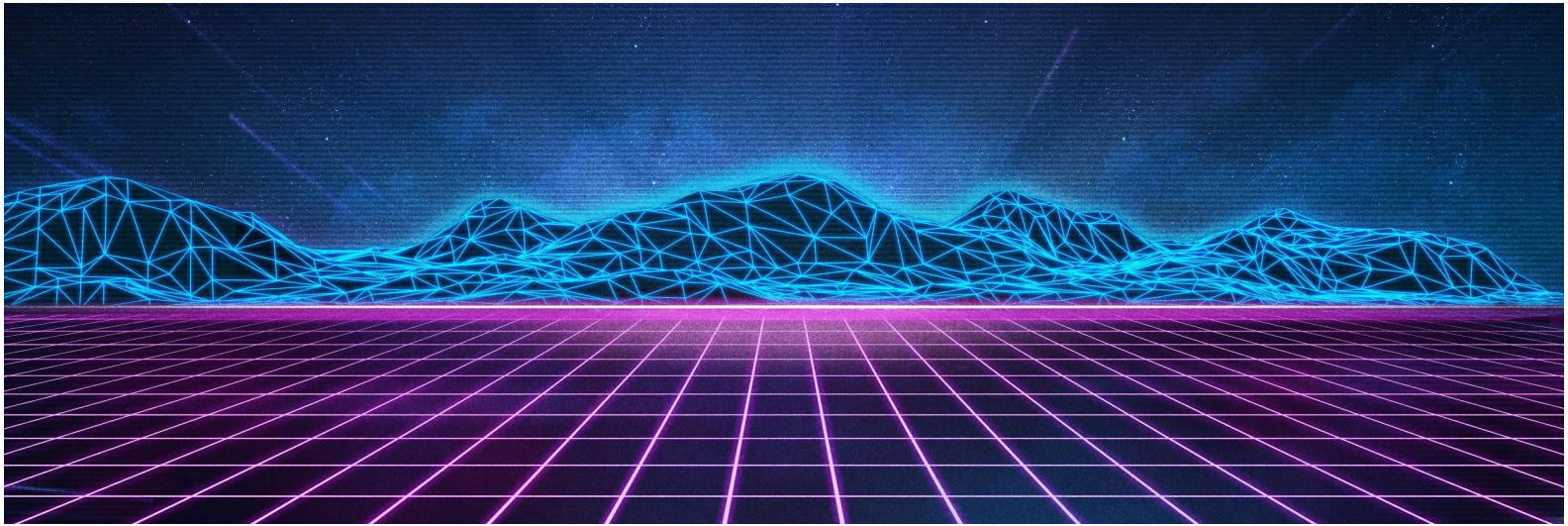


The World System

Combining data
with respect to the launch point



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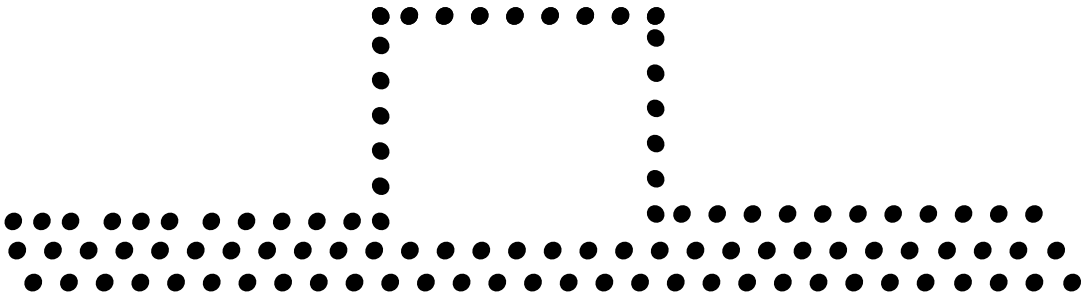

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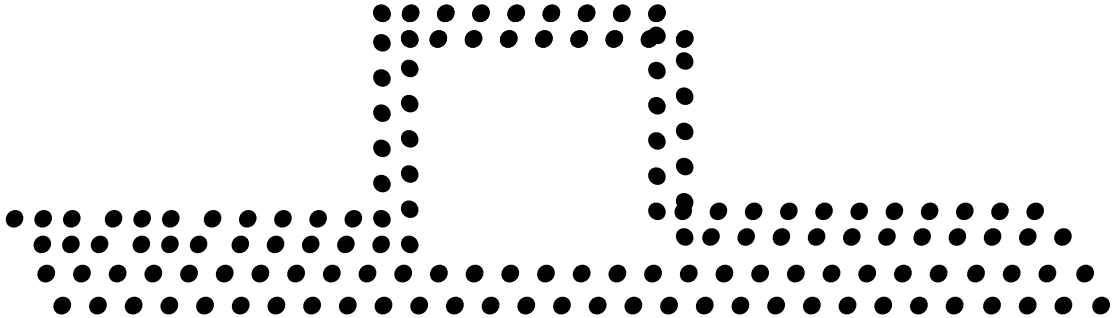

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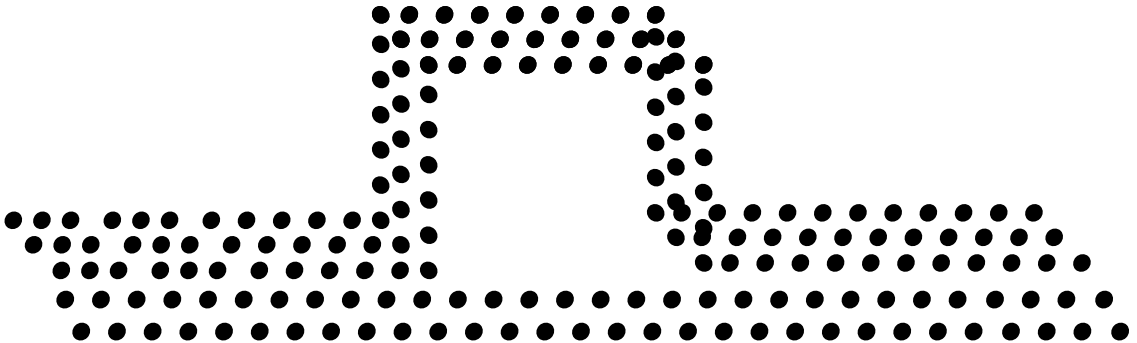

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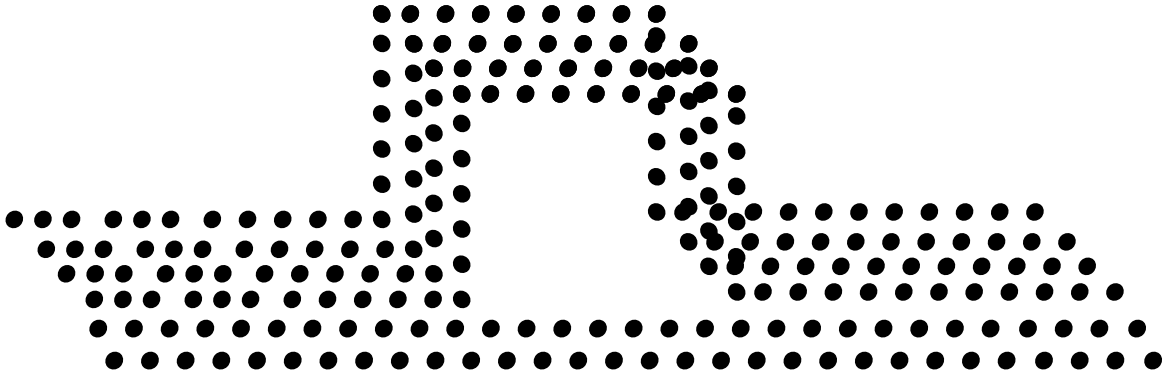

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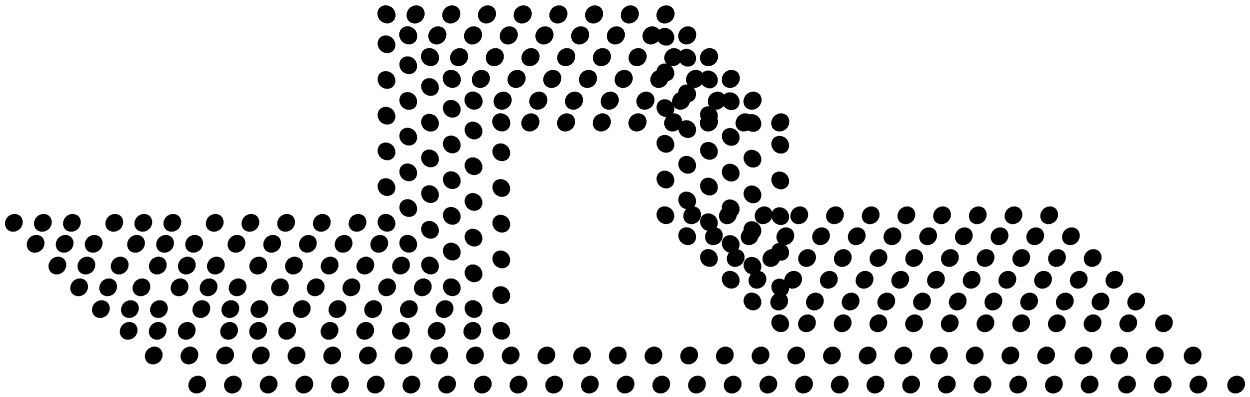

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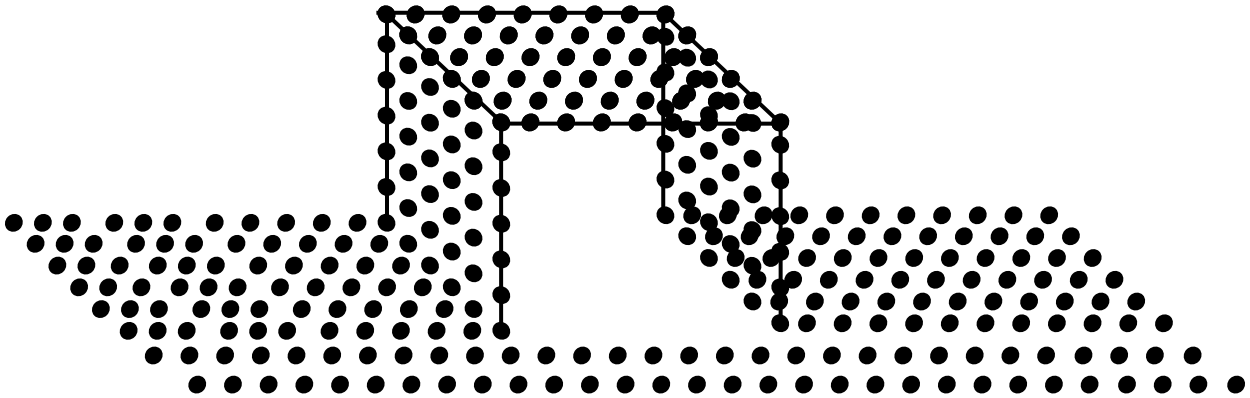

Future Work

- Autonomous flight integration with mobile app
- Stitch multiple maps to create a larger map
- Terrain history for landmark changes
  (e.g. eroding cliffs)

Special Thanks To:

Cal Cluff, Ben Davies, Samantha Demonte, Andres Oviedo, Chandra Krintz, Christopher Kruegel, Chris Salls & Steve Bako

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Any Questions?