Surfzone Bathymetry Estimation using Unmanned Aerial Systems
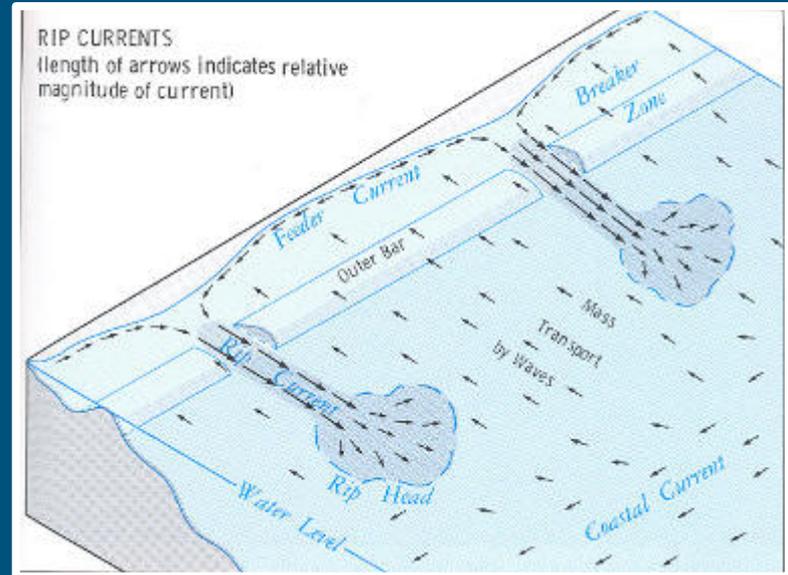
Jesse McDonald
Jason Pollard

Introduction

- ❑ Bathymetry
    - ❑ Measurement of water depth
        - ❑ Oceans, seas, or lakes
    - ❑ Sandbars
- ❑ Motivation
    - ❑ Surveying
    - ❑ Beach conservation research
    - ❑ Rip current detection
        - ❑ 80% beach fatalities
        - ❑ 100x more dangerous than shark attacks


Rip current bathymetry
http://www.ripcurrents.com/ripcurrents101.html

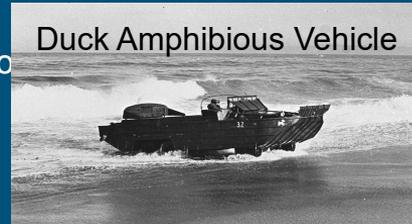# Limits of Traditional Methods

- ☐ Sonar
    - ☐ Requires large ship
    - ☐ Thrown off by waves
    - ☐ Too large for surfzone

- ☐ Traditional Surveying
    - ☐ Slow, Tedious, Expensive, Dangero
    - ☐ Equipment is expensive
    - ☐ Higher environmental impact

- ☐ Lidar
    - ☐ Requires crystal clear water
    - ☐ Water bends light
    - ☐ Waves are even worse


https://gisgeography.com/mapping-the-ocean-floor-water-bathymetry-data/
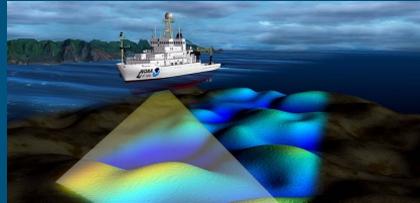
Duck Amphibious Vehicle

https://www.tankmuseum.org/home

Coastal Research Amphibious Buggy
C.R.A.B

http://www.frf.usace.army.mil/crab.html

3

Introduction

- ❑ Wave Bathymetry Equation
  - ❑ Estimates wave velocity from water depth
  - ❑ Run it backwards!
- ❑ Particle Image Velocimetry (PIV)
  - ❑ Method used for determining the velocity of particles in fluids
  - ❑ Traditionally uses seeded tracer particles
- ❑ Unmanned Aerial Systems (UAS)

  - ❑ Used to capture surfzone video
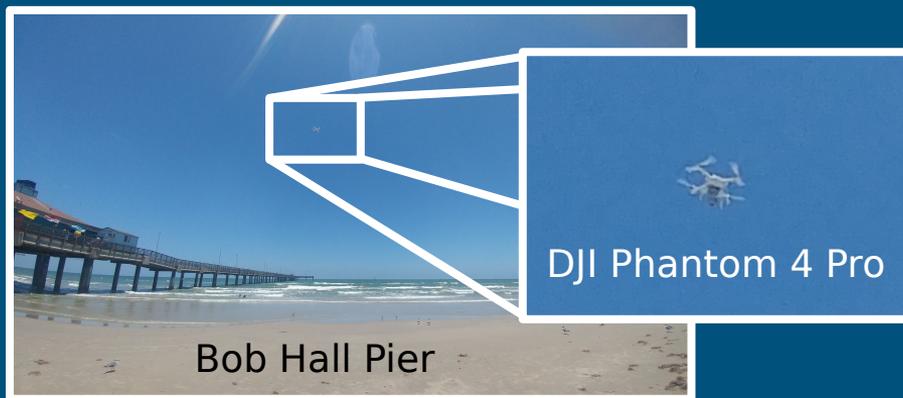
$$h = c^2/g$$
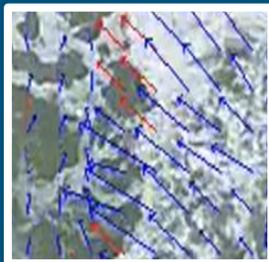
- ❑ Higher Frame Rate vs. Lower Frame Rate
  - ❑ Which has the best impact on outcomes?
    - ❑ 60fps, 30fps?
- ❑ Flight Altitude Above Ground Level (ABG)
 - ❑ Is there a best elevation to capture images?
    - ❑ 75m, 50m?

Setup

- ☐ Depth Measuring tools
  - ☐ Striped every 10cm
- ☐ Ground Control Targets
  - ☐ Surveyed in references

Depth Measuring Tools

DJI Phantom 4 Pro

Bob Hall Pier

Ground Control Target

Water Depth Inverted from Wave Velocity

- ❑ Current automated method
  - ❑ Average velocities
  - ❑ Run bathymetry on average
- ❑ Automated issues
  - ❑ Only data at wave crest is needed
  - ❑ Depth off by nonuniform linear constant
- ❑ Still useful
  - ❑ Finds sandbar geometry
  - ❑ Known depths allow the constant to be found
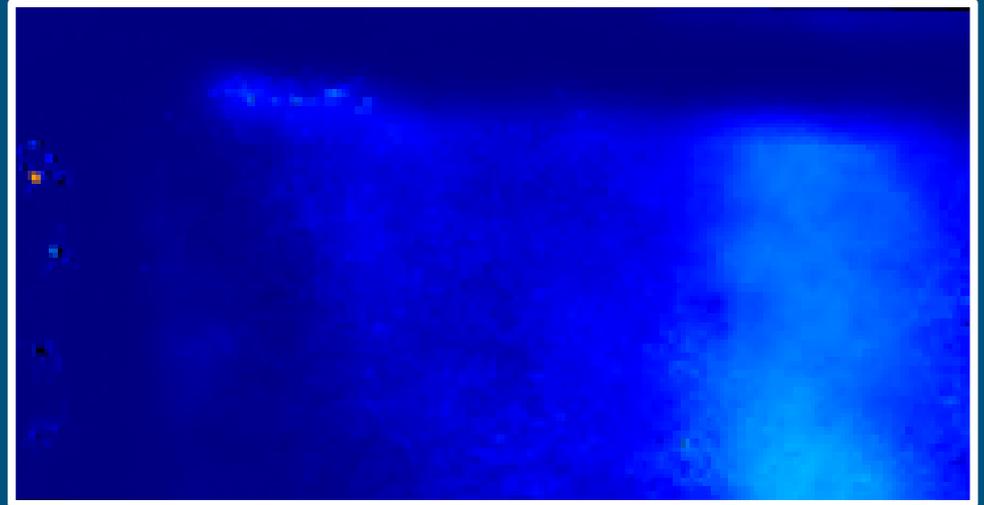
Lighter = Deeper

50m Point Clouds

60fps vs 30fps
60fps
30fps
Side View

60fps vs 30fps
Side View
60fps
30fps
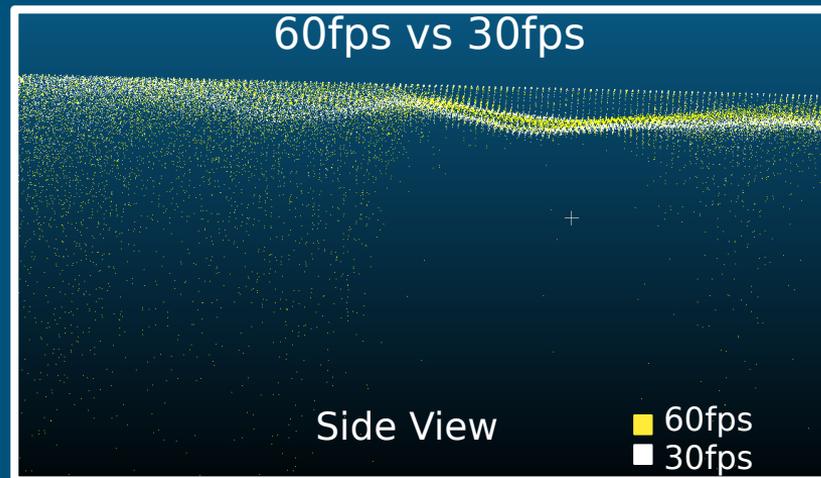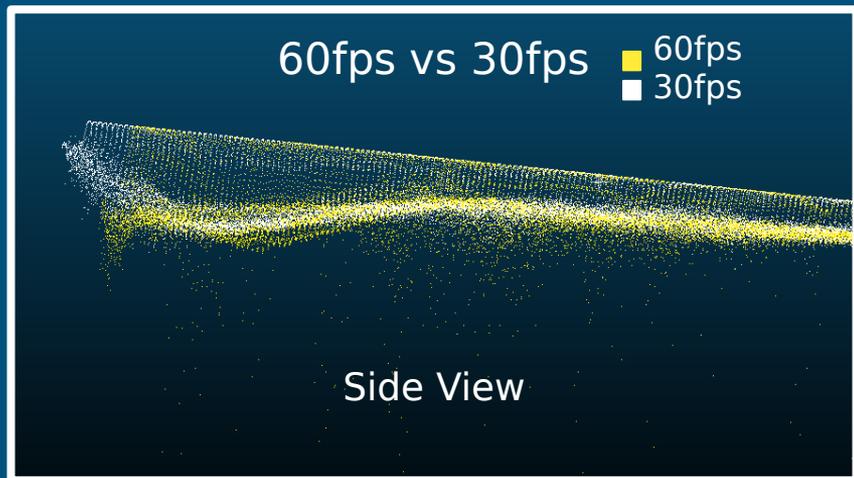
Conclusions

- ❑ PIV conceptually Good
- ❑ Use Lower Framerates
- ❑ Use Ground Truth Poles
    - ❑ Buried 1/3rd pole length
    - ❑ Checked between flights

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Kevin Wilson at TAMUCC for piloting the UAS

Data and code available at
http://isoptera.lcsc.edu/~jamcdonald/reu/

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