Swimming Tango

An underwater navigation mechanism for deep-sea divers.

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ECE 4012 - L7A

Project in a Nutshell

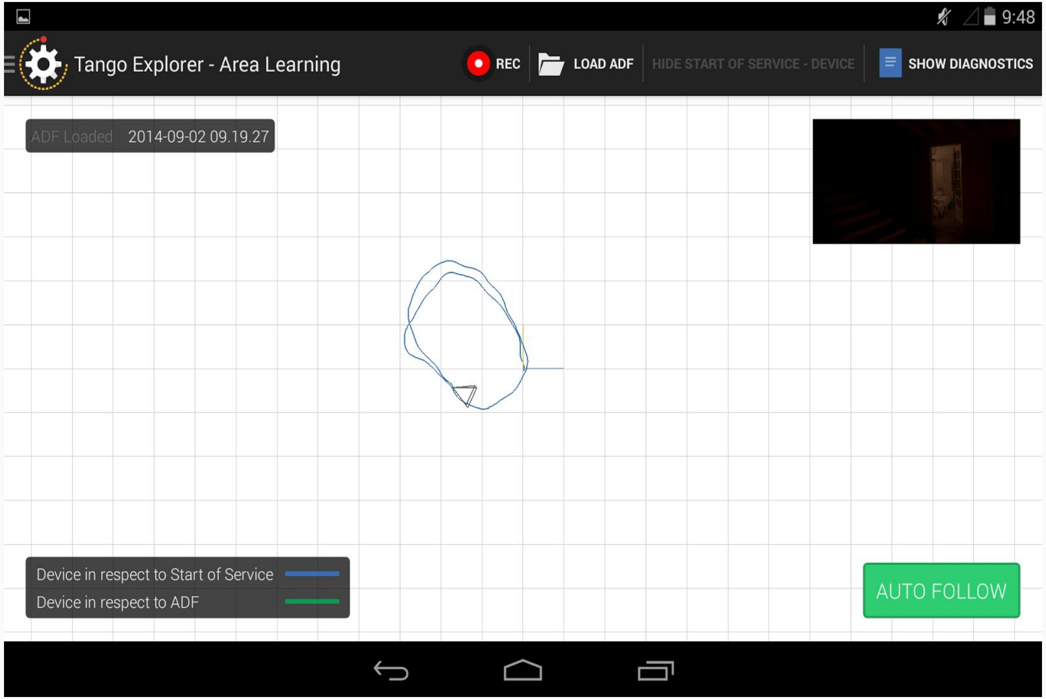
- Creating a means of underwater navigation.
- Hardware size limited to that of a small tablet.
- The end goal is to perform visual odometry, similar to that of the Google Project Tango Explorer app.

Motivation

- Allows divers to determine their current location and find a way back to the starting point in case they've lost their way.

- Helps divers communicate in case of emergency.

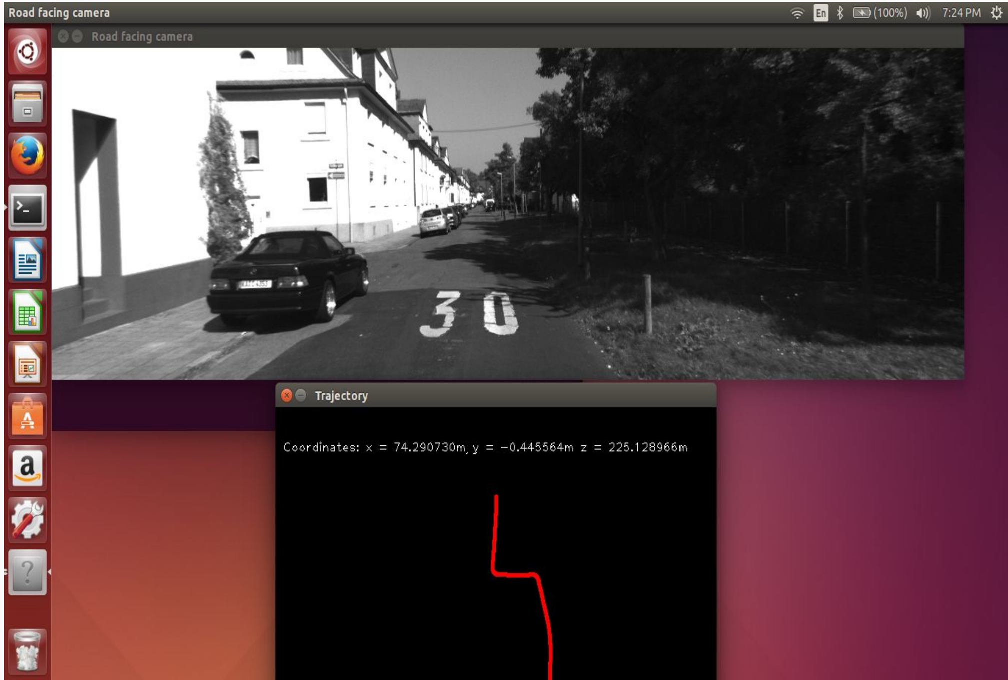
Background



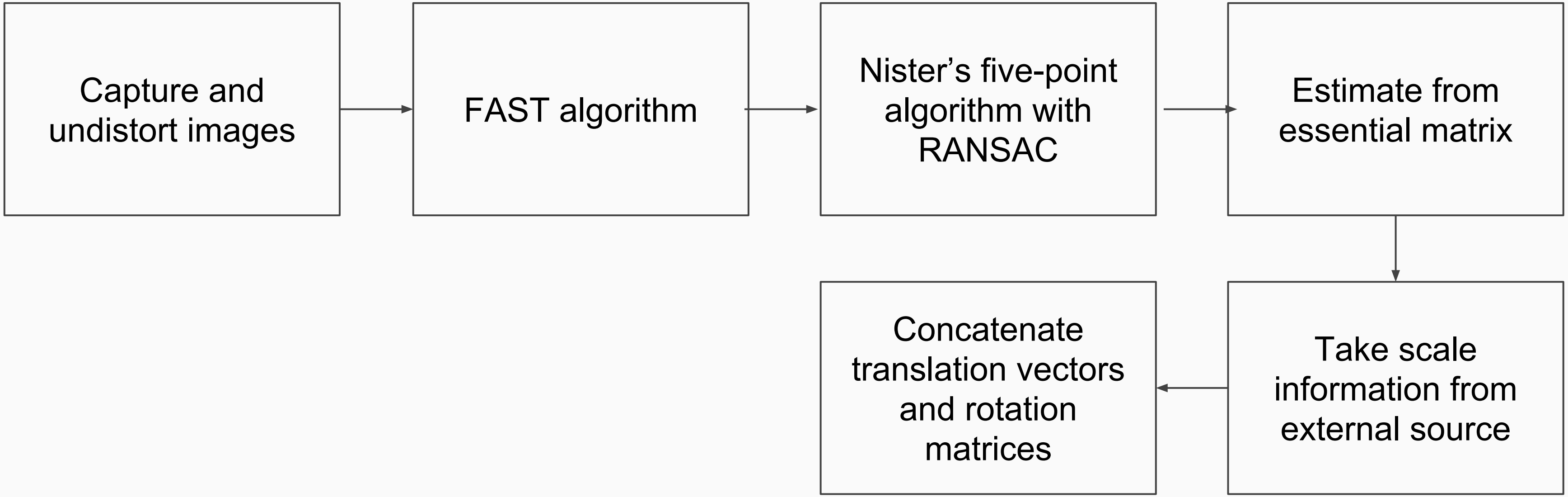
- Project Tango uses computer vision to help devices detect their position relative to surroundings.
- It implements a kinect-like sensor and uses pointcloud data for imaging.

Visual Odometry

- Determining position and orientation based on imaging data.
  - Images
  - Pointclouds
- Is of various types.
  - **Monocular - Our algorithm!**
  - Stereo
  - Egomotion: Motion of a camera within a 3-D environment.

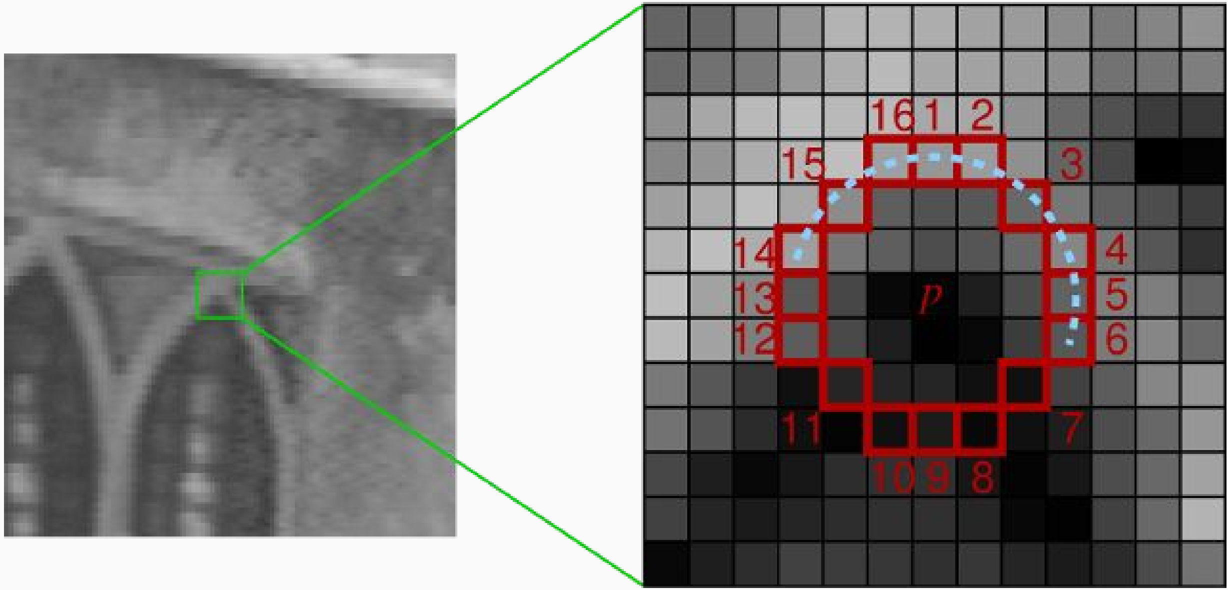


Visual Odometry Implementation



FAST Feature Detection

- Algorithm for corner detection.
    - Easy to detect and track corners
- Developed by Edward Rosten and Tom Drummond.



Nister’s Five-Point Algorithm and RANSAC

- Five-point Algorithm: Algorithm used to generate the Essential Matrix, which is a collection of homogenous normalized image coordinates.

- RANSAC: Iterative algorithm that handles outliers when doing model estimation.
    - Randomly samples five points at every iteration, computes essential matrix and checks whether the rest are inliers with respect to the essential matrix.
    - The algorithm terminates after a fixed number of iterations, and the essential matrix with which the maximum number of points agree is used.

Conditions of Algorithm

- Uses image data.
  - SONAR generates pointclouds.

- Monocular algorithm
  - Only gets one perspective.
  - Requires an calibrated camera or sensors for actual position data.

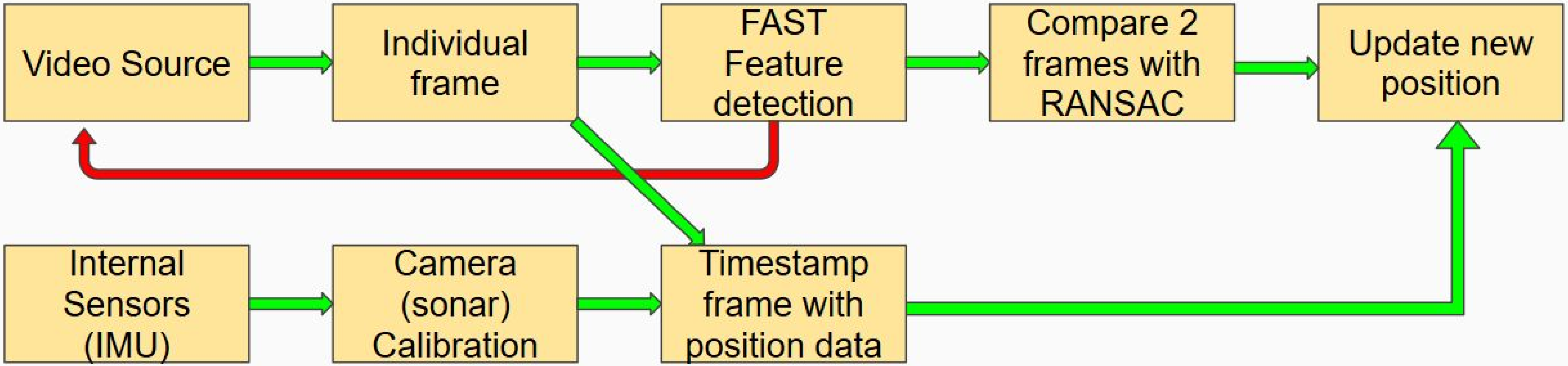
Potential Solutions

- Modify algorithm to work with pointcloud data.
  - Likely to be time-consuming.
- Replace the SONAR with a device that can obtain images underwater.
  - Underwater camera or visual sensor.
  - Less time consuming as algorithm can be used as-is.
  - Would also greatly help portability of the potential device.

Underwater implementation

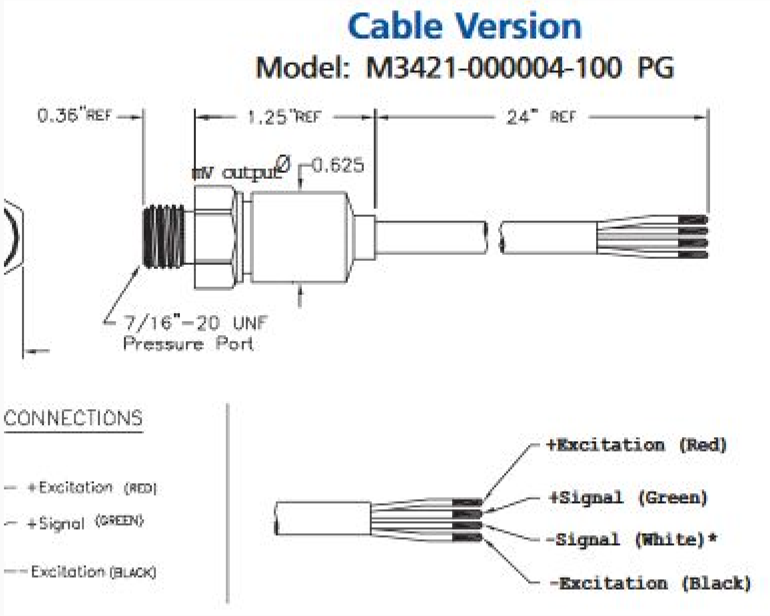
- Use an underwater imaging device such as a sonar to obtain imaging data of the underwater environment.
- Utilize an IMU and pressure sensor obtain position information and data.
- Run visual odometry and use the data in a SLAM algorithm for a real time up-to-date map.

Underwater Implementation cont



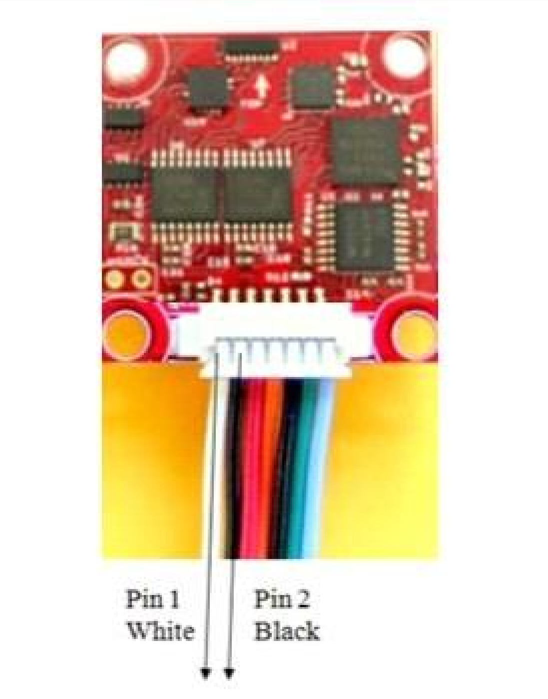
Pressure Sensor

- Analog device.
    - Connected to an mbed microcontroller, which acts as an A-to-D converter.
    - Mbed can be powered by connecting to a computer.
    - Takes in 3.3-5V and outputs an analog signal.
    - Raw analog data is expressed as a proportion of max PSI and supply voltage



Compass

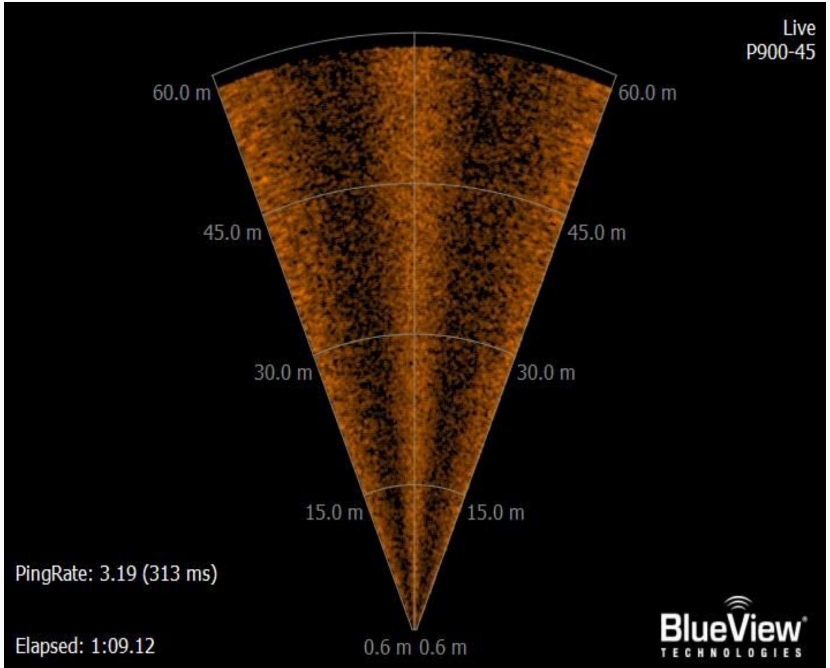
- Powered by the same rails that power the pressure sensor.
    - Operates on a serial interface.
- Parsed data of compass and pressure sensor using a Python script.
    - Script also adds a timestamp which would be useful for the purposes of visual odometry.



SONAR

- Wanted to use a Tritech Micron DST.
    - However exceeded budget constraints.
    - Thus settled for Blueview P900-5.
    - Larger and bulkier.

- Were able to obtain capture via ProViewer software.
    - Faced issues compiling BlueView SDK on Raspberry Pi.
    - Was able to get it to compile on laptop.



Challenges Faced

- Had to switch platforms twice.
    - Initially we couldn’t install ROS on the small netbook that we were using. So we switched to a Raspberry Pi.
    - Blueview SDK wouldn’t compile on the Raspberry Pi, so we switched to Anupam’s laptop.
- Compass had wire connectivity issues and as such wiring had to be redone multiple times.
- We were slated to have four members, but this dropped to two. As such, managing time became an issue.

Future Work

- Collect underwater data and run visual odometry algorithm.
  - Could rework it to support pointclouds and use the SONAR.
  - Most time-effective option would be to replace the SONAR with an underwater camera.

- Package all components together in order to be able to create a lightweight, portable device.
  - PVC.
  - Goop for waterproofing.