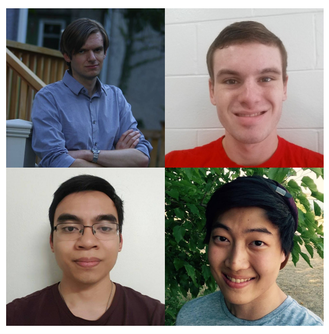

Just A T.A.D. (Traffic Analysis Drone)

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Abstract

Unmanned aerial vehicles (UAV or drone) provide an effective way to get expensive or otherwise inaccessible images and video. This type of data is especially important for traffic analysis as the top-down view from a drone is ideal for gathering data about traffic. Just a T.A.D. (Traffic Analysis Drone) is a road traffic monitoring system that provides a system for capturing and analyzing video. The system uses a drone camera to capture top-down videos of traffics and performs image processing to extract traffic data such as density and interval between cars in a lane. The data is communicated to a data server, and a web interface is available to easily access the data.

System Overview

- The Raspberry Pi is the primary component of the system and contains the image processing, camera module, and 3G modem
- The drone holds the Raspberry Pi and allows for a bird's eye view to be captured
- Image processing algorithms provides analysis of road traffic. It calculates car density and spacing between cars
- The 3G modem communicates that data to a cloud server for user display
- Web application allows for easy viewing and display of data as well as .csv download for further anlysis
- Drone can be controlled via remote control or autopilot so altitude and camera view can be controlled

Block Diagram

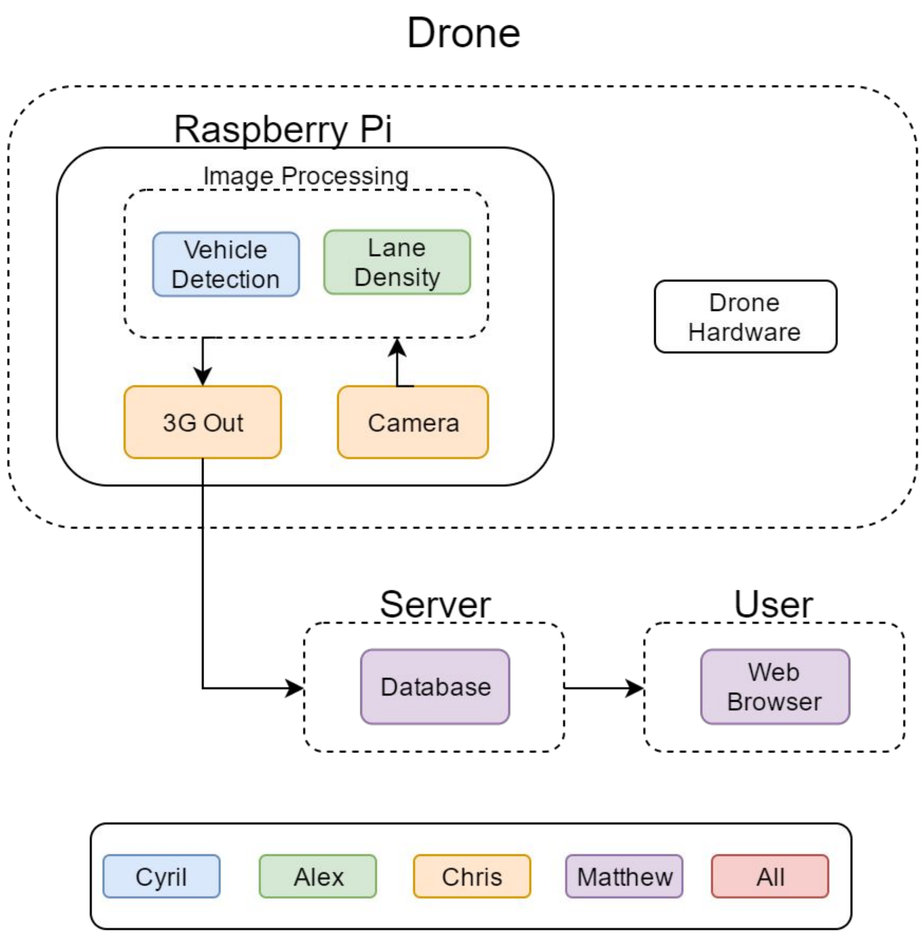

Fig.1. Just a TAD's block diagram.

Specifications

Specification	Implementation
Flight Time per Battery	15 minutes
Altitude	40 m (131.2 feet)
Autopilot	Available
Payload	< 3 ounces
Range	1 km (0.621 miles)
Data Refresh Rate	5 seconds

Fig. 3. Specifications Table. Source: Just a TAD

Results

The image processing algorithm correctly identified cars 80% (and identified every car for at least 60% of the frames the car was in view) of the time, but had significant issues with false positives and momentarily missing cars, making the density noisy.

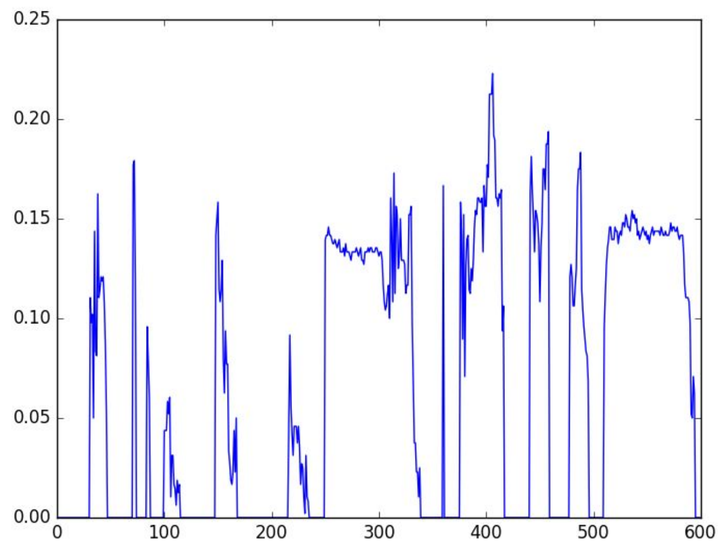

Fig. 2 A density graph for 20 seconds of analyzed traffic. Source: Just a TAD

Acknowledgement

We would like to thank Professor Pishro-Nik for advising our porject and purchasing our drone for us. We would also like to thank Professor Ni for helping us establish the project idea and providing information about traffic analysis concepts. We would like to thank Professor Hollot and Professor Koren for their insight and feedback in establishing our project. We would also like to thank Mr. Fran Caron for his assistance in the SDP lab and in ordering our parts for our project.

3DR Iris+

- Ready-to-fly, quadcopter drone that is fully built with many easy to use features
- Stable hover mode for easy control and reduced camera shake
- Autopilot allows drone's altitude, location, and yaw to be controlled for any flight
- The flight mission for autopilot can be set by Mission Planner for Windows or DroidPlanner for Android

Fig. 4. Mission Planner Flight View. Source: Just a TAD

Image Processing

The final image processing algorithm functioned like so:

1) The location of the road was given and the drone rotated to match the orientation of the road.
2) We iterate over the expected location of the lane, and calculate the mean and standard deviation of the pixels' gray values along the lane.
3) We iterate over the lane once more, and note pixels (minus mean) that fall outside a standard deviation.
4) A large enough cluster of these pixels would be designated as a "car".

Fig. 5. Correctly detected car. Source: Just a TAD

Cost

Development		Production	
Part	Cost($)	Part	Cost($)
Drone	Free*	Drone	598.00
Raspberry Pi	49.99	Raspberry Pi	49.99
Raspberry Pi Battery	16.99	Raspberry Pi Battery	16.99
Camera Module	14.99	Camera Module	14.99
Huawei 3G Modem	33.99	3G Dongle	33.99
3G Subscription	25.00	3G Subscription	25.00
USB cord	5.00	USB cord	0.41
FAA Registration	5.00	FAA Registration	5.00
Total	**150.96**	**Total**	**744.37**

*Provided by Professor Pishro-Nik

Camera and 3G

- Raspberry Pi Arducam OV5647 Video Module is a plug & play camera that provides pictures and video
- Interfaces with Raspberry Pi via Python code that feeds video to image processing algorithm
- Huawei E353 3G USB Wireless Modem (3G dongle) provides speeds of up to 150Mbps
- AT&T 3G subscription allows internet access wherever AT&T has service
- Both camera and 3G modem are lightweight , only adding 1.35 ounces to the Raspberry Pi

Fig. 6. Arducam on Raspberry Pi Source: Amazon

Server & Web App

- Database is hosted on cloud via mongolab, which provides up to 500MB of storage for free
- Utilizes mongoDB, a NoSQL database system that stores flexible JSON documents for varying structures
- Web app automatically updates to display traffic analysis data for every frame of video data from Image processing algorithm
- Allows exporting of data via CSV for end user

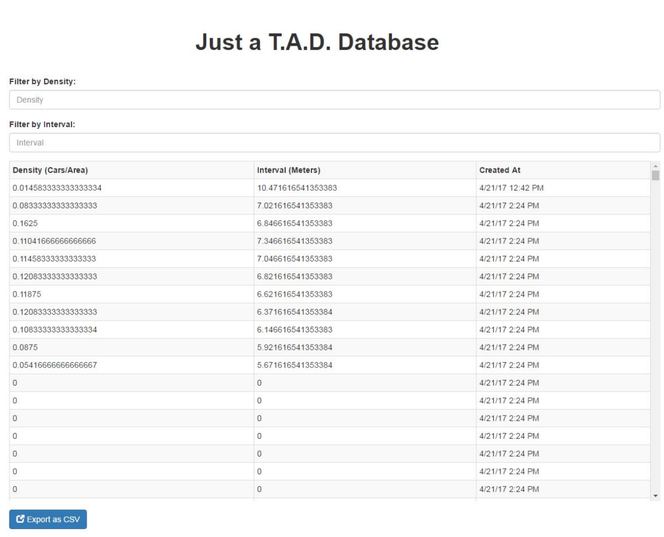

Fig. 7. Just a TAD's database Source: Just a TAD

Experiment and Analysis

Our experiments were conducted on a straight stretch of road on Governor's Dr., on the University of Massachusetts campus. We flew the drone (using autopilot and onboard telemetry) for 3 minutes, at a height of 40 meters.

Density was calculated as the apparent number of pixels belonging to cars over the total number of pixels counted. Intervals between visible cars were calculated using the known height of the drone and the number of pixels between cars.

The image processing was performed on the Raspberry PI offline due to unforeseen complications with the 3G dongle, but we did send data to the web server demonstrating its functionality. The project shows significant progress. With more time, we should be able to complete all stated objectives.