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

Senior Design Project 2017:
Preliminary Design Review
Meet the Team

▪ Cyril Caparanga (CSE)
▪ Alex Dunyak (CSE)

▪ Christopher Barbeau (CSE)
▪ Matthew Shin (CSE)
Problem

- Traffic data needs to be more comprehensive as more and more cars are on the roads.
- In addition, data needs to be analyzed quickly:
  - Detect and track vehicles.
  - Develop statistical models and conclusions about traffic density, flow, etc.
Current Solutions

- **Floating Car Data (FCD)**
  - Costly communication
  - Requires all drivers to have FCD and all data available on a single platform for analysis
  - Privacy concerns

- **Video Camera**
  - Static placement
  - Limited coverage
  - Limited angle of view
  - Difficult to see behind car
Motivation

- Current traffic data collection methods are expensive and/or insufficient
- Traffic is expected to increase by 50% over the next 16 years
- $124 billion in direct/indirect losses for Americans in 2013
  - Could rise to $186 billion by 2030

Source: http://www.forbes.com/sites/federicoguerrini/2014/10/14/traffic-congestion-costs-americans-124-billion-a-year-report-says/#dd89866252b0
Our Approach

▪ An Unmanned Aerial Vehicle (UAV) can be used to provide aerial image and video
▪ This data is sent to a server in the cloud for processing and analysis
▪ Image processing will analyze the image/video for car density and spacing
Block Diagram

Drone

3G Out → Raspberry Pi → Camera → Drone

Server

Image Processing

Vehicle Detection

Lane Density

User

Web Browser

Cyril  Alex  Chris  Matthew  All
Traffic Analysis Concepts

- Space sensor data - information provided by aerial sources (UAV)
  - Spacing
    \[ s_i = x_{i-1} - x_i \]
  - Density
    \[ k = \frac{N}{L} \]
  - Space-mean speed
    \[ v_s = \frac{1}{N} \sum_{i=1}^{N} \dot{x}_i \ldots \text{ in the space domain} \]

Image Processing Requirements

- Detecting Cars from a top down view
- Counting the amount of cars in the picture
- Distinguishing between different lanes of a highway
  - Determining spacing between cars in each lane
Image Processing Approach

- **Background Subtraction**
  - Drone takes images as initial “background”
  - Uses recursive averaging to create estimate of background image

- **Cropping**
  - Remove traffic in opposite direction
  - Remove extraneous roads (ramps) and nonroad components

- **Vehicle Detection**
  - Use background subtraction as vehicles are only moving objects
  - Vehicles can be better segmented from background through thresholding
Drone - UDI U818A

- Used for preliminary testing
  - Retrieve test images
- Suboptimal for final design
  - 10 min flight time
  - 50g payload capacity
  - 30m flight range
Drone Alternative - 3DR Iris+

- Cost: $550
- Payload: 0.8lb
- Flight Time: 20 minutes
- Range: 1km
- Programmable Autopilot
Internet Connection

- Take pictures at one second intervals
- Transmit images over 3G to data server
Data Server

- Server receives images from the drone and performs image processing
- Displays data on web page and file for download
# Price Estimation - UDI U818A

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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<td>Drone</td>
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<td>Raspberry Pi</td>
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<td>3G Subscription</td>
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<td>Battery (Pi)</td>
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**Department of Electrical and Computer Engineering**

**SDP17 - TAD**
# Price Estimation - 3DR Iris+

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Design Alternatives

- Process images on board and only transmit data
- Collect all data and then return for offline processing
- Collect data and return for WiFi transmission to data server
- Have a GUI for the end user to view data
  - Ex. Google Maps interface
- Calculate space-mean speed of vehicles and determine flow
MDR Deliverables

- Alex/Cyril: Image processing
  - Identifies 80% of visible cars in ideal conditions in sample tests
  - Identifies distances between cars to within one car
  - Has 35 distinct test cases for our image processing software
- Matt: Data server for performing image processing and storing data is set-up
- Chris: Camera and network system can send image data to data server via 3G
Thank You!

Questions?