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

## Senior Design Project 2017:
## Preliminary Design Review
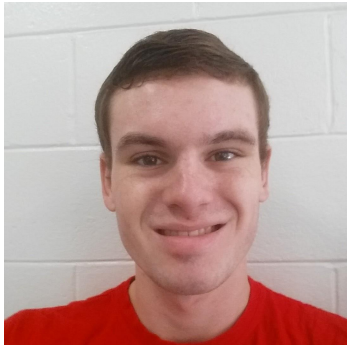
# Meet the Team
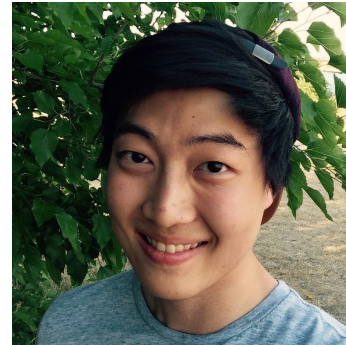
- Cyril Caparanga (CSE)
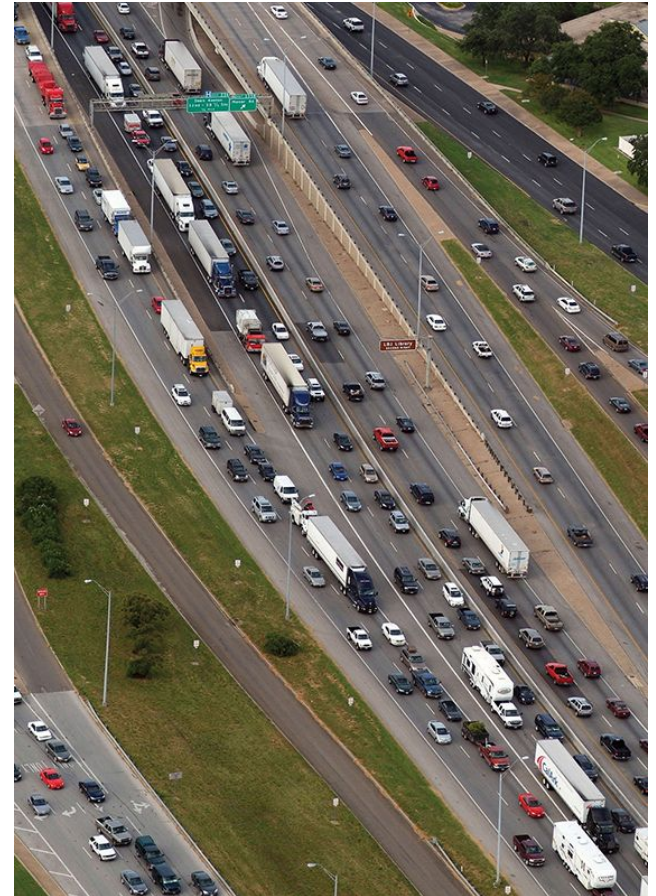
- Alex Dunyak (CSE)

- 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 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
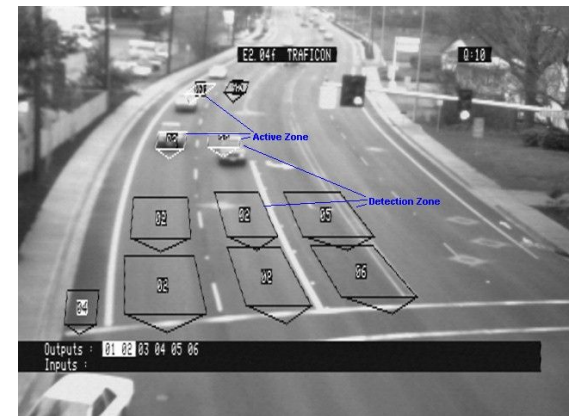
# Motivation

- 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
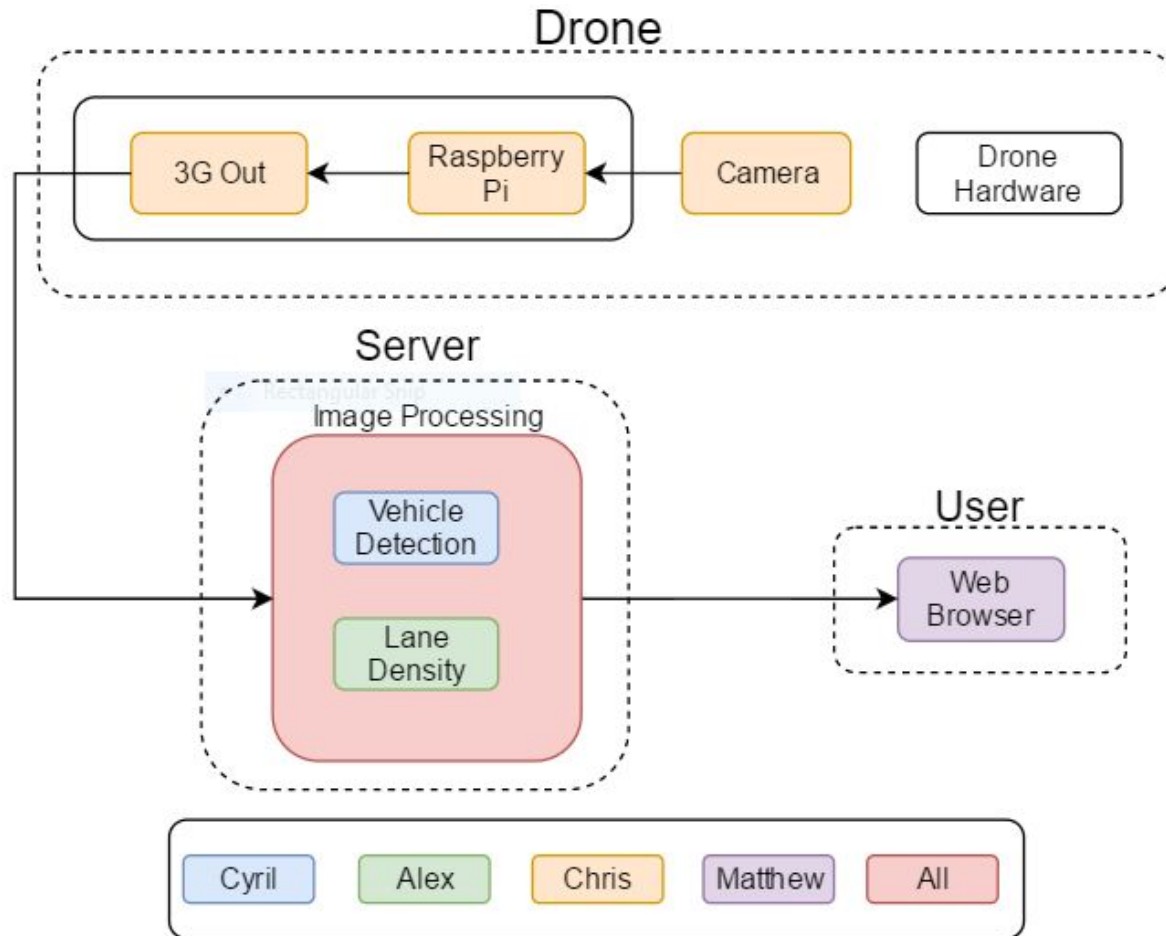


Source: http://www.forbes.com/sites/federicoguerrini/2014/10/14/traffic-congestion-costs-americans-124-billion-a-year-report-says/#dd89866252b0

# 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 Hardware

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

$$v_s = \frac{1}{N} \sum_{i=1}^{N} \dot{x}_i \ \dots \ \text{in the space domain}$$

Source: *Traffic Flow Theory: A Unified Perspective*, Ni (2015)

# 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

| | |
|---|---|
| Drone | $50 |
| Raspberry Pi | $35 |
| 3G Dongle | $20 |
| 3G Subscription | $30 |
| Battery (Pi) | $20 |
| FAA Registration | $5 |
| **Total** | **$160** |

# Price Estimation - 3DR Iris+

| | |
|---|---|
| Drone | $550 |
| Camera | $50 |
| Raspberry Pi | $35 |
| 3G Dongle | $20 |
| 3G Subscription | $30 |
| Battery (Pi) | $20 |
| FAA Registration | $5 |
| Total | $710 |

# 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?