Identifying Aggressive Driving Behaviors in a Traffic Scene

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JULY 21, 2010

Goals of this project

- Given the trajectory information for the vehicles on a road, we would like to apply a mathematical model that can differentiate between safe and aggressive vehicles.
- After identifying aggressive vehicles, we would like to determine which types of aggressive behavior that vehicle exhibits

Common Aggressive Behaviors

- Aggressive behaviors can be grouped into four categories
  - Road Rage (hand signals, yelling, etc.)
  - Speeding
  - Tailgating
  - Unsafe or excessive lane changing
- Using vehicle trajectories, the latter three can be identified
- Using only the Intelligent Driver Model (IDM), Speeding and Tailgating can be identified

The Intelligent Driver Model

- Developed by sociologists for use in simulating traffic flows
- Output is an expected acceleration, based on distance to the previous vehicle, velocity, etc.
- The model is 'safe', meaning that it does not allow collisions

$$\dot{v}_\alpha = a^{(\alpha)}\left[1 - \left(\frac{v_\alpha}{v_0^{(\alpha)}}\right)^{\delta} - \left(\frac{s^*(v_\alpha, \Delta v_\alpha)}{s_\alpha}\right)^2\right].$$

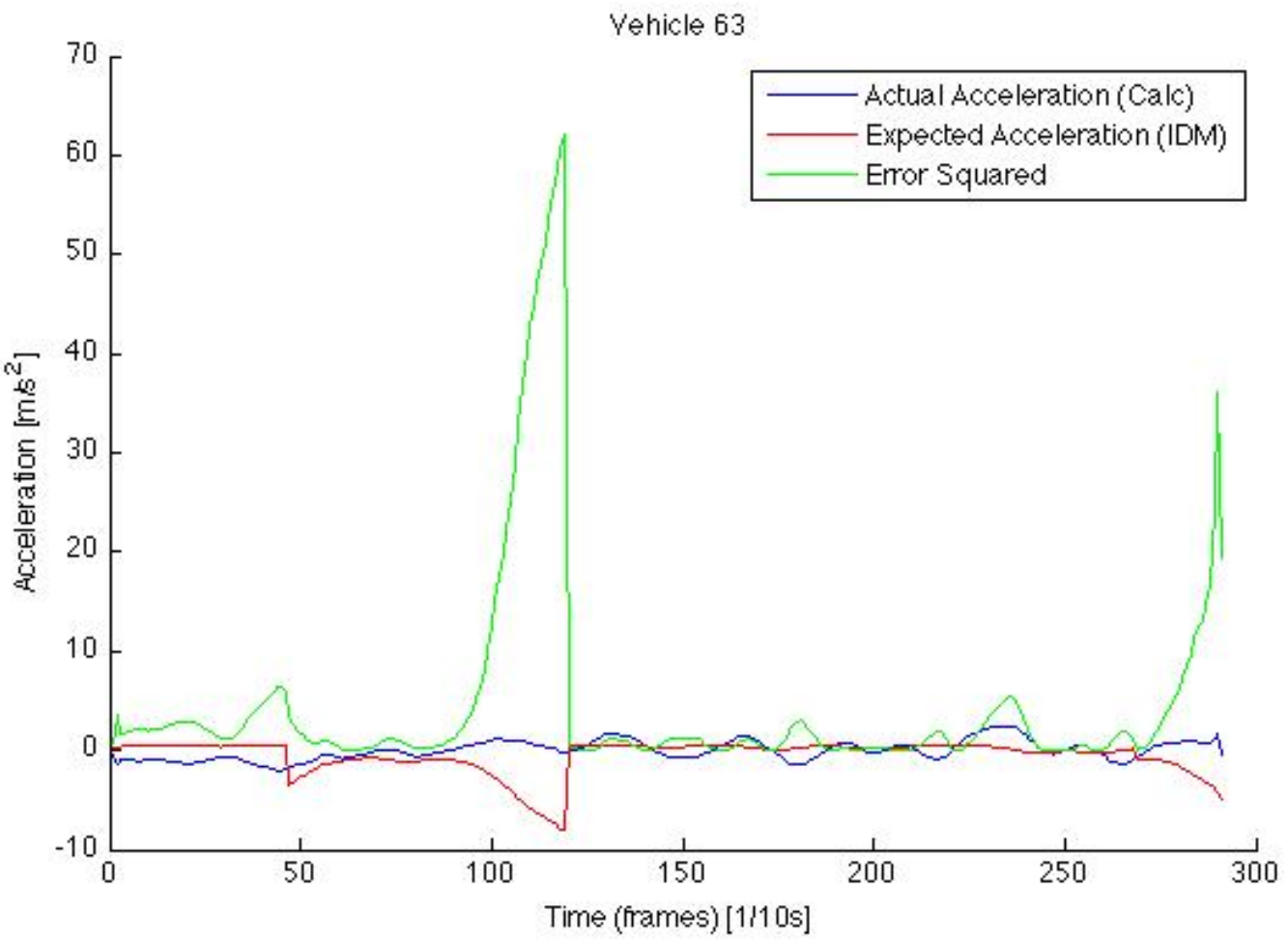
$$s^*(v, \Delta v) = s_0^{(\alpha)} + s_1^{(\alpha)}\sqrt{\frac{v}{v_0^{(\alpha)}}} + T^\alpha v + \frac{v\Delta v}{2\sqrt{a^{(\alpha)}b^{(\alpha)}}}$$

Parameter	Typical value
Desired velocity v_0	120 km/h
Safe time headway T	1.6 s
Maximum acceleration a	0.73 m/s^2
Desired deceleration b	1.67 m/s^2
Acceleration exponent δ	4
Jam distance s_0	2 m
Jam distance s_1	0 m
Vehicle length $l = 1/\rho_{max}$	5 m

Method Used

- For each vehicle, we smooth the trajectory by averaging over several frames.
- We then calculate velocity and acceleration at each time-instance, smoothing at each step
- For each vehicle, at each time instance, the expected acceleration is calculated using the IDM
- The error between the expected and actual accelerations is compared and thresholded:
  - `error = (a_actual – a_exp)^2`
  - `if error > threshold, vehicle is marked as abnormal`

Graph of Accelerations



Method Used

- Times when a vehicle has an abnormal acceleration are compared to when the vehicle is known to be exhibiting an aggressive behavior
- If there is a strong relationship between vehicles we identify as abnormal and vehicles that exhibit a behavior, the model is assumed to be working well.

Data Set Used

- NGSIM, US 101 in Los Angeles, CA
- 7:50-8:05 AM
- 8 cameras over a 2100 foot stretch of road
- Total of 2169 vehicles
  - For each vehicle, the position in each frame is given along with acceleration, velocity, and lane information
  - The information was collected using an advanced tracking algorithm

Results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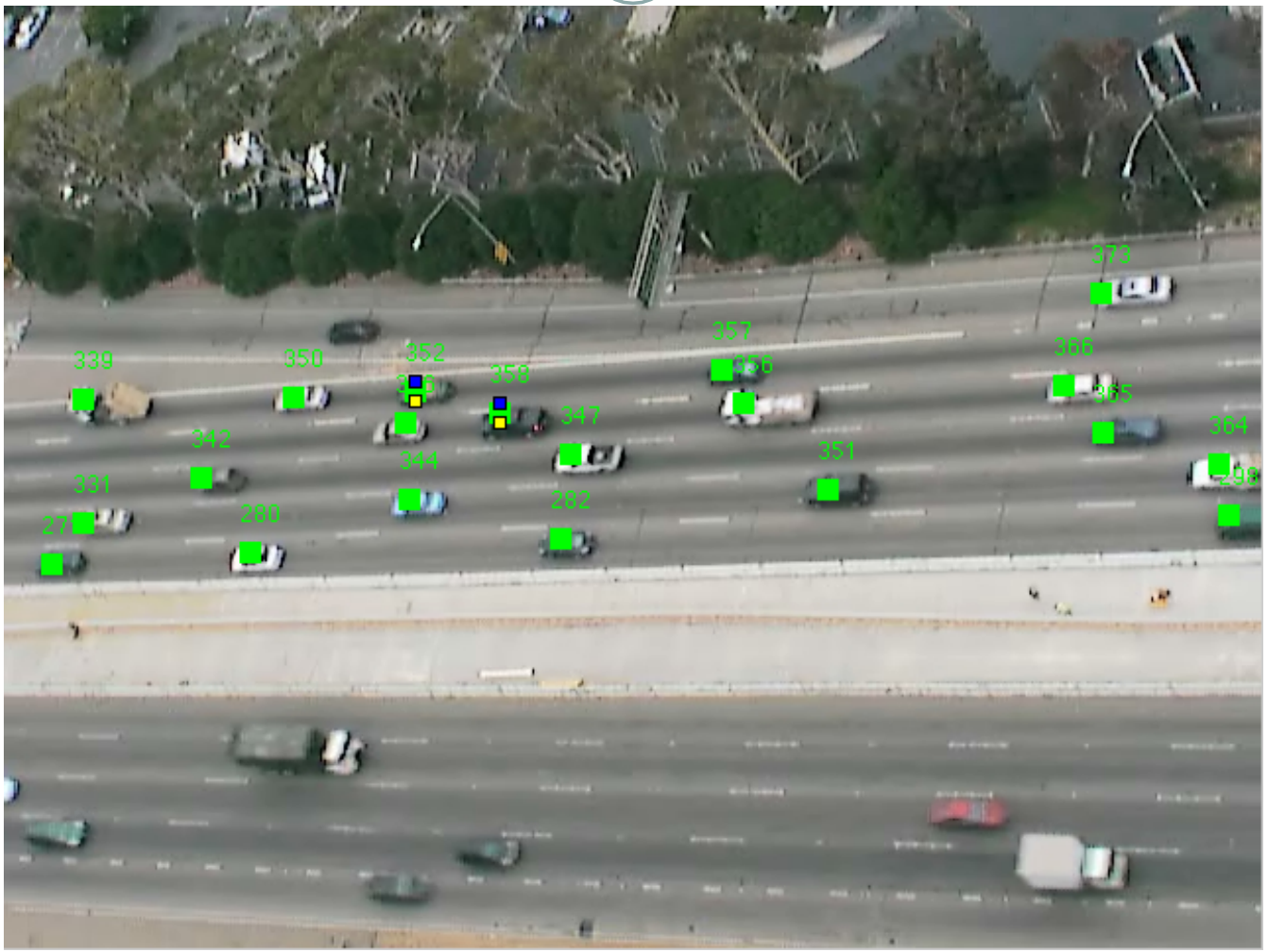
Results



Weaknesses

- The IDM is based only on a single lane of traffic, so it is unable to detect unsafe lane changing behaviors
- In the current data set, traffic is relatively dense, so very little speeding occurs
  - We are looking into ways to identify vehicles traveling in excess of the local average speed
- Some issues that were arising:
  - Too many vehicles were being detected as abnormal, we are only interested in the vehicles that are very aggressive
  - This was fixed by using a new error calculation

Future Plans

- Currently, we are using the vehicle's behavior to determine appropriate values for the IDM parameters through learning.
- We are also looking into a method that creates an overall aggression or safety score for a driver
  - This model would be similar to the one currently used, however it would include factors related to the safety of a lane change
- Would like have several people watch the videos and identify the vehicles that they believe to be aggressive
  - This can be used to compare how well our model identifies what real people consider aggressive