USING NATURALISTIC DRIVING DATA TO ANALYZE EFFECTS OF DRIVER AGE ON VEHICLE DECELERATION AND ITS IMPACTS ON SAFETY AND TRAVEL TIME

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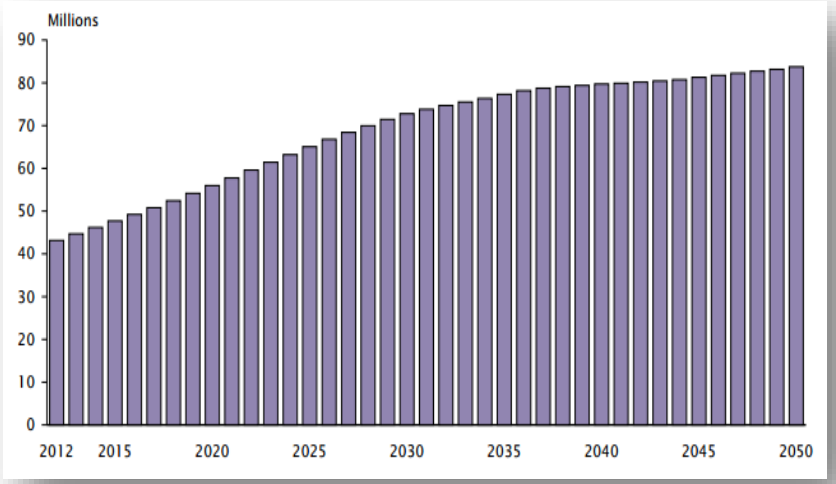
Outline

- Introduction
- Objective of the study
- Data collection
- Descriptive Statistics
- Vissim modeling
- SSAM
- Results and Analysis
- Conclusions
- Recommendations and Opportunities

Introduction

Aging population in US

- 2050 projection (*National Highway Traffic Safety Report*) : doubles 2012 aging population



Projected Growth in U.S. Population Age 65+

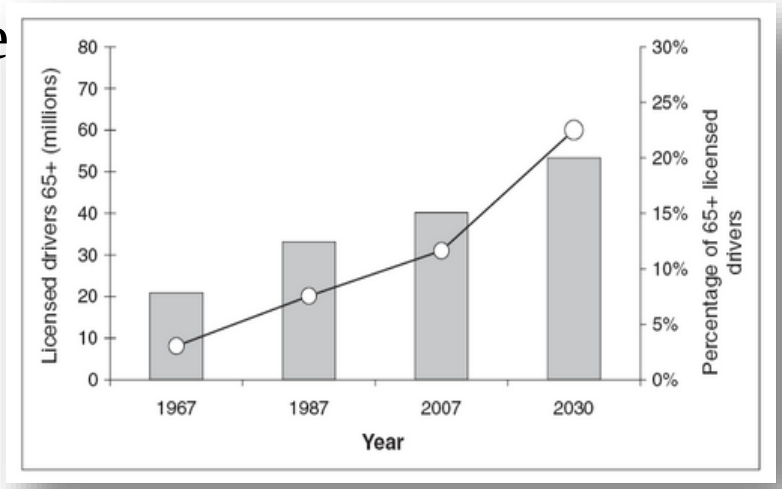
Aging population in Florida

- 32.5% of Florida's population will be older (60+) by the year 2030
- An increase of 34% from 2012

Introduction Cont…

Currently, 65+ occupy 11% of driver population in US

Florida - licensed drivers over the age 65 are almost 20%

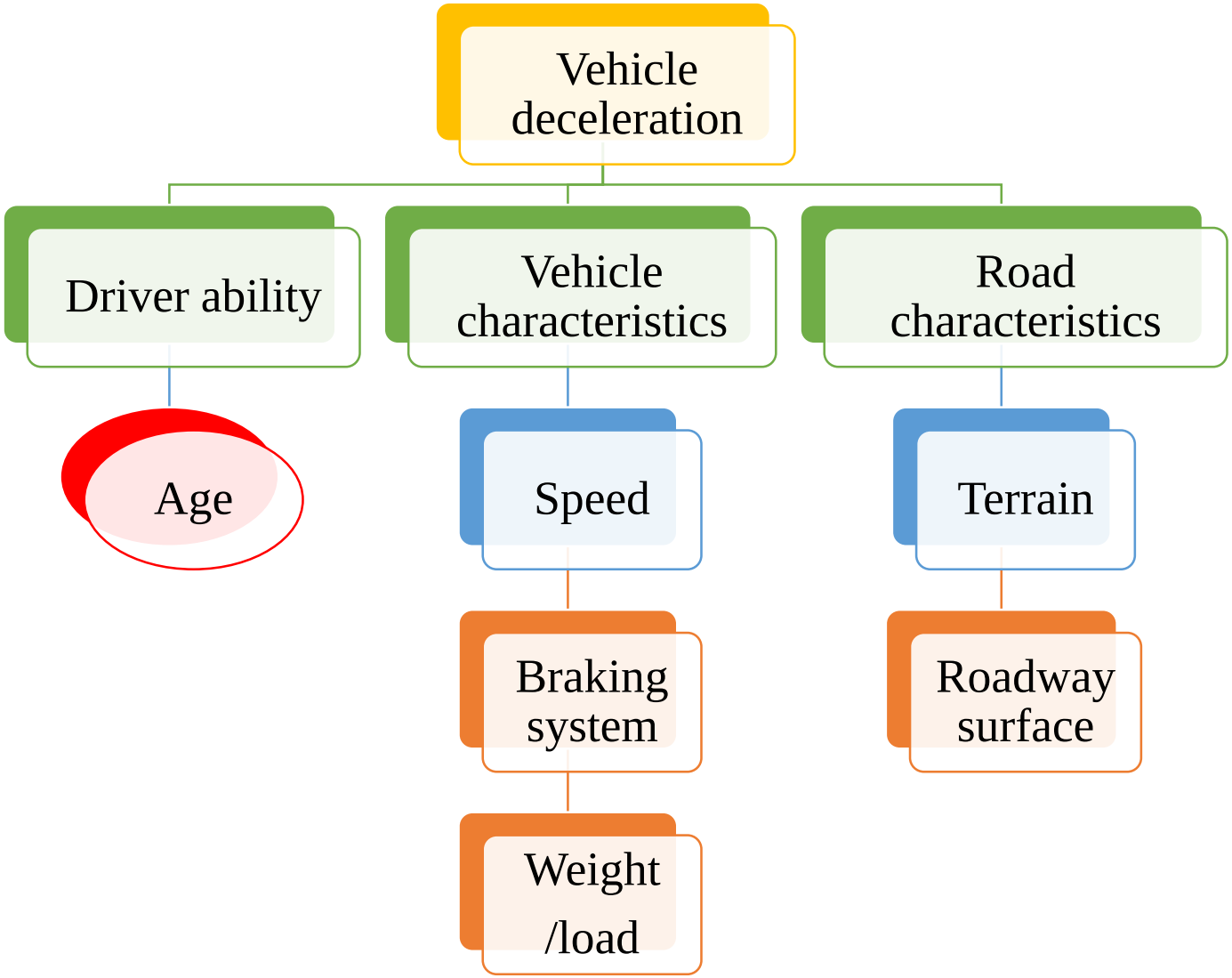


Number and percentage of drivers (65+) in the U.S. driver population

Decline: sensory, cognitive or physical function

Florida traffic crash report -11.3% increase in crashes involving elderly in Florida (2008 to 2012)

Factors affecting vehicle deceleration



Introduction Cont…

Differential deceleration

Vehicle deceleration is observed to be a function of driver's age among other factors:

- Young drivers are more likely to engage in risky driving habits;
  - ✓Speeding up
  - ✓Tailgating
- Older drivers are more likely to be defensive;
  - ✓Decelerating gently

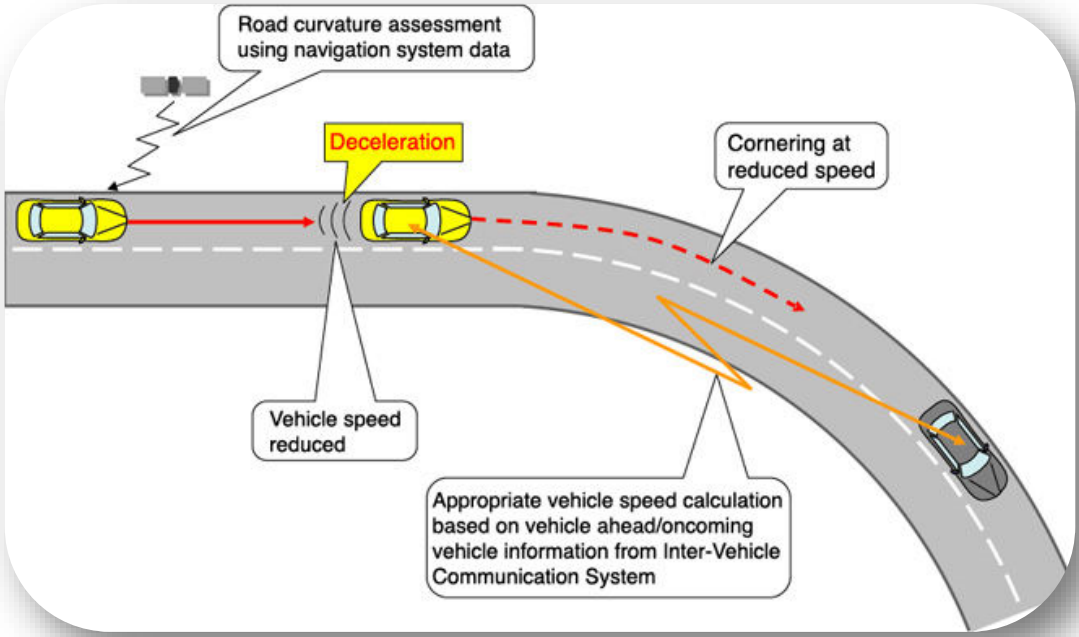
Vehicle deceleration: Application

- Modeling
  - ✓Traffic simulation
  - ✓Instantaneous fuel consumption rate
  - ✓Vehicle emission
- Traffic elements
  - ✓Length of yellow light at Intersection
  - ✓SSD at intersection
  - ✓Sign position
  - ✓Clearance and change interval
- Geometric element design
  - ✓Auxiliary lanes
  - ✓Freeway ramps

Vehicle deceleration Cont…

Common deceleration maneuvers:

- At intersection, during onset of yellow phase
- Sharp corners
- Upgrades
- Congested traffic flow
- Pedestrians crossing
- Changing speed following the speed limit from one facility to the other



Objectives of Study

- To examine the effects of driver age on vehicle deceleration rate and how it affects
  - ✓Safety
  - ✓Travel time
- Comparing the existing traffic flow condition with vehicles having uniform smooth deceleration maneuvers

Data Collection

Data used to model the intersections are obtained from:

- Naturalistic driving study data: 2010-2013
  - ✓401 to 646 participants
  - ✓75,500 trips

The selected corridor has 4 signalized intersections

I. Bruce B Downs Blvd & E Fletcher Avenue
II. Bruce B Downs Blvd & USF Holly Drive
III. Bruce B Downs Blvd & USF Pine Drive
IV. Bruce B Downs Blvd & E Fowler Avenue

Bruce B Downs is a corridor with leading severe injury crash locations in Hillsborough County
(Source: Tindale-Oliver and Associates Incorporation, 2013)

Descriptive statistics

The data were categorized into three age groups:

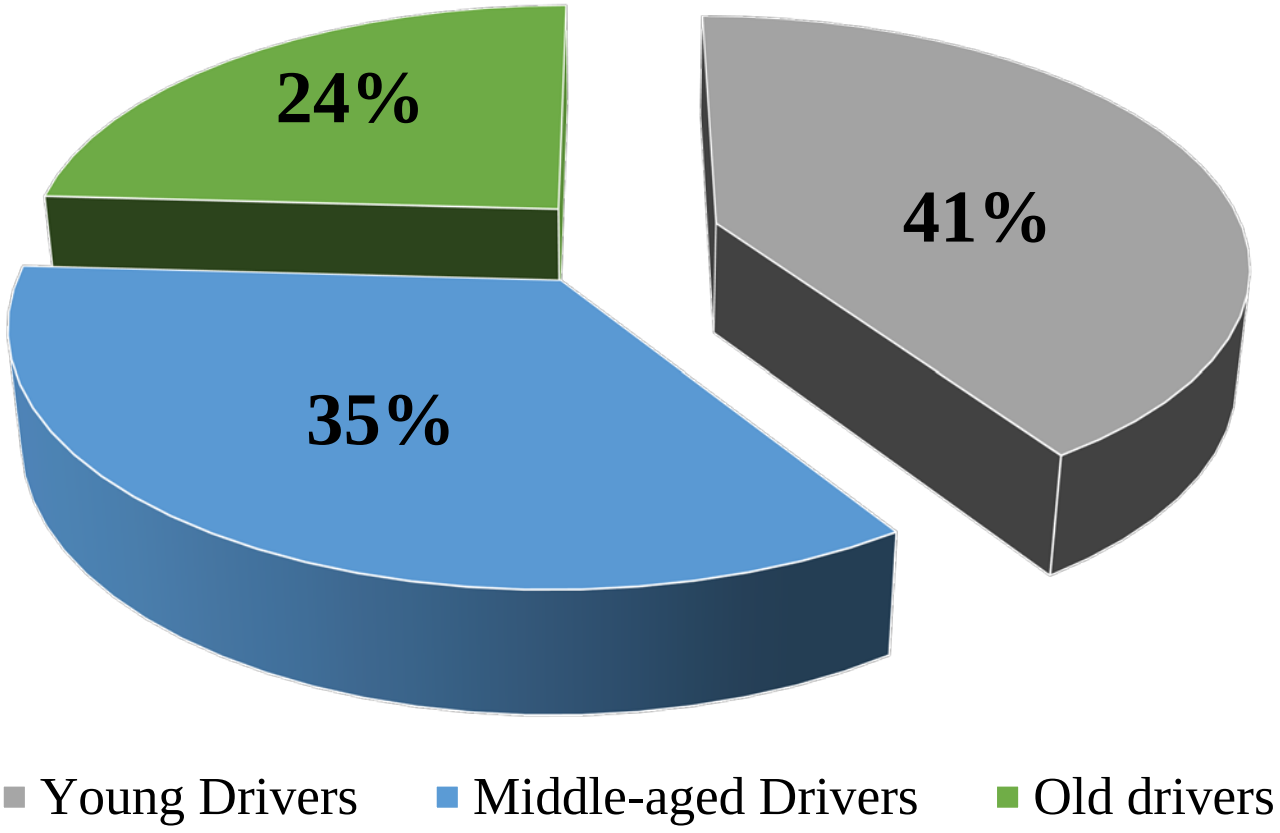
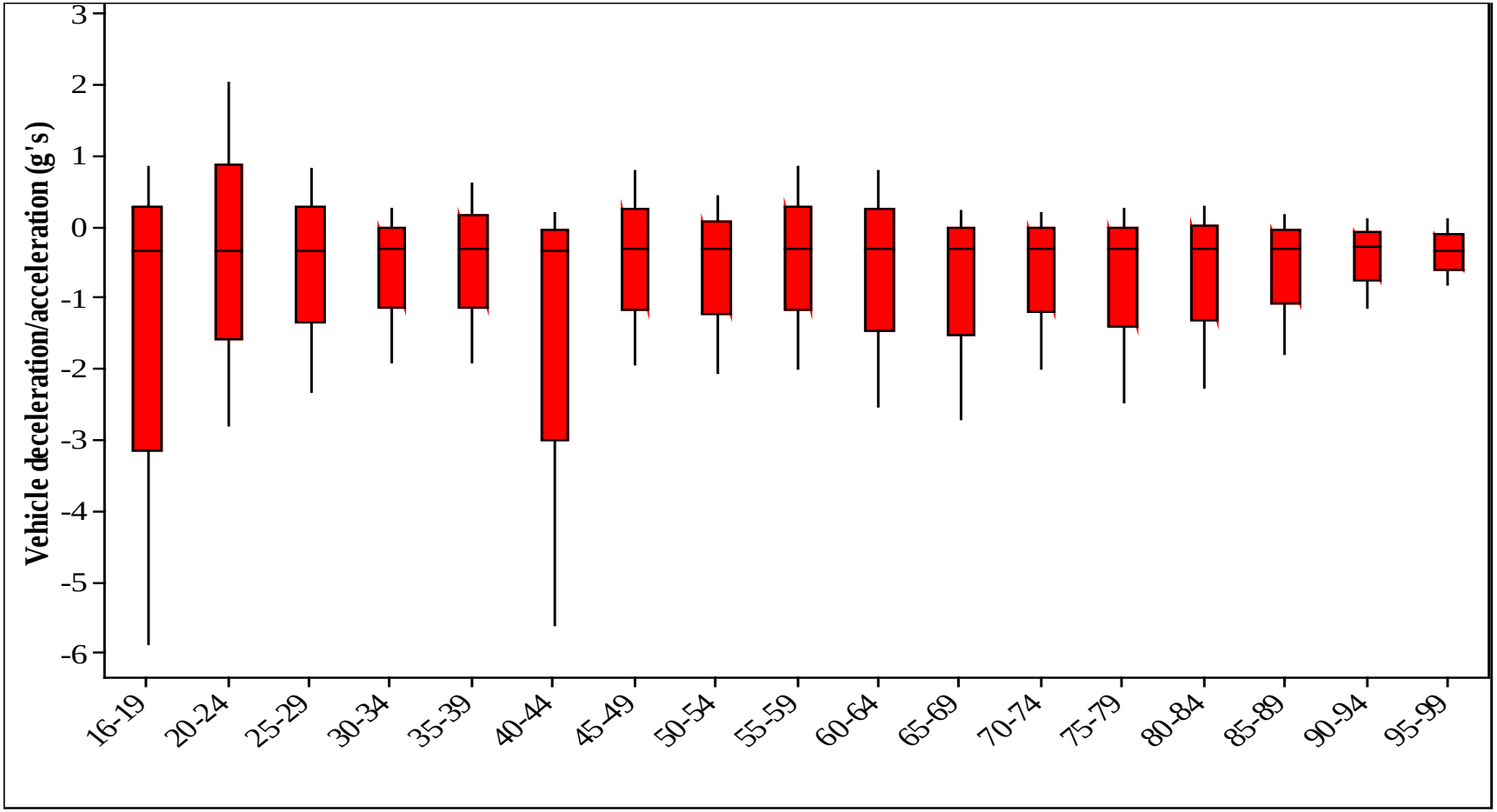


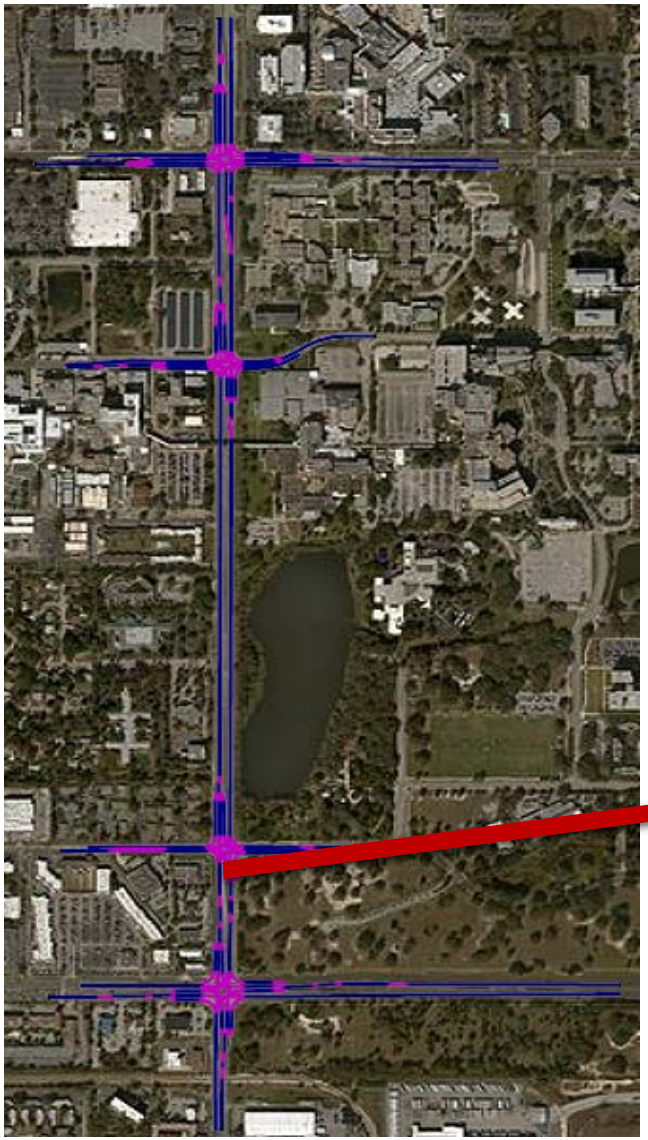
Chart showing the percentage distribution of drivers used in the study

Descriptive statistics

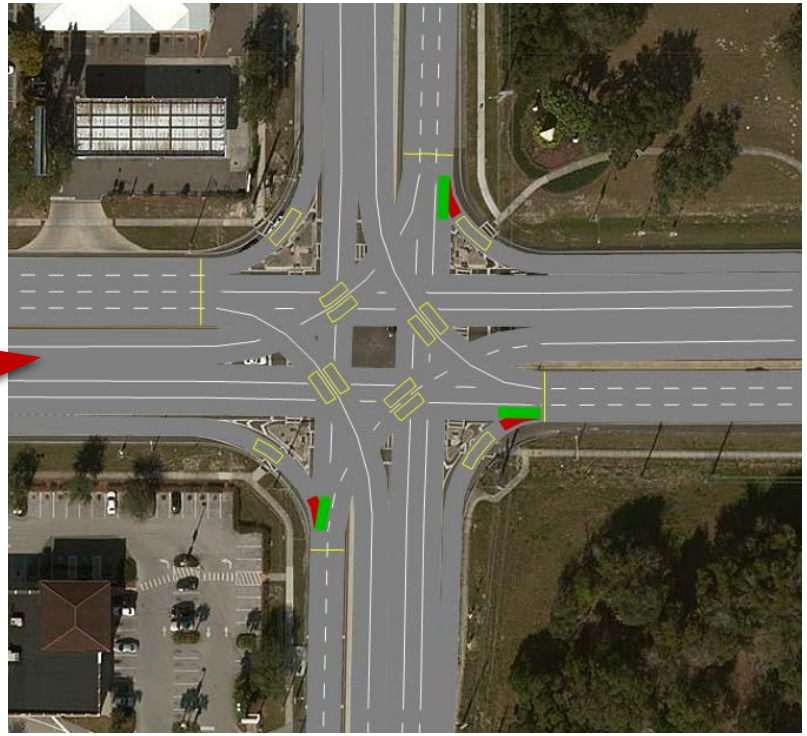


Maximum deceleration and acceleration based on driver's age group

VISSIM modeling



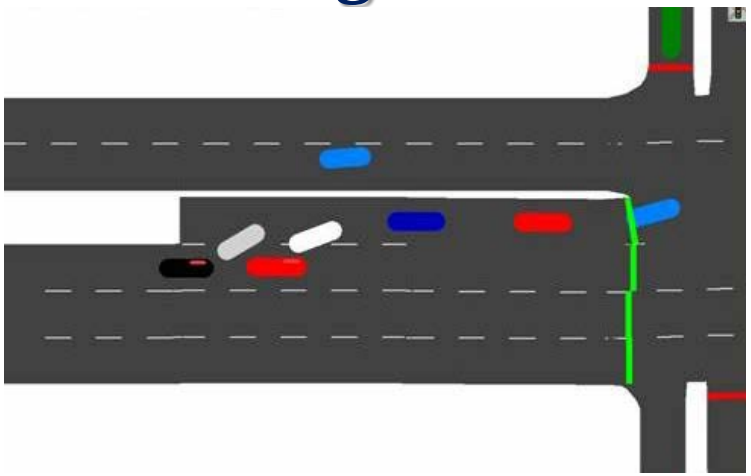
Layout of one of the intersection modeled in VISSIM taking into account all parameters; reduced speed area, no overtaking area, desired speed, detectors and lane width and configuration etc.



VISSIM modeling

Vehicle characteristics

- Deceleration
- Acceleration
- Speed profiles



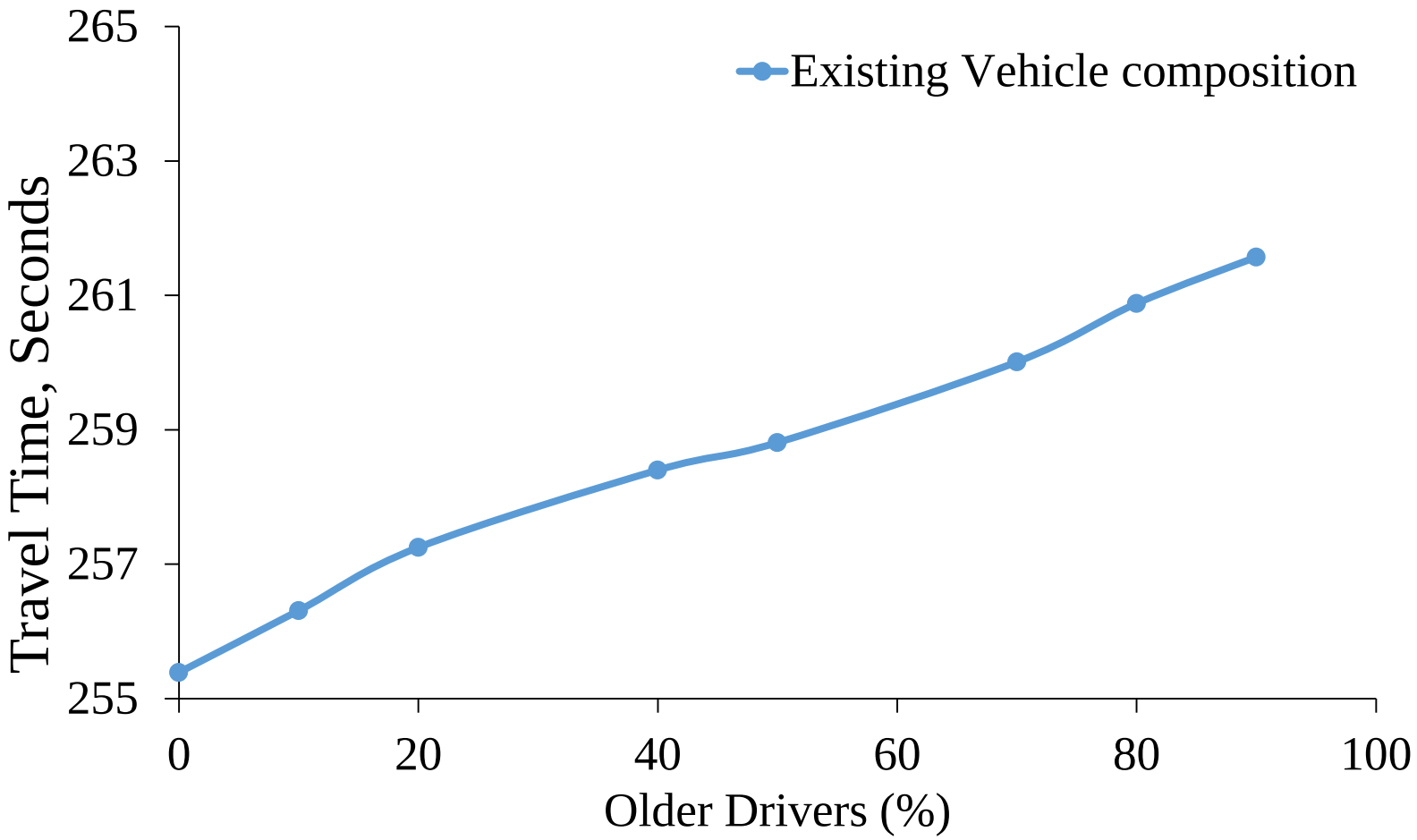
Calibration based on FDOT simulation guidelines

Output parameters

- Travel times & delays
- Conflicts trajectory files (*.trj*)

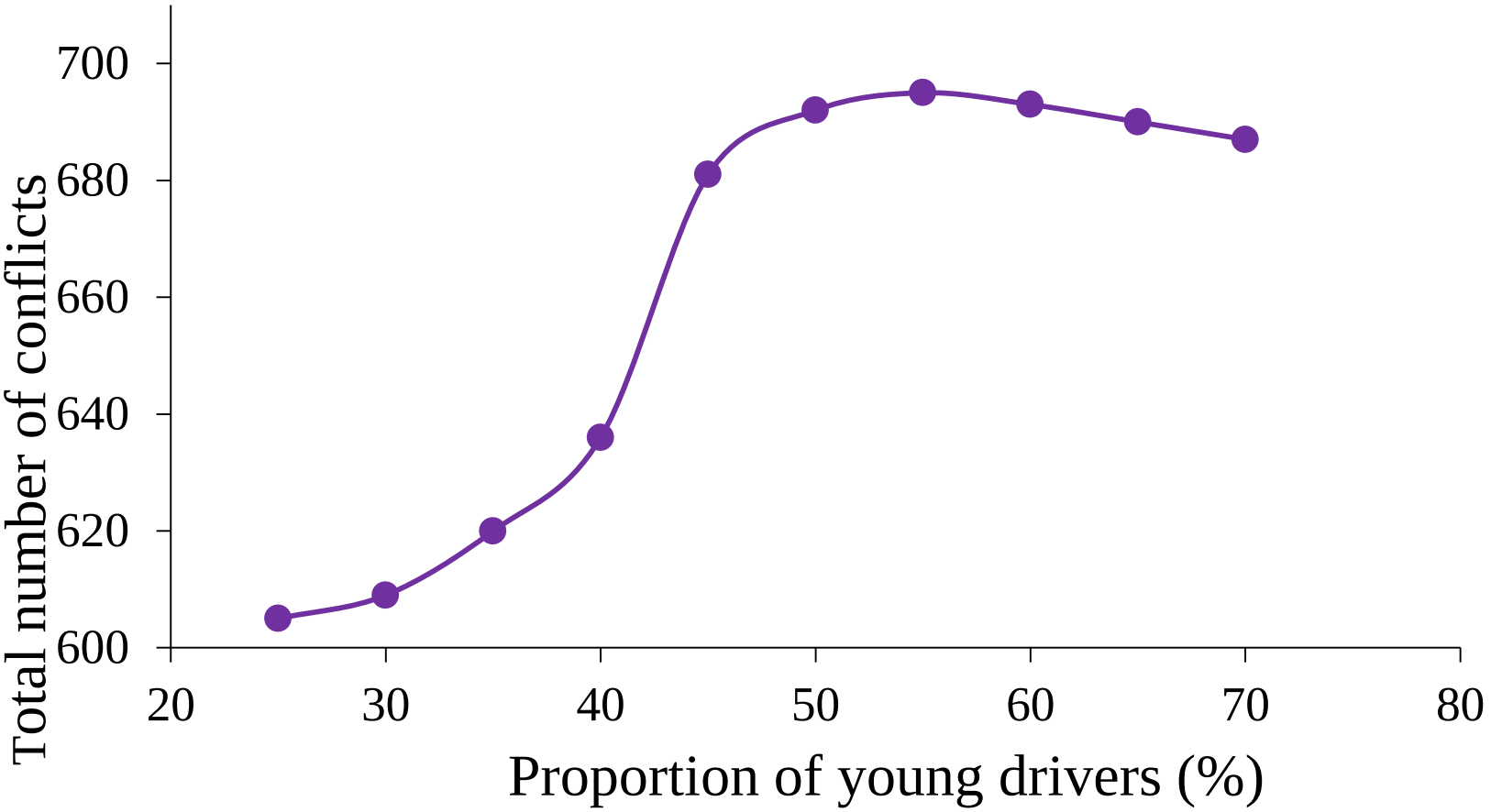
- Results obtained are the average of 10 simulation run performed
- Percentage of older drivers
- Evening peak hour (4 – 5) pm

Simulation results



Travel Time simulation results

Simulation results



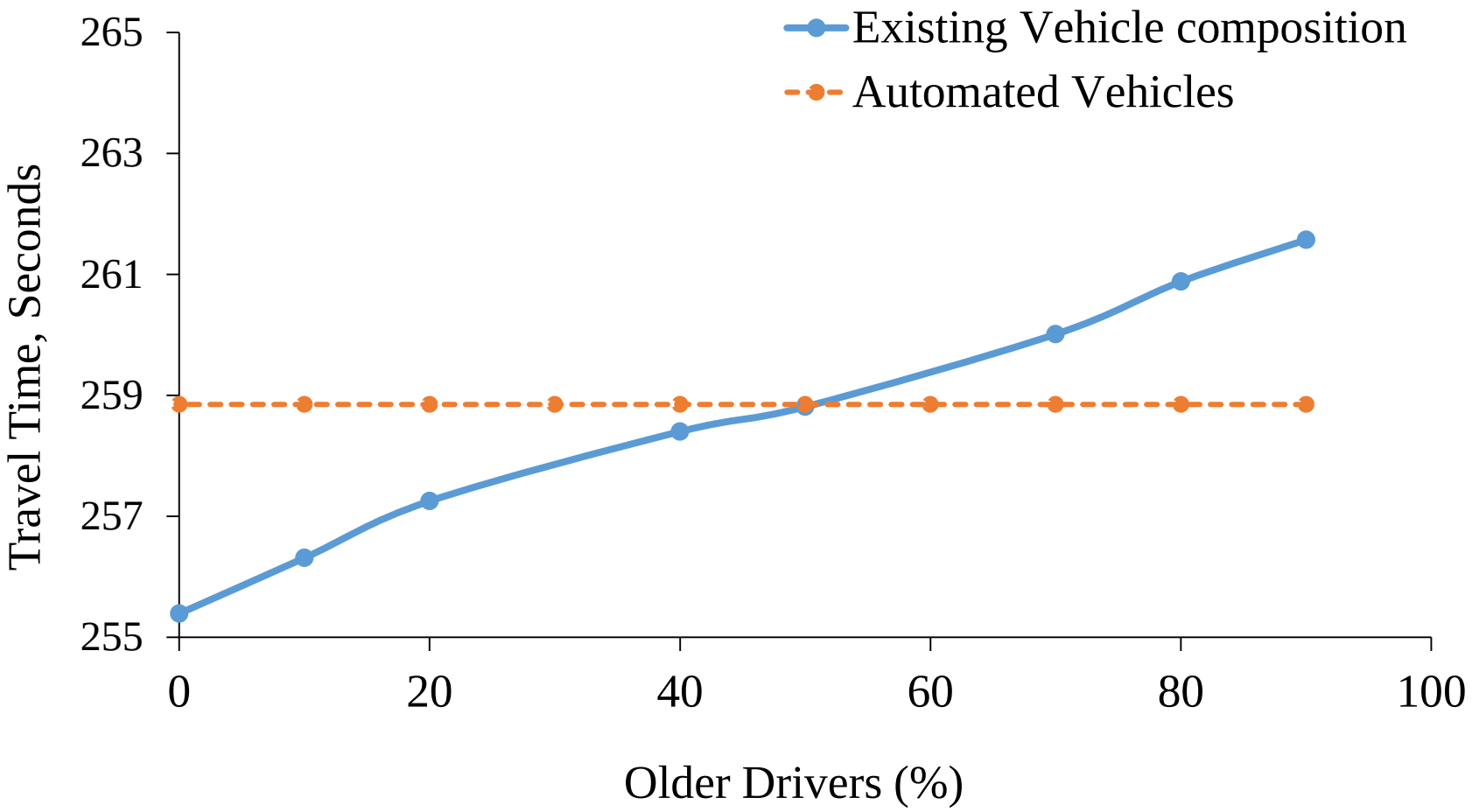
Relation between total number of conflicts and proportion of young drivers

Conclusions

- Old drivers exercise lower deceleration rates than young drivers;
  - ✓Increase travel times & delays
- Young drivers tend to decelerate at higher rate than old drivers;
  - ✓Increased number and severity of conflicts
- Presence of drivers with differential deceleration maneuvers at intersections increase number and severity of conflicts
- Automated vehicles vehicles with automatic braking systems;
  - ✓Improves traffic flow travel time
  - ✓Reduce conflicts

} *Due to differential vehicle deceleration maneuvers*

Recommendations



Travel Time simulation results: comparison between existing vehicle composition & automated vehicles

Recommendations

Conflict results-paired t-test

SSAM Measurement	Mean (BV)	Var. (BV)	Replications (BV)	Mean (AV)	Var. (AV)	Replications (AV)	t value	t critical	Mean Difference	Significant
TTC (second)	0.57	0.40	3280	0.55	0.42	1730	-0.47	1.66	-0.01	NO
PET (second)	0.59	0.96	3280	0.67	1.10	1730	1.99	1.66	0.09	YES
MaxS (mph)	23.17	70.55	3280	17.47	44.86	1730	-8.60	1.66	-5.71	YES
DeltaS (mph)	11.28	21.44	3280	10.06	21.82	1730	-2.80	1.66	-1.22	YES
DR (mph2)	-3.03	12.12	3280	-2.20	3.70	1730	2.54	1.66	0.83	YES
MaxD (mphs)	-6.85	32.33	3280	-4.45	6.37	1730	5.31	1.66	2.40	YES
MaxDeltaV (mph)	6.69	8.21	3280	5.30	1.84	1730	-5.84	1.66	-1.39	YES
Conflicts	**Mean (BV)**	**Var. (BV)**	**Replications (BV)**	**Mean (AV)**	**Var. (AV)**	**Replications (AV)**	**t value**	**t critical**	**Mean Difference**	**Significant**
Total	656	324	10	346	193	10	-3.03	2.92	-310	YES

Recommendations

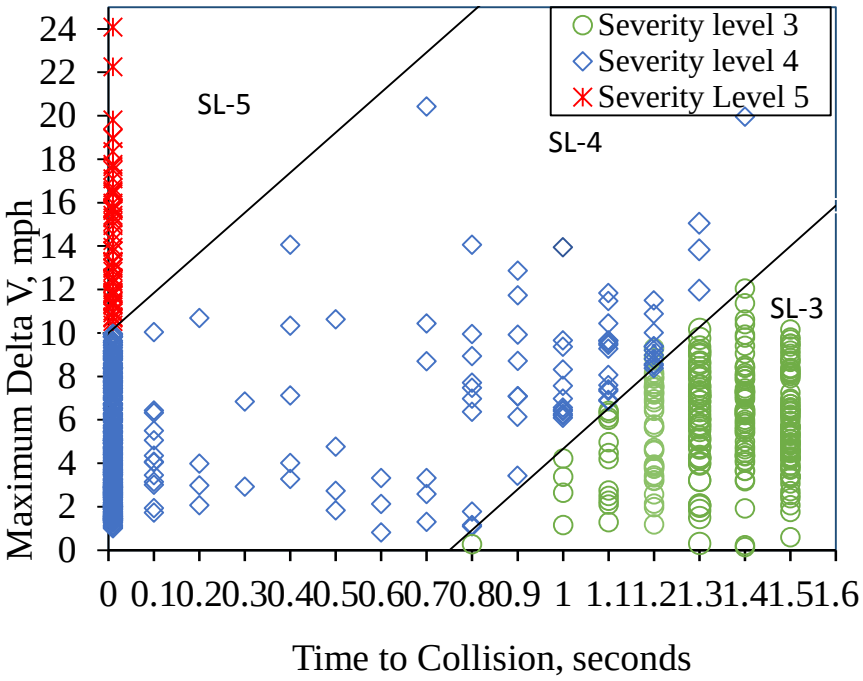
- Conflict severity increase with line number, i.e. line 1 & 2 has the lowest severity

Overall severity score contour line equations

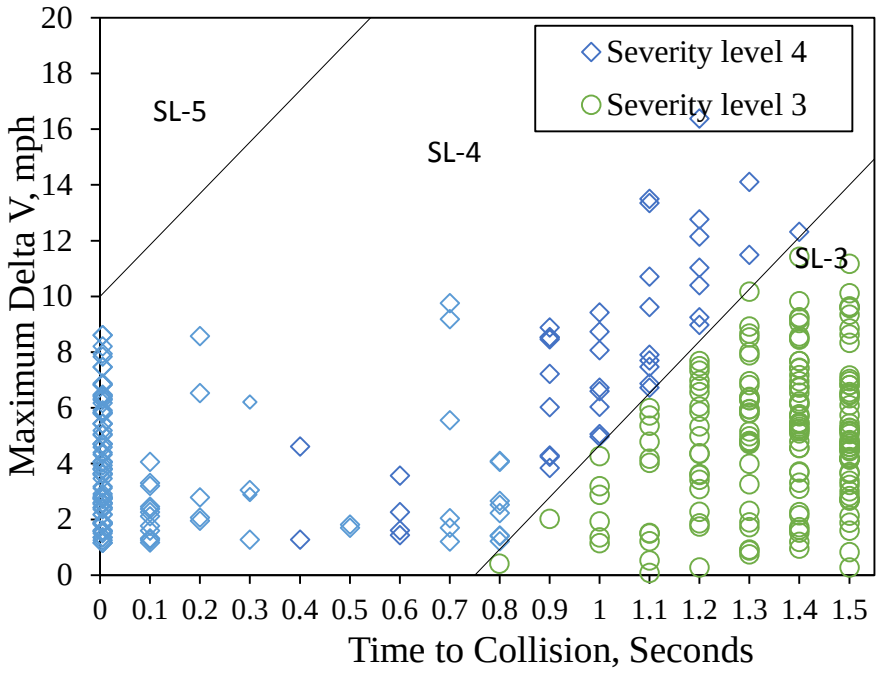
Severity level	Equation (Maximum DeltaV=)
SL-1	(120/7)(TTC)-(390/7)
SL-2	(55/3)(TTC)-(110/3)
SL-3	(280/15)(TTC)-14
SL-4	(240/13)(TTC)+10
SL-5	20(TTC)+30

Recommendations

Comparing conflicts severity level between normal condition and automated vehicles



Normal condition



Automated vehicles

Therefore automated vehicles saves a better way in both travel time and conflicts

THANKS FOR LISTENING ☺