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Indicators of assessing vehicle safety status under platoon conditions at freeway

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Background / Research Objective

Issue on level freeway segment (Interstate 80) in Nebraska:

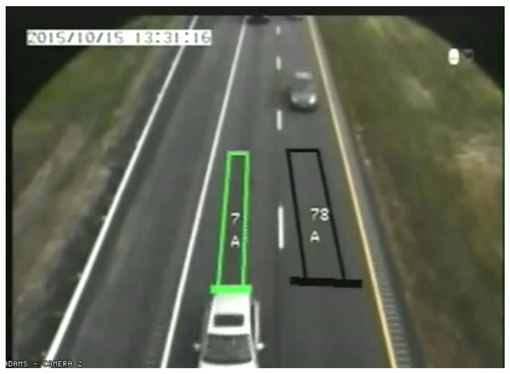
- High truck percentage (higher than 25%)
- Different speed profile
  - The speed of trucks are set to 67 mph, on average.
  - The speed of passenger cars are 75 mph, on average.
- Result platoons
  - Approximately 85% of vehicles are observed in platoon.
  - the degree of freedom to maneuver for drivers are constrained by other in-platoon vehicles.
  - Vehicles in platoons may face unsafe situation.

Goal:

Develop indicators to assess the safety status of vehicles under platoon conditions at level freeway segment.

Data Collection

NTC's ITS data collection van

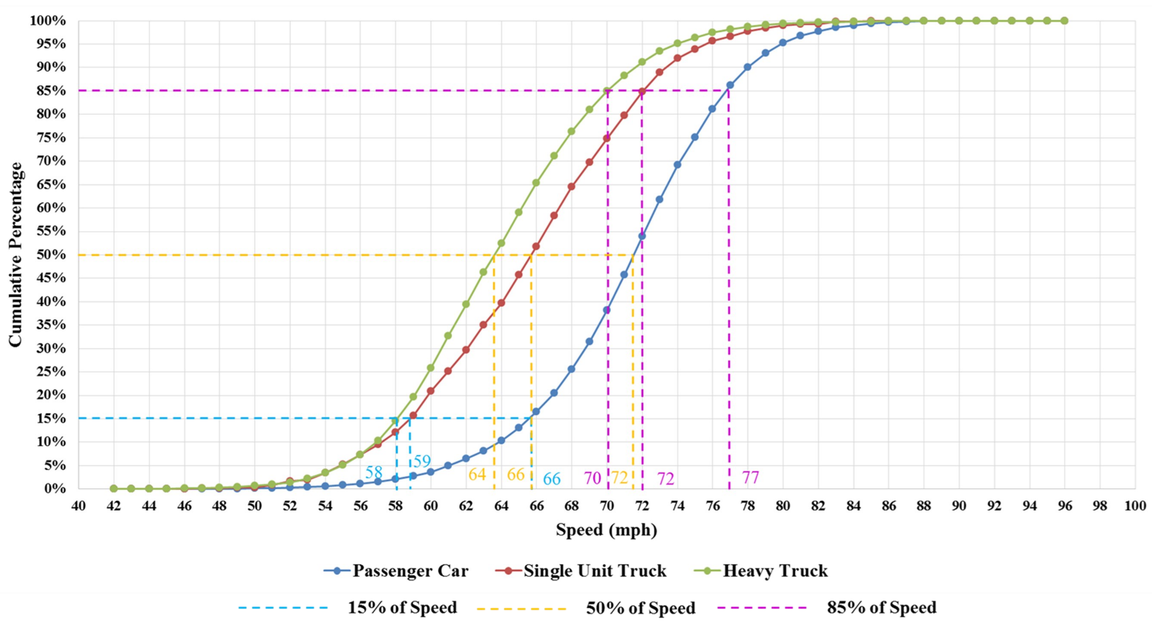


Virtual speed detectors on video

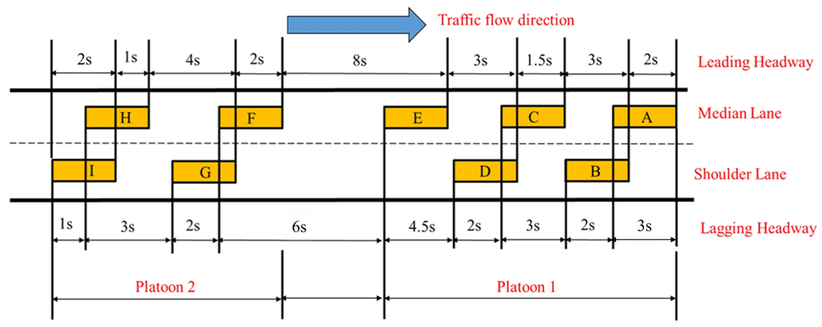
The data were collected at 13 sites on Interstate 80 between Lincoln and North Platte in western Nebraska. 48,903 vehicles are observed in total, including 14,231 trucks.

Basic Data Information

Groups	Indicators	Noted as
Vehicle Characteristics	Lane	lane
	Vehicle speed	speed
	Vehicle length	length
	Taken-up space	space
	Vehicle class	class
Speed Difference for	Leading vehicle on same lane	sd. ls
	Following vehicle on same lane	sd. fs
	Leading vehicle on adjacent lane	sd. la
	Following vehicle on adjacent lane	sd. fa
Headway for	Headway type	h.type
	Leading vehicle on same lane	h. ls
	Following vehicle on same lane	h. fs
	Leading vehicle on adjacent lane	h. la
	Following vehicle on adjacent lane	h. fa
Gap for	Leading vehicle on same lane	g. ls
	Following vehicle on same lane	g. fs
	Leading vehicle on adjacent lane	g. la
	Following vehicle on adjacent lane	g. fa
Traffic Flow	Traffic volume	volume
	Truck percentage	tp
Platoon Type	Platoon type	pt



Platoon Identification/Type



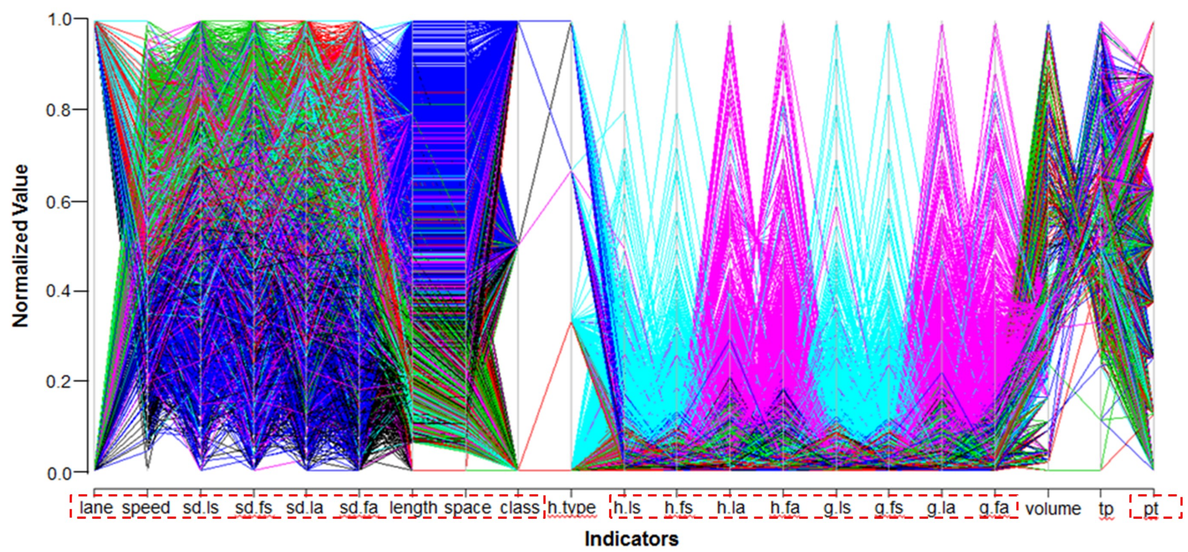
Critical Leading Headway = 3s, Critical Lagging Headway = 4s

Vehicles with leading or lagging headways less than or equal to the critical headways (CH) are considered in a platoon.

Headway Type	CH (s)
Car follow car leading	3.0
Car follow truck leading	8.0
Truck follow car leading	6.0
Truck follow truck leading	5.0
Car follow car lagging	3.0
Car follow truck lagging	7.0
Truck follow car lagging	6.0
Truck follow truck lagging	4.0

Platoon Type	Lanes	Leader on Shoulder Lane	Leader on Median Lane
0	Free flow vehicle (vehicle not in platoon)		
1	Two	Passenger car	Passenger car
2	Two	Truck	Passenger car
3	Two	Passenger car	Truck
4	Two	Truck	Truck
5	One	Passenger car	--
6	One	--	Passenger car
7	One	Truck	--
8	One	--	Truck

Cluster Results / Indicators



*The groups are clustered into 6 groups by K-means method.
*Values for category variables: 1) lane 0 – shoulder lane, 1 – median lane; 2) class 0 – car, 1 – single truck, 2 – heavy truck; 3) h.type 0 – cc, 1 – ct, 2 – tc, 3 – tt; 4) pt the values are as table above.
*If there are significant difference among groups on a given indicator, the indicator could be used for describing the vehicle safety status.
*The recommended indicators are shown in the red box above.

Cluster Group	Vehicle Characteristics	Safety Status delivered to Drivers
1 - Red	Median lane, medium speed, high sd.la, sd.fa, low length, car or single truck, low h.ls, h.fs, h.la, h.fa, g.ls, g.fs, g.la, g.fa, high volume, pt 6	Keep following preceding vehicle at a safety distance on your lane. Don't change your lane. Keep alert about drivers behaviors on your adjacent lane.
2 - Green	Shoulder lane, high speed, high sd.ls, sd.fs, sd.la, sd.fa, low length and space, car or single truck, low h.ls, h.fs, h.la, h.fa, g.ls, g.fs, g.la, g.fa, high volume, low tp, pt 0,1,5,7	Brake down when you are approaching your preceding vehicle. Don't change your lane. Keep alert about drivers behaviors on your adjacent lane.
3 - Light Blue	Median lane, low length and space, car or single truck, high h.ls, h.fs, g.ls, g.fs, low h.la, h.fa, g.la, g.fa, low volume, medium tp, pt 0,1, 2, 3	Keep your speed or higher on your lane. Don't change your lane. Keep alert about trucks in front of you and on our adjacent lane.
4 – Purple	Shoulder lane, low h.ls, h.fs, g.ls, g.fs, high h.la, h.fa, g.la, g.fa, medium volume, medium tp, pt 5, 7	Keep following preceding vehicle at a safety distance on your lane. You can change your lane when there is no vehicle on adjacent lane in your vision field. Keep alert about trucks in front of you and on our adjacent lane.
5 – Dark Blue	Low speed, low sd.ls, sd.fs, sd.la, sd.fa, medium to high length and space, single or heavy truck, medium h.ls, h.fs, g.ls, g.fs, h.la, h.fa, g.la, g.fa, high tp, pt 0, 2, 3, 4, 7	Keep your speed or higher on your lane. You can change your lane when there is no vehicle on adjacent lane in your vision field. Keep alert about trucks in front of you and on our adjacent lane.
6 - Black	Low speed, low sd.ls, sd.fs, sd.la, sd.fa, medium h.ls, h.fs, g.ls, g.fs, h.la, h.fa, g.la, g.fa	Approach or keep following preceding vehicle at a safety distance on your lane, don't change your lane.

Concluding Remarks

1) The recommended indicators for assessing safety status include vehicle speed, length, taken-up space, the speed difference, headway and gap between leading and following vehicles on the same and adjacent lane, and the platoon types that vehicles impeded in.
2) A set of logit models with cluster groups as dependent variable and with indicators above as independent variables could be developed, and then the cluster group to which the vehicle belongs could be predicted, and the corresponding safety status could be delivered to drivers.

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