USER MANUAL

Real-Time Crash Risk Visualization Tool for Traffic Safety Management

UCF Smart & Safe Transportation Team (UCF SST)

Submitted for Stage III of
Solving for Safety Visualization Challenge

http://SmartSafeSST.com

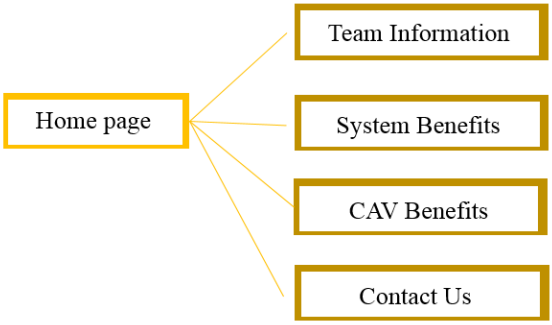
List of Icons

Type	Icon	Name
Data Input		CCTV
		Drone
		GRIDSMART
PATM		Queue warning
		Ramp metering
		Variable Speed Limit (VSL)
Bus/shuttle		Hard brake
		Hard acceleration
		High speed standard deviation
		Bus
		Shuttle
Others		School

1

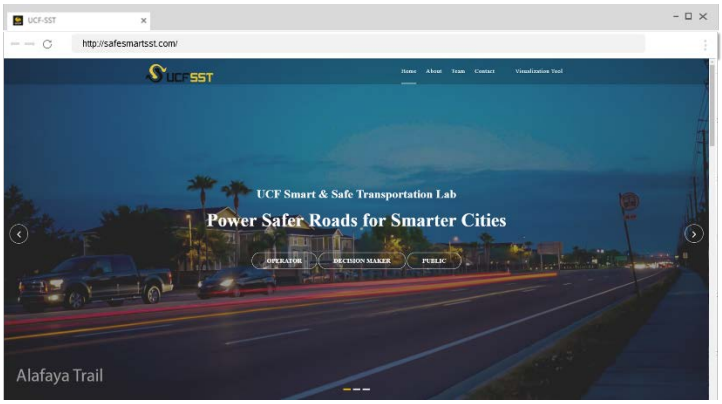
Getting Started

Home page



No hardware & software installation and data preparation process are required for using the system. The SST team is responsible for accessing and integrating the input data. Users can access the system from the following URL to enter the home page of the system: http://smartsafesst.com/.

The home page includes information about the team, system benefits, Connected and Automated Vehicles (CAV) benefits, etc.



System maintenance

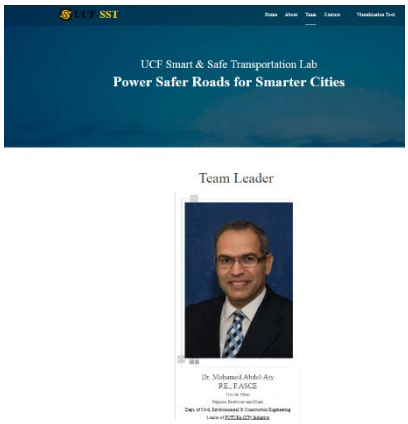
Users can select one of the following methods to maintain the system:

1) The SST team is willing to provide maintenance service and ongoing support of the system to users. Meanwhile, since the system will access local database(s), the team can also provide data management services to users as needed. SST team will provide warranty & support service to users.

2) The SST team can also work with a third-party (e.g., company or agency) to maintain the system and provide necessary support. If users prefer to maintain the system by their IT team from their agencies, the SST team would not be responsible for updates and maintenance, but can answer technical inquiries as needed.

Team member page

Click “Team”, the team member information of the SST team will be shown in the web page.



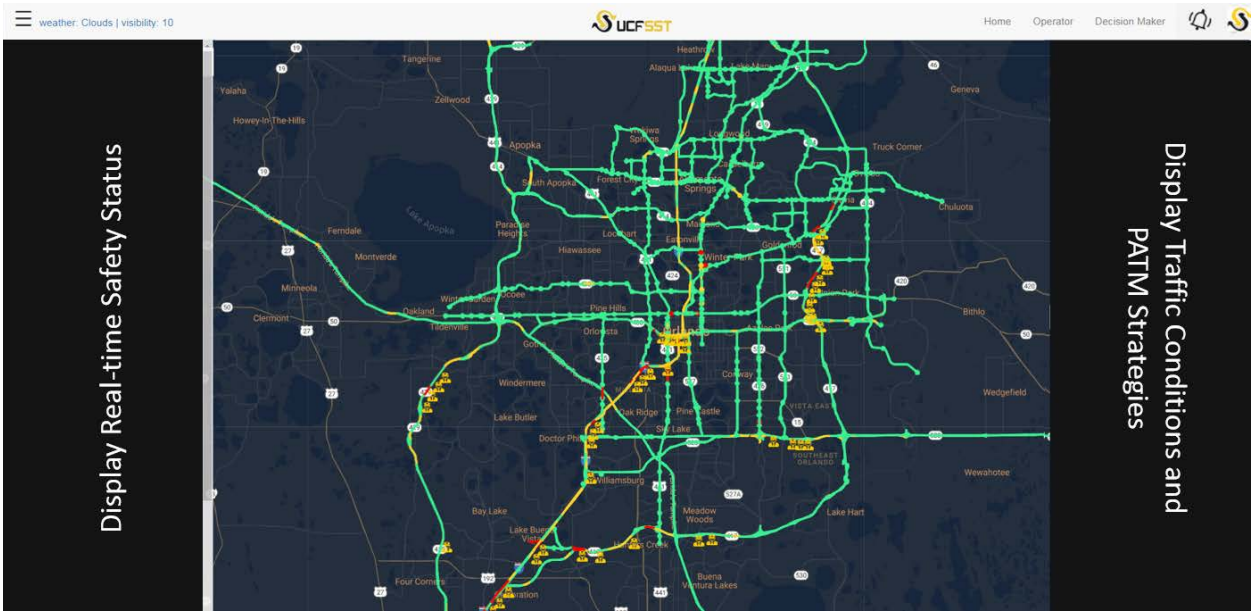
Contact page

Users can send their feedbacks or support requests through the “contact page.”

2

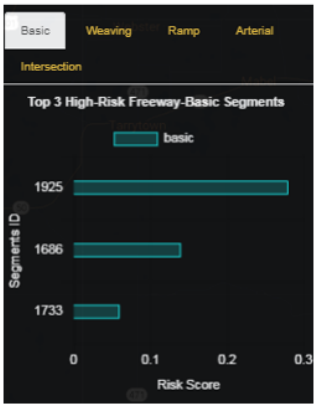
Operators

Go “Visualization Tool” > “Operator”, or directly click “OPERATOR” in the homepage. The following Figure shows the interface design for operators.



Real-time crash risk prediction

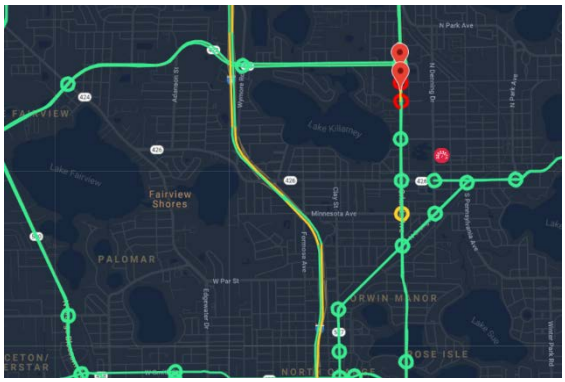
Location counts



Top 3 high crash risk locations

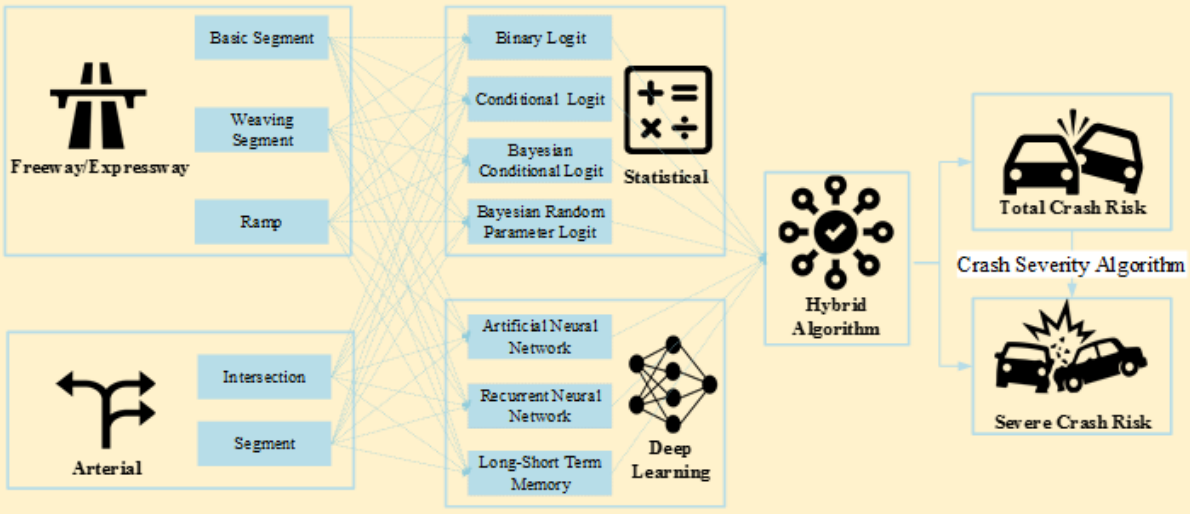
The left bar of the user interface displays the real-time safety conditions for the next 5-10 minutes.

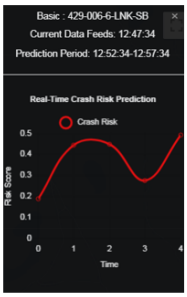
The predicted crash risk levels are visualized by different colors: red indicates high crash risk; yellow indicates medium crash risk; green indicates low crash risk. The icon indicates high severe crash risk. Users can select a location from the left bar or select a location from the map. Then, more information for the selected location will be displayed.



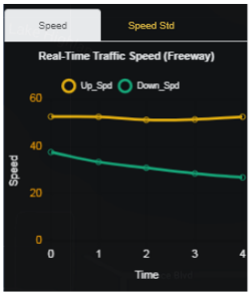
Real-time Crash Risk Prediction Models

The following Figure illustrates the system framework of real-time crash risk prediction algorithms, which are separated into two types of roadway facilities, i.e., freeways/expressways and arterials. In addition to the basic segments, all special locations along freeways/expressways (i.e., weaving segments and ramps) and arterials (i.e., signalized intersections) are also considered with specific algorithms. With respect to the algorithms, two categories of algorithms are employed in real-time crash risk prediction studies: statistical methods and deep learning algorithms. As crash risk analysis is a typical binary classification problem, statistical methods mainly include binary logit model, conditional logit model, Bayesian conditional logit model, and Bayesian random parameter/effect logit models. On the other hand, deep learning algorithms mainly include artificial neural network, recurrent neural network, and long-short term memory. For every roadway type, both statistical analyses and deep learning algorithms are applied to predict real-time crash risk, and then hybrid algorithms, e.g., average ensemble, weighted average ensemble, etc., are employed to combine all the prediction results into a final predicted crash risk. In addition, severe crash risk are estimated based on crash severity prediction algorithms.

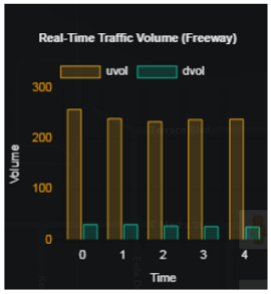




Predicted crash risk



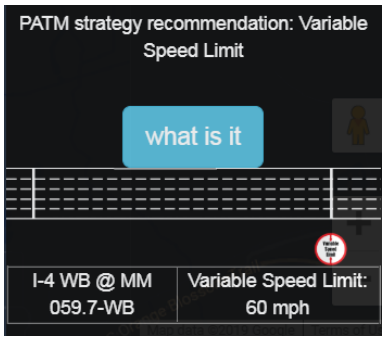
Speed/std. Speed



Volume

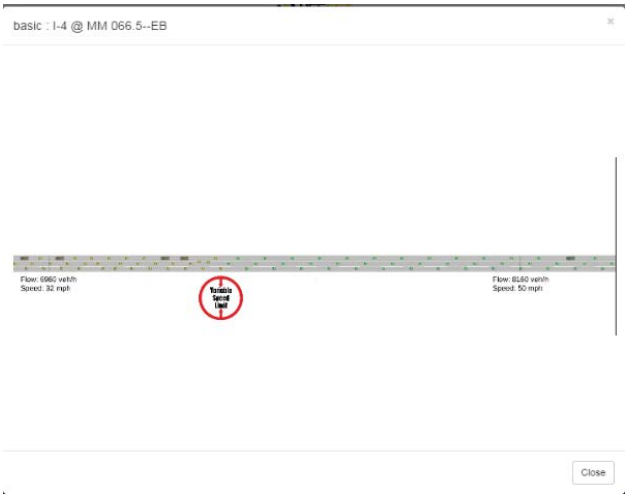
The right bar of the user interface displays more information of the real-time conditions, which include roadway name, predicted crash risk, and real-time traffic parameters (i.e. average speed, speed standard deviation, volume) of the upstream and downstream locations.

Pro-active Traffic Management (PATM)



Recommended PATM strategies will be provided for high risk locations at the right bar.

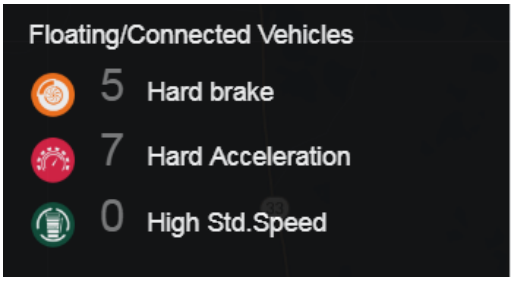
Click “what is it”, the animation for the countermeasure will be displayed to help users to visualize the countermeasure.



Proactive Traffic Management Strategies

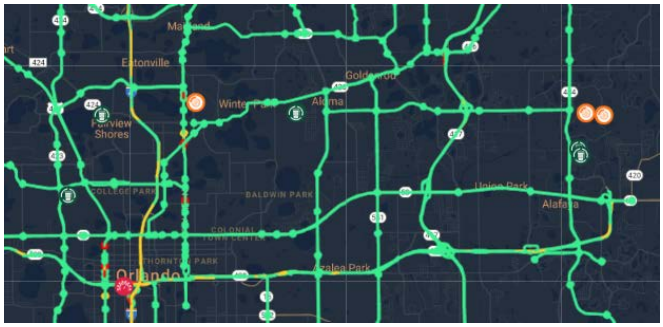
Over ten research studies regarding the safety and operation benefits of PATM strategies are evaluated and four of them are selected to serve as initialization. They are Zonal Variable Speed Limit (Abdel-Aty et al., 2008), Zonal Ramp Metering (Abdel-Aty and Gayah, 2010) and Integrated Queue Warning (Unpublished Research) for freeway basic segments as well as Integrated Variable Speed Limit and Isolated Ramp Metering (Wang et al., 2017) for freeway weaving segments. Their logic are integrated into a decision tree. Traffic condition and roadway geometric design of the high-risk locations and the roadway network topology are collected as the input of the algorithm. Then the algorithm selects the countermeasure(s) based on several rules abstracted from our previous research.

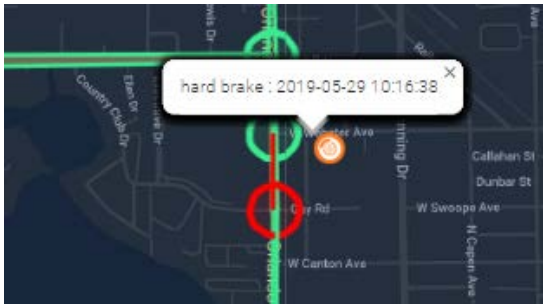
Floating/connected Vehicles



Critical driving events (i.e. hard brake, hard acceleration, high speed standard deviation) for floating/connected vehicles are monitored and recorded by the system. The numbers of different types of criterial driving events for the last 60 minutes are displayed in the left bar.

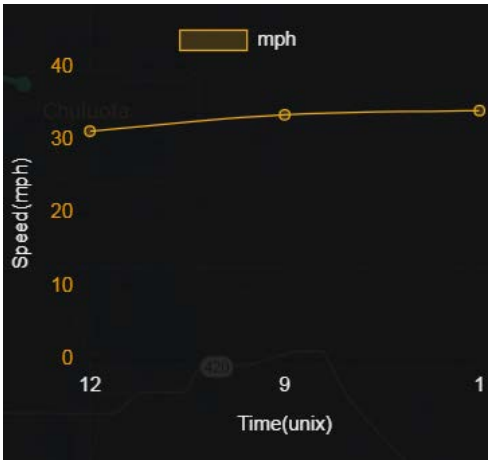
The critical driving events for the last 60 minutes are also plotted on the map. For example, if the current time is 10:27 AM, the map will display the critical driving events that happened between 9:27 AM and 10:27 AM. It is worth noting that buses/shuttles may operate on roadways that are not covered by the base map of real-time crash prediction. Thus, the locations of buses/shuttles and the critical driving events may not always be on minor roadways that are not part of the base map.





Select the critical events on the map, more information will be displayed.

Select a floating/connected vehicle from the map, the real-time speed information of the selected vehicle will be displayed at the right bar.

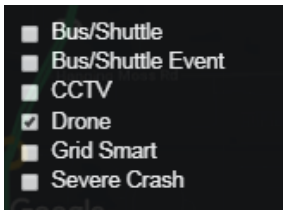


Thresholds of Critical Events

In order to alert users of the system about abnormal driving situations, three critical driving events can be obtained from the real-time bus database, which are hard acceleration, hard brake and high speed standard deviation. Their thresholds are shown in the following table.

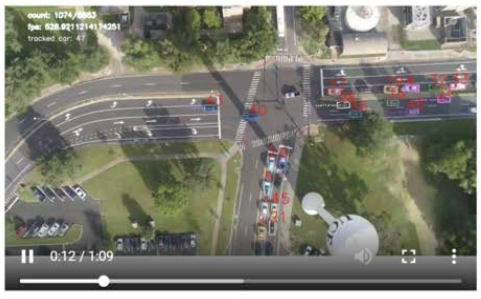
Indicator	Definition
Hard Acceleration	Acceleration > 0.4 g
Hard Brake	Acceleration < −0.4 g
High Speed Standard Deviation	Speed Standard Deviation > 99% Percentile of the speed standard deviation

More information



More visualization resources can be shown by selecting the corresponding check boxes, such as CCTV, drone, and GRIDSMART (as the following Figures).

CCTV



Drone

GRIDSMART

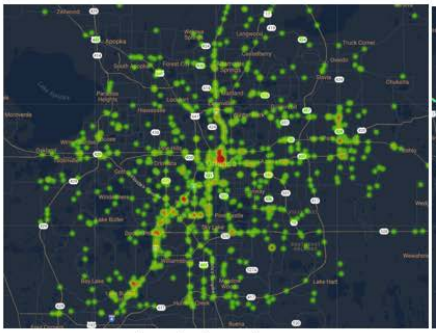
3

Decision Makers

Go “Visualization Tool” > “Decision maker”, or directly click “DECISION MAKER” in the homepage.

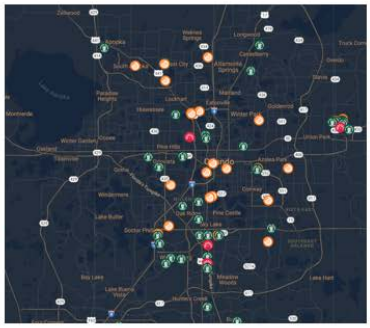
Temporal status

Weekly data includes crashes, crash risk, and floating/connected vehicles can be displayed on the map to have a better understanding of the safety conditions.



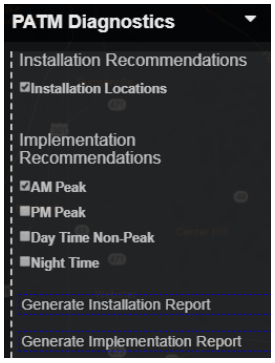
Historical Crashes

Historical Crash Risk



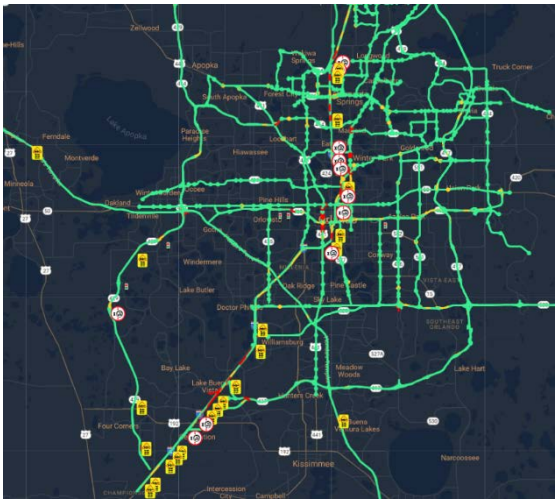
Floating/Connected Vehicles

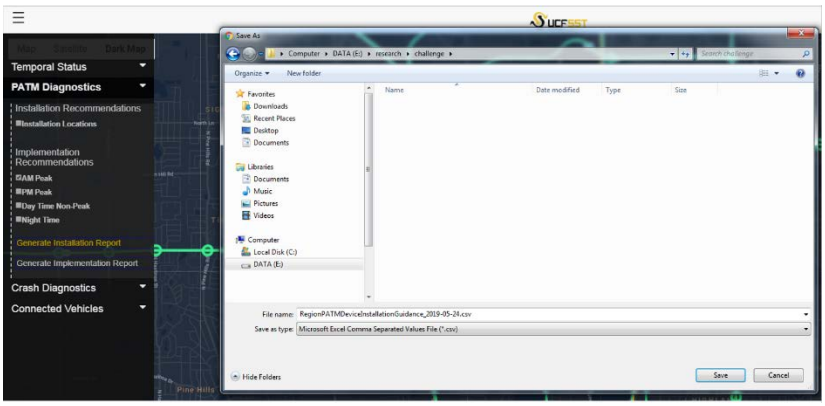
PATM diagnostics



The PATM diagnostics components include 2 parts: installation recommendations and implementation recommendations.

Select “Installation Locations” or select a certain time period (i.e. AM peak, PM peak, Day time Non-Peak, Night Time) from “Implementation Recommendations”, countermeasures will be displayed on the map at the recommended locations.





Users can download the PATM reports by selecting "Generate Installation Report" or "Generate Implementation Report".

Installation Recommendations

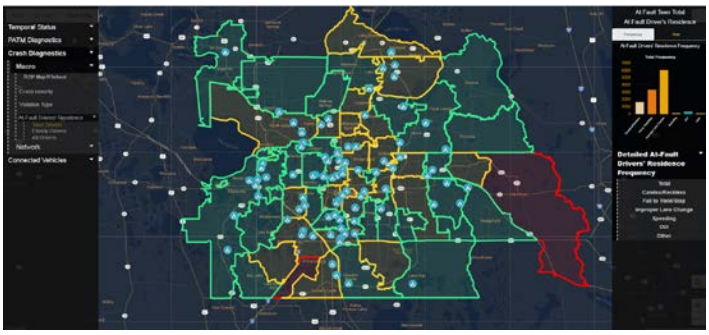
When there is no existing PATM device (e.g., queue warning signs) for a certain high-risk location but the system recommends frequently certain PATM countermeasure, installing a new device might be recommended to the decision maker to reduce the crash risk.

Implementation Recommendations

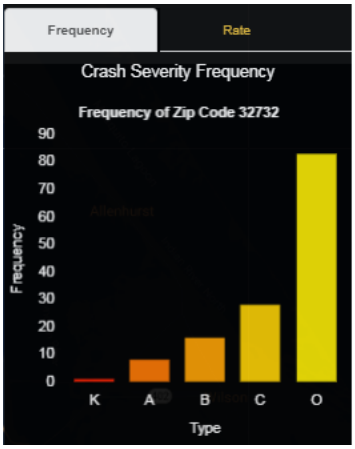
The PATM AI tracks the history of the implementations of PATM strategies and provides a visualization of locations where the problem and countermeasure are repeated frequently. The locations are visualized as icons on a map which illustrates the frequency of high-risk events. We suggest to decision makers to repeat the solution at the same location(s) automatically for certain time periods to alleviate the risk pro-actively.

Crash Diagnostics

The crash diagnostics component includes two levels: macro level and network level. Users can select the corresponding level from the left bar.

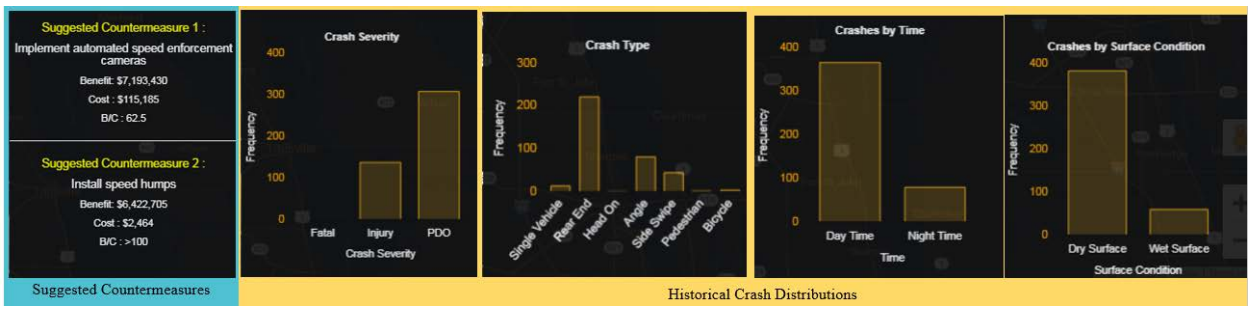


Macro Level: select "Macro", zone level information of the selected crash type/ violation type will be displayed on the map. Also, the right bar will show the corresponding frequency/rate distribution.

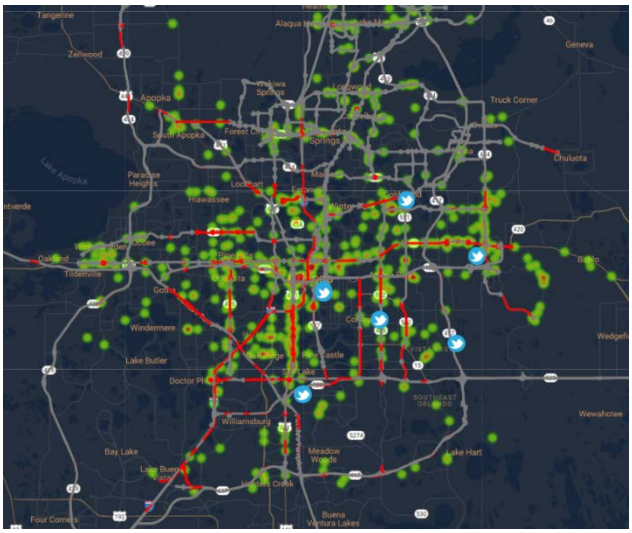


Select a ZIP code area in the map, the distribution for the certain area will be displayed on the right bar.

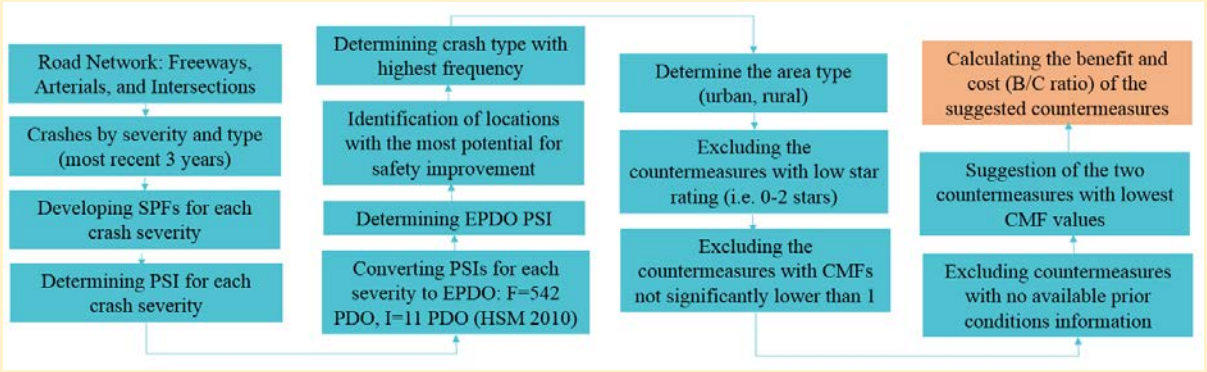
Network Level: Select "Network", crash hotspot locations (locations with red color) will be displayed on map. After selecting locations in the map, historical crash information and suggested countermeasures for hotspot locations will be displayed at the right bar.



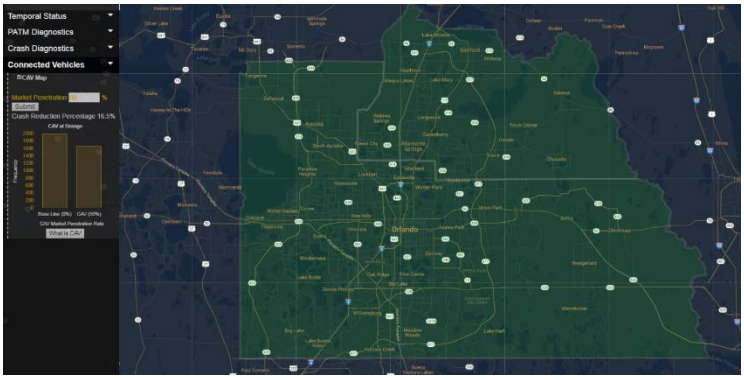
Twitter data and Strava data can also be plotted on the map by selecting the corresponding check box.



Historical Crash Diagnostics Process



Connected Vehicles

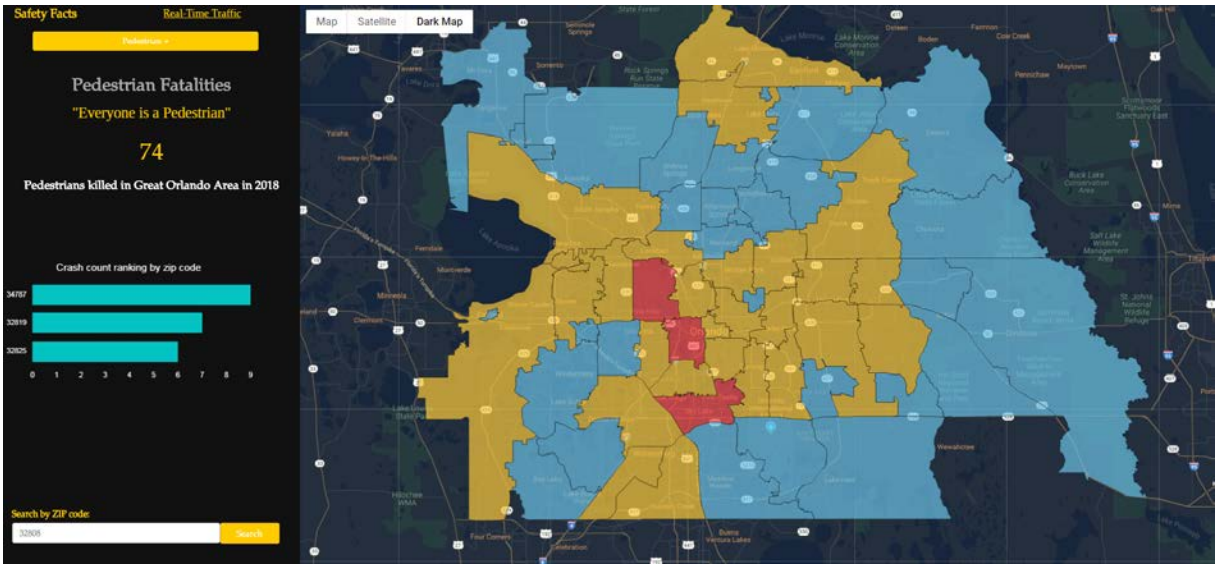


Select “Connected Vehicles” > change the Market Penetration Rate > select an area in map > Click “submit”. The expected safety benefit of connected vehicles based on our research will be shown at the left bar.

4

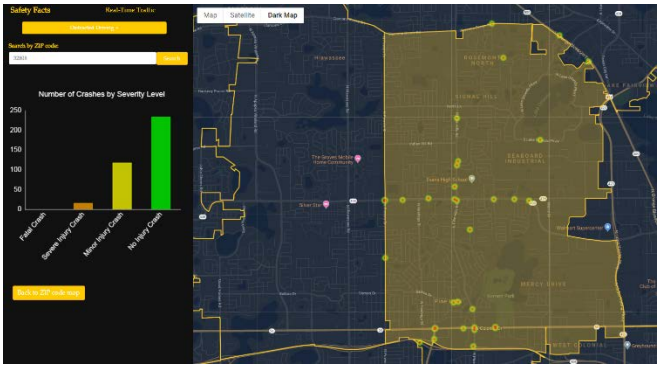
Public Users

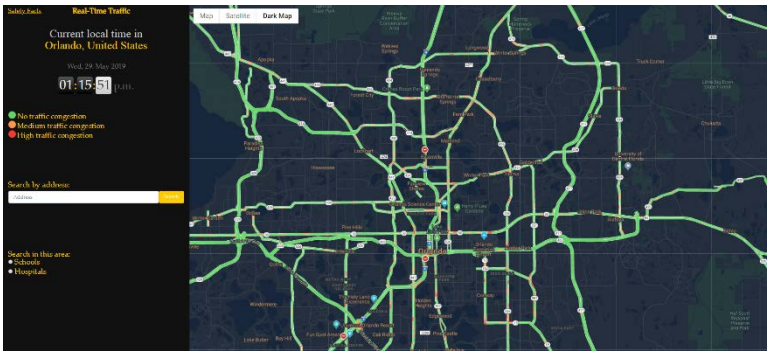
Go “Visualization Tool” > “Public”, or directly click “PUBLIC” in the homepage. Safety conditions for the area will be displayed.



Select different crash types, zone level map will be changed to the corresponding crash type.

Select a ZIP code area or type a ZIP code in the left bar, the historical crash information for the selected area will be displayed on the map and the left bar.





Select “Real-Time Traffic” from the left bar, real-time traffic information will be shown on the map.

Select “Schools” or “Hospitals”, the corresponding locations for schools/hospitals will be plotted on map. Moreover, messages will be sent to users to improve their safety awareness.

Schools

Hospitals

References

Abdel-Aty, M., Cunningham, R., Gayah, V., Hsia, L., 2008. Dynamic Variable Speed Limit Strategies for Real-Time Crash Risk Reduction on Freeways. Transp. Res. Rec. J. Transp. Res. Board 2078, 108–116. doi:10.3141/2078-15

Abdel-Aty, M., Gayah, V., 2010. Real-Time Crash Risk Reduction on Freeways Using Coordinated and Uncoordinated Ramp Metering Approaches. J. Transp. Eng. 136 5 , 410–423. doi:10.1061/(ASCE)TE.1943-5436.0000100

Wang, L., Abdel-Aty, M., Lee, J., 2017. Implementation of Active Traffic Management Strategies for Safety on Congested Expressway Weaving Segments. Transp. Res. Rec. 2635 1 , 28–35. doi:10.3141/2635-04