

Research Report Summary



SAFER-SIM University Transportation Center

Mohamed Abdel-Aty, Ph.D., P.E.
Ma'en Al-Omari, Ph.D.

8/13/2021

Investigation of Driving Behavior at Alternative Intersection Designs and Safety Improvement: A Driver Simulator Study

Overview

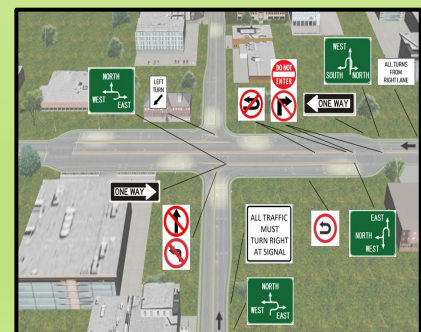
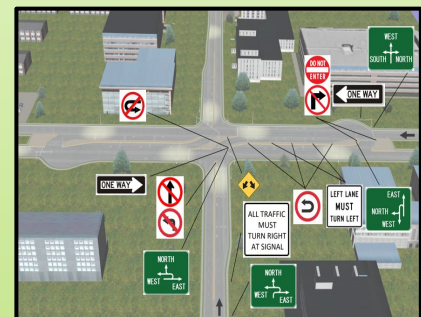
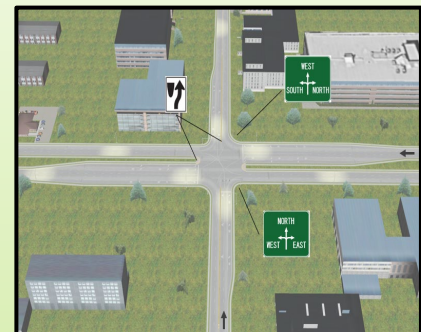
This research project aimed to investigate the safety aspects of the shifting movement (SM) intersection design. A driving simulation experiment was conducted in this study in order to evaluate the traffic safety at the SM intersection design and to determine the extent of confusion that drivers could have while crossing this intersection design in comparison with conventional and Restricted crossing U-turn (RCUT) signalized intersections. Furthermore, an evaluation of the effect of implementing the infrastructure to vehicle (I2V) communication on driving behavior and traffic safety improvement at unconventional intersections was also accomplished in this study.

Alternative Intersection Designs

RCUT and SM intersections were considered for analysis in this study because they have the lowest number of conflict points (14 conflict points) among other alternative intersections designs.

Experiment Design

- 1) RCUT and SM intersection designs were simulated along with the conventional intersection in the daytime in an urban environment.
- 2) RCUT and SM intersections were controlled by traffic signals.
- 3) Lane marking was implemented at the intersections to specify the permitted movement(s) that can be done by using any particular lane.
- 4) Different regulatory and guide signs were used in the experiment especially at intersections.



The simulated conventional and unconventional intersection designs

- 5) Two full factorial design experiments were conducted in this study. The factor of the first experiment was the intersection type while the factor of the second was the use of I2V communication at unconventional intersections.
- 6) The I2V communication was simulated by sending navigation information for guiding drivers to accomplish the unconventional movements. Visual and voice messages were sent to drivers before every stage of each unconventional movement at RCUT and SM intersections.
- 7) Three (10-minutes) routes were designed to perform right-turn, through, and left-turn movements at a combination of conventional, RCUT, and SM intersections.
- 8) Light traffic was set in the roadway environment to give the driver freedom to drive at a free-flow speed without impedance with other vehicles. This is to examine the geometric design of the unconventional intersections.
- 9) Enough spacing between intersections was provided to give the driver enough time to go back to normal driving behavior before reaching the next intersection.
- 10) All traffic signals were triggered to have a green light except for some intersections which have red traffic signals to avoid the expectation of green light at every intersection in the route. Data at intersections with red traffic signals were excluded from the analysis.
- 11) The driver was asked to head in a specific direction at every intersection by sending text and voice messages upstream of the first stop line at the intersection.

Experiment Development

- 1) The data in this study was obtained from 32 participants who had completed the experiment.
- 2) The participant was briefed about the driving simulator and the experiment. The participant also learned about unconventional intersections especially about the two unconventional intersections in this experiment.
- 3) The participant was asked to complete a questionnaire about some personal and driving experience information.
- 4) The participant was subjected to a 5-minutes trafficless practice route before starting the experiment.
- 5) The order of unconventional intersections within every route, the order of the with-I2V and without-I2V routes, and the order of without-I2V routes themselves were changed to mitigate the order effect.
- 6) Participants reported their feedback about the experiment, the confusion at unconventional intersections, and the extent of signs and I2V communication usefulness after finishing the experiment.

Findings and Recommendations

- 1) Most participants have accomplished the unconventional movements at RCUT and SM intersections except the major left-turn movement at the SM intersection.
- 2) RCUT and SM intersections have similar safety effectiveness and performing the minor road movements at them is safer than at the conventional intersection.
- 3) Using I2V communication is effective in guiding drivers to perform the major left-turn movement at the SM intersection.
- 4) Improving drivers' awareness regarding the major left-turn movement at the SM intersection must be achieved by educating drivers through the different media sources.
- 5) Testing the effectiveness of different sign configurations to guide drivers for performing the major left-turn movement at the SM intersection must be covered in future research.