

Modeling Safety of Lane Change Maneuvers Based on Driver Gaze and Vehicle Operation Behavior

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Abstract:

Changing lanes is one of the most common driving maneuvers, and risky lane change behavior is often the cause of accidents. In order to analyze driver behavior during lane change maneuvers and estimate risk levels, we collected driving data from expert and non-expert drivers on expressways while they passed other vehicles using an instrumented vehicle. In order to assess the actual risk level of each lane change scene, we first recruited nine subjects who watched front-view video of each lane change scene, and they rated how risky they felt a scene was on a scale from 1 to 5, with 5 representing the highest risk level. We then assumed that the direction of a driver's gaze could be roughly categorized into one of ten directions, such as "front," "left," "rear-view mirror," "instrument panel," etc., and manually labeled each driver's gaze direction frame by frame using video of the drivers' faces. Vehicle operation behavior was also broken down into discrete acts such as "brake-on," "steady speed," "left-low acceleration," etc., based on amounts of pedal pressure and on longitudinal/lateral acceleration. Next, we modeled safe and risky lane change maneuvers based on gaze directions and discrete acts of vehicle operation behavior using hidden Markov models (HMMs). We found that there were significant differences between the parameters of the HMMs modeling safe and risky behavior. We then estimated risk levels of lane changes using HMMs. Our models could successfully estimate current risk levels of lane change maneuvers, compared to the risk levels assigned by our risk raters, by accumulating HMM likelihood over the previous fifteen minutes.