RoadLab: Predicting Driver Intentionality

Sense, purpose and aim:

The innovation consists of perdicting driver intentionality from ocular behaviour and driving context analysis.

Initial Situation

According to the World Health Organization, deaths from injuries are projected to rise from 5.1 million in 1990 to 8.4 million in 2020, with traffic-related incidents as the major cause of this increase. Driving is an essential economic aspect which impacts a number of critical safety factors. In North America, there were 6 million accidents, 1.7 million injuries, and 39,000 fatalities in 2006. Yet the simplest of Driving Assistance Systems (DAS) such as enhanced stability control may reduce single-vehicle crashes by 29 to 35%.

Problem

The socio-economic costs of vehicle related injuries and deaths are excessively high, and on the rise in emergent countries, due to a sizeable increase in vehicle ownership. How can vehicles help minimze driver error, while being non-intrusive and preventing information overload? It is known that an increase in the penetration of DAS generates a decrease in the number of fatalities. However, most DAS exclude driving behaviour and driver intentionality analysis from the control feedback mechanism, only to focus on vehicular attitude and external driving condition analysis.

Proposed Solution

Research in Driving Assistance Systems (DAS) is concerned with monitoring the driving environment to enhance safety by way of driver warning systems. DAS can detect other vehicles, road lanes, pedestricans, and obstacles. Ocular behaviour sensors have been designed to infer levels of attention by registering eye movement such as gaze direction, saccade, and blink frequency. We propose to enhance safety by relating gaze direction to environment features detected by DAS to warn driver only when driving context is misunderstood and driver intentionality is inappropriate.

Degree of Innovation

At this time, there is very little research effort to fuse driver ocular behaviour and DAS to predict driver intentionality. We believe that the vehicle drivers should be at the centre of DAS feedback mechanism, for clearly eastblished reasons: it has been repeatedly demonstrated in the literature that ocular behaviour is a very reliable predictor of physical movement. This confirmed hypothesis can be extended to driver behaviour, if one realizes that automotive vehicles constitute an extension of human physical capabilities for displacement. Consequently, driving behaviour is predictable.

Degree of Maturity

The development stage is at the prototype level. We have instrumented a vehicle with on-board mutli-core computers, stereo sensors for DAS implementation, with CANbus/OBDII interface to analyse vehicle attitude and driving actions, and 3D driver ocular analysis, including 3D driver gaze estimation. Future expenses relate to developing the required software for testing the reliability of our hypothesis, robustness to sensing errors, study commercial feasibility and impact. Risks are linked to the level of safety increase of solution and driver acceptance of DAS. Timeframe is 3 to 4 years.

Economic Potential

Ultimately, every vehicle can be equipped with our proposed DAS with focus on driver ocular behavior. The proposed system offers benefits even in the case that penetration of technology is limited (unlike V2V-based DAS), and will likely surpass the safety benefits of other DAS. Costs to bring this proposal to market are significant but the potential benefits are immensely superior in terms of the cost reductions related to decreases in deaths and injuries. Drivers wil find non-intrusive DAS (warning only when required) desirable from the safety standpoint.

Invrease in Comfort

The first stage of deployment of DAS would target senior markets in the western world, where nascent DAS technology is already well received by consumers. As production costs decrease, other markets can then be ventured in. Utimately, the resulting DAS product should be programmable to cater to drivers individual needs. This includes costomizing warning levels, preference for warning modality, and user-motivated system shut-off. We believe that our innovation increases comfort by providing superior levels of safety and user confidence in the overall capabilities of the proposed DAS.

Improvement in Functionality

A central aspect of the automotive industry is vehicle safety. The improvements in vehicular functionality for this proposal reside in higher levels of safety for drivers, passengers, and others on the road, in addition to intelligent warning systems preventing driver information overloads, and a user centric approach to DAS, all in the context of intentionality prediction given ocular behavior and road and traffic conditions. Ultimately, vehicles instrumented with such systems will drastically decrease injuries, and will make the public more trusting of aspects of driving automation.

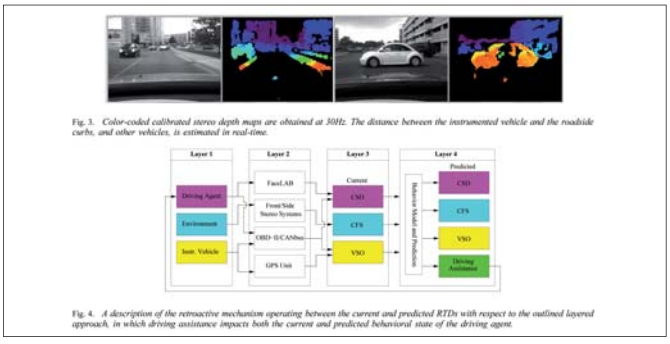

Fig. 3. *Color-coded calibrated stereo depth maps are obtained at 30Hz. The distance between the instrumented vehicle and the roadside curbs, and other vehicles, is estimated in real-time.*

Fig. 4. *A description of the retroactive mechanism operating between the current and predicted RTDs with respect to the outlined layered approach, in which driving assistance impacts both the current and predicted behavioral state of the driving agent.*

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