Signs With Smart Connectivity For Better Road Safety

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LITERATURE SURVEY :

In its Global Status Report on Road Safety – 2015, the World Health Organization (WHO) noted that the worldwide total number of road traffic deaths has plateaued at 1.25 million per year, with tens of million either injured or disabled [1]. Different initiatives, such as the United Nations' initiative for the 2011-2020 Decade of Action for Road Safety, have led to improvements in road safety policies and enforcements. However, the WHO notes that the progress has been slow and has maintained the call for urgent action to reduce. The Safe System (SS) approach to transport networks originated with the "Safe Road Transport System" model developed by the Swedish Transport Agency. In its essence, the approach migrates from the view that accidents are largely and automatically the driver's fault to a view that identifies and evaluates the true causes for accidents. Through the categorization of safety into the safety of three elements (vehicle, road, and road user), SS minimizes fatalities and injuries by controlling speeds and facilitating prompt emergency response. The model has been widely adopted since its introduction and is currently motivated by the WHO as a basis for road safety planning, policy-making, and enforcement.

The Safe System (SS) approach to road safety emphasizes safety-by-design through ensuring safe vehicles, road networks, and road users. With a strong motivation from the World Health Organization (WHO), this approach is increasingly adopted worldwide. Considerations in SS, however, are made for the medium-to-long term. Our interest in this work is to complement the approach with a short-to-medium term dynamic assessment of road safety. Toward this end, we introduce a novel, cost-effective Internet of Things (IoT) architecture that facilitates the realization of a robust and dynamic computational core in assessing the safety of a road network and its elements. In doing so, we introduce a new, meaningful, and scalable metric for assessing road safety. We also showcase the use of machine learning in the design of the metric computation core through a novel application of Hidden Markov Models (HMMs). Finally, the impact of the proposed architecture is demonstrated through an application to safety-based route planning.

A central emphasis is given to speed in the SS approach as it is the strongest and most fundamental variable in the outcome of fatality. The fragility of the human body makes it unlikely to survive an uncushioned impact at a speed of more than 30 km/h, with lower speeds resulting in either death or serious injury . The objective of the SS approach is that the three model elements should be designed and monitored to proactively prevent deadly speeds from happening and allow for a reduced emergency response time in the event of an accident.Emphasis on vehicle safety is verified through mandated regulatory testing and rating, as well as technologies such as electronic stability control. Beyond this, enforced checks (e.g., upon license renewals) combined with on the road reporting work to review the status of vehicle safety. The assessment of road (or road network) safety is multifaceted. Road inspection enables clear and direct observation of the state of the road and assesses the need for repairs or modifications. The structure of the road network is amenable to safety assessment through partitioning into what is called "Traffic Analysis Zones (TAZs)" . In addition, considerations for crash data and other supporting data offer further insights into general safety assessment.

Using new technology such as smart traffic light and traffic control systems, artificial intelligence, the use of telematics and automotive technology can contribute to prevent and reduce the number of road related accidents and improve road safety. Mobile network and fast data transmission solutions can be used, for instance, to collect data on vehicles on the road and condition of roads, as well to provide real-time weather information and warnings. Ultimately with the objective of reducing accidents.

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In 2011, the European Road Assessment Programme (EuroRAP) generated the European Road Safety Atlas for EU countries. The atlas indicated the safety level of roads with a star rating based on specially equipped vehicles for multimedia-based data aggregation. The EuroRAP efforts continue to implement an SS approach across the EU, along with several other national programmes within the International RAP, or iRAP, initiative . There are several aspects to road user safety, including measures for education and awareness, travel distance, exposure, licensure, enforcement, and sober driving . The need for such characterization rises substantially as the findings of crash report analysis in cities typically note a critical dependence on either driver behavior or driver awareness . A great need is further established in these studies for innovative mechanisms to instill safe driving at the licensing and post-licensing stages. It can be seen in the figure that the scope of consideration in the SS approach is medium-to-long term, facilitating by design, systemic actions that are made to ensure the safety of the road.

SS to the short-to-medium term through exploiting recent advances in the context of the Internet of Things (IoT) and Intelligent Transport Systems (ITS) . This fits the outlook for Smart Cities where automation is emphasized to address the increasing dynamic nature of city elements . IoT-based architecture with the objective of assessing the safety of the transportation road network.In doing so, the proposed architecture is aligned with the SS approach in its entirety.It also complements the SS approach by addressing the void in its short-to-medium scope of considerations, making the approach further fitting to the dynamic nature of smart cities.Finally, the proposed architecture showcases the viability of an economic road safety monitoring through advances in IoT and ITS, especially those aimed at realizing smart cities.

An alternative telematic approach involves accessing a vehicle's Controller Area Network (CAN), which is the network that interconnects a vehicle's computing and sensing capabilities . Such access is made possible by a North American standard ratified in 1996, namely, the second-generation On-Board Diagnostics, or OBD-II. Since their introduction, OBD-II dongles have come a long way, with some models offering a mix of connectivity including Bluetooth, WIFI, and cellular . Through the OBD-II, various real-time and diagnostic information can be accessed, logged, and communicated, including RPM, speed, pedal position, coolant temperature, etc. This has allowed for applications such as TorquePro , which monitors a vehicle's fuel efficiency, and advises the driver more fuel-efficient driving behavior. More relevant here, another application has made it possible to identify when maintenance is required for a vehicle . Meanwhile, OBD-II manufacturers, such as MUNIC , offers cloud-based portals for aggregating, processing, and visualizing sensed data, and that can be access for further processing by users.

Driver Behavior Modelling (DBM) is an area of road safety management that is concerned with the characterization of driver behavior. This characterization is enabled through the analysis of various inputs from either the transportation infrastructures, e.g., on-road CCTV cameras, speed-sensors; other infrastructures, e.g., smartphones, reporting to services such as Waze or Google Maps, registrations to cellular-base stations; or an in-vehicle sensing setup. Combined or separated, baselines for "safe" or "responsible" driving can be synthesized, against which counter driving behaviors are identifiable. Meanwhile, considerations for driver awareness or alertness can also be realized to extend identification to behaviors exhibited when driving under fatigue, distraction, or influence.

A smartphone-based driver activity recognition system is proposed in with the objective of preventing drivers from texting while driving. The system identifies whether a smartphone holder (a) has entered a vehicle; (b) has boarded the vehicle from the left or the right; (c) sat in the front or back seat; and (d) is texting. Another system that differentiates drivers from passengers is offered in . The system in employs fuzzy logic and utilizes the acceleration, gravity, magnetic, and GPS sensors to estimate driving aspects such as jerk, orientation rate, speed variation, and bearing variation. A fusion module is then employed to distinguish activity such as hard/sudden acceleration or overspeeding.

Achieving road safety is a multiterm and multifaceted objective, and the above discussion indicates strong emphasis in the SS approach on the medium-to-long term whereby road safety is achieved by design. Our interest in this work is to complement SS with a framework for a dynamic assessment of road safety. Our objectives are to first accommodate the dynamic nature of city traffic, especially in cases of major events and/or crisis. Secondly, it is to showcase the viability of an economically attractive alternative to monitor road safety using ubiquitous technologies and advances in IoT. This becomes critical to overcome any barring limitations, especially for low-to-medium income countries.

Hidden Markov Modelling (HMM) is a powerful statistical tool for modelling time-series systems that can be characterized to represent probability distributions over a sequence of observations. The tool thus lends itself easily to the nature of data gathering found in IoT and smart cities applications. It further stands as a potential base model for several machine learning approaches, including Bayesian or Mixture Density Network inferences.

Using the dynamic safety assessment proposed above, it is now possible to route vehicles across cities based on a safety. In this manner, drivers can be directed through routes that minimizes their overall risk in traversing the road network. Meanwhile, enforcement can distribute vehicles across different paths to distribute risk of the network and avoid having critically unsafe links or routes within the network. It is furthermore possible to target auxiliary mechanisms for safety-control across the network by controlling and redirecting traffic based on user driving behavior or in-response to incidental changes in the road network.the Internet of Things (IoT) within the context of smart cities. The introduced architecture facilitates robust and dynamic road safety assessment that complements the Safe System approach motivated by the World Health Organization (WHO), which has been increasingly adopted worldwide. An application of the dynamic assessment framework for route planning is also demonstrated.