SIGNS WITH SMART CONNECTIVITY FOR BETTER ROAD SAFETY

ABSTRACT

In this paper ,signs with smart connectivity for better road safety. The Safety by design through ensuring safe vehicles , road network , and road users.A strong motivation from the World Health Organization (WHO), this approach is adopted worldwide .We can consider some cases when there are some road diversion due to heavy traffic or due to accidents.To replace the smart connected sign boards get speed limitation .In safety system are made for the medium to long term.In this work is to compliment the approach with a short -to-medium term dynamic assessment of road safety.This project a system to alert th driver about the speed limits in specific areas .We introduce a novel,cost effective Internet Of things(IOT) architecture that realization of a dynamic core in assessing the safety of a road network .Finally , the impact of the proposed architecture is through an application to safety based planning.

KEYWORDS

Smart road safety,Ultrasonic sensor ,Road network,Microcontroller

1.INTRODUCTION

The WHO describes different measures that can be implemented with minimal economic impacts in its “Save LIVES: Road Safety Technical Package” [1]. A cornerstone of these steps is realizing economic systems for “monitoring road safety by strengthening data systems”. Meanwhile, a key theme in the package is motivating the adoption of a Safe System approach, which is a holistic approach to road safety that parts from traditional management solutions by emphasizing safety-by-design.

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.

An illustration of the model is provided in Figure 1. A central emphasis is given to speed in the SS approach as it is the strongest and most fundamental variable in the

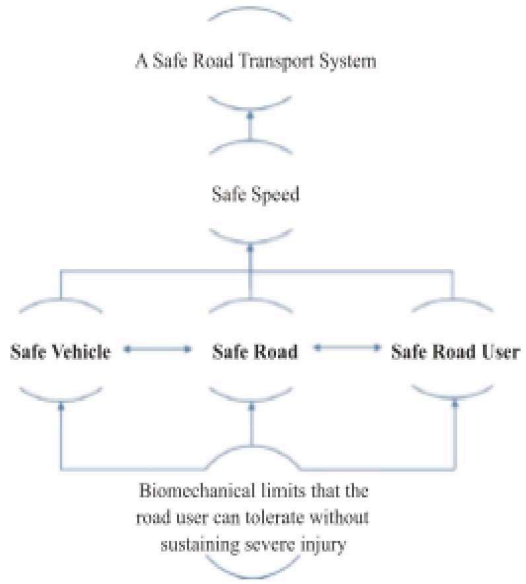

Figure 1: The Safe-System-based Safe Road Transport Systems, with its elements: safe vehicle, safe road, and safe road user

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.

Elements of the SS approach are as follows:

Safe Vehicle: 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.

Safe Road: 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)" [2]. In addition, considerations for crash data and other supporting data offer further insights into general safety assessment.

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 [3]. 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 [4].

Safe Road User: There are several aspects to road user safety, including measures for education and awareness, travel distance, exposure, licensure, enforcement, and sober driving [5]. 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 [6]. A great need is further established in these studies for innovative mechanisms to instill safe driving at the licensing and post-licensing stages.

*Contributions:*Figure 2 illustrates elements of assessing road safety. 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 network. While the use of "data monitoring systems" is motivated in and can be utilized for shorter term scopes, the general emphasis is maintained at the medium-to-long term reaction cycles.

Our interest in this work is to extend SS to the short-tomedium term through exploiting recent advances in the context of the Internet of Things (IoT) .

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.

The proposed architecture involves a novel use of machine learning as part of its road safety assessment core.

2.RELATED WORK AND MOTIVATION

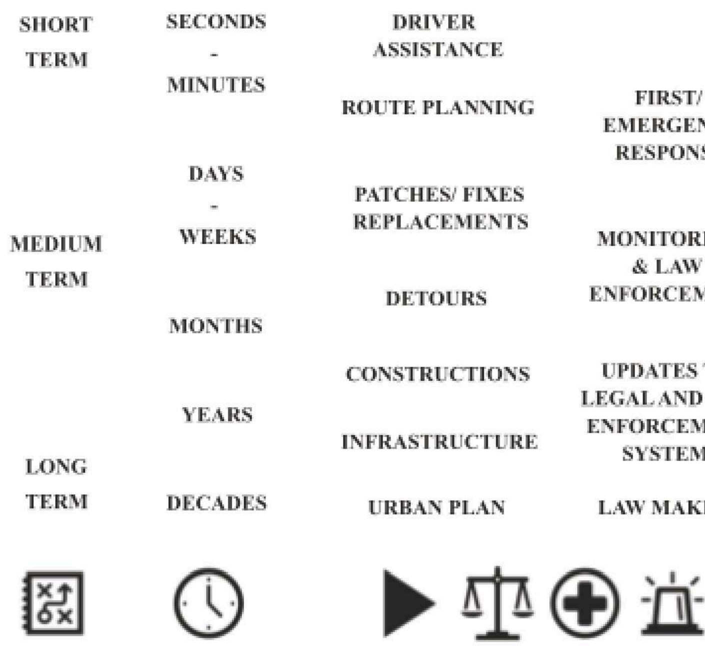

Figure 2: Safe System (SS) elements across different time long-term.

This section reviews related works within the context of IoT and ITS, and their integrations within the more general context of smart cities. The reviewed works have been categorized and presented per their relevance to elements of the adopted SS approach, i.e., in terms of facilitating safety in vehicles, roads, and drivers.

As noted above, regulatory enforcements frame a substantial aspect of ensuring that vehicles traversing a city's road network are safe and reliable. Considerations for the short-to-medium term, however, require a more "realtime" monitoring of the vehicle status. Telematics allows for such monitoring within the IoT/ITS context and is facilitated by several options. The first includes having dedicated sensors, such as accelerometers, Carbon Monoxide (CO) level sensors, etc., mounted on the vehicle to gather and log information . Such setups can be augmented with a communication module so that the collected data can be transferred to a local unit or to the cloud[7].

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 [8]. Such access is made possible by a North American standard ratified in 1996, namely, the secondgeneration 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, variousreal-timeand logged, and communicated, including RPM, speed, pedal position, coolant temperature, etc. This has allowed for applications such as TorquePro [9].

Many of these applications targeted the assessment of either road status or capturing driving behavior and are thus further elaborated on in the following two subsections.

For example, in [10] an embedded device is realized to support various sensing techniques in road surface monitoring.Specifically, the system employs image analysis for extracting features related to water and snow on the road. Other systems require the addition of simple hardware to such vehicles to widen the scope of the detection applications. For instance, the pothole patrol depends on the deployment of 3-axis accelerometers on board of vehicles for detecting such road conditions through monitoring vibration. Another example proposed in [11] is a system that detects ice on roads by analyzing tire-to-road friction ultrasonic noise detected by a transducer installed behind the front bumper.

A smartphone system of note is *Nericell*, which utilizes smartphone accelerometers, microphones, and GPS to detect events related to the quality of the road, e.g., potholes and bumps [12]. The sensor measurements, accelerometers and photometers, are compared against a set of empirical thresholds and the anomaly is then detected when all thresholds are satisfied in a given road. The values of the thresholds are chosen based on measurements that indicated the existence of true anomalies within their values, while making sure that no anomalies are outside these intervals.

For example, the viability of crowdsourcing for smartphone users facilitates a further advantage, especially when it comes to validation. Meanwhile, authors in consider pothole detection using a large dataset collected through implicit crowdsourcing, i.e., crowdsourcing without repeated user prompt/input. Thresholds are used on the phone's z-axis acceleration, with empirical data used for differentiating potholes from speed breakers.

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 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.

3.DYNAMIC ROAD TRANSPORT SYSTEM

The objective of this section is to introduce a novel and adaptive IoT architecture that enables the assessment of safety in a city's road network. We also describe the architecture components and their interrelationships, including a robust computational core for safety assessment.

Assessment Elements:

The three elements of safe vehicle, safe road, and safe driver facilitates a hierarchical safety assessment approach whereby the safety of the individual elements can provide a collective indicator of safety for the road network, as illustrated in Figure 3.

For vehicles, the assessment core would rely on inferences from the vehicle's Vehicle Identification Number (VIN) (thus establishing car make, manufacturing, and basesafetyrating); regulator's information (e.g., the outcome of the last regulatory check); and the updated information from an OBD-II unit.

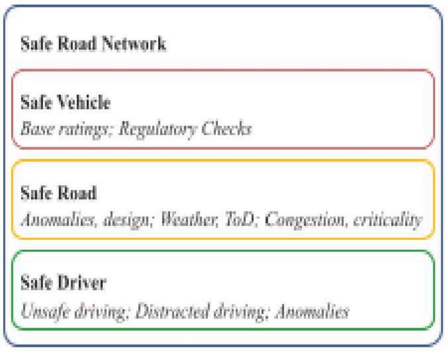

Figure 3: Elements in assessing the safety of the road network based on the safe systems approach.

It is possible to consider a meaningful safety metric based on the live (or real-time) status of the road. For example, the safety level of a certain segment/road depends on the aggregate safety of vehicles currently traversing it, combined with the number of potholes and/or the wetness or how slippery is the road, in addition to safety/alertness of the drivers on the road.

The individual assessments rely on a wide array of sources that generally fall into two categories. The first is sourced through in-vehicle sensing, while the second through sources that establish the general context of the road. These include traffic problems, regulatory checks, crash reports, processing of news and social media, weather updates, and time of day.

In the following section we demonstrate how this assessment core can be utilized in a safety-based route planning application.

Assessment Core: This is especially the case in cities and high density urban areas where traffic dynamics becomes further involved and further engaged with other planes of city activity.

In remarking on dependencies above, we noted that a reasonable model to assess a road network's safety should mind the interelement dependencies in SS, as well as the dependencies in both space and time. It should also facilitate the quantification of these interdependencies without substantial overhead.

The design of such assessment core is elaborated upon in the next section.

4.DYNAMIC ASSESSMENT CORE

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.

This is particularly advantageous in the computation of link safety for our purposes. Furthermore, once the HMM is determined, the state of the links (as well the state of regions) can be identified and utilized using various services, including route planning, as will be discussed in the next ssection.

5.ROUTE PLANNING

Route planning has become widely used in both personal and commercial use, resulting in an increasing dependence on its reliability. Various applications employ efficient algorithms for route planning [13]. Trip time and cost, e.g., for tolls, have been the typical metrics for route planning applications, but other metrics, however, have been utilized, e.g., for fuel emission/consumption or energy requirements of electric vehicles.

An advantage of the assessment core proposed above is that a routing algorithm can be operated directly on its generated values. In what follows we describe a direct application for routes assumed to be traversed shortly after the route have been computed, and that require a traversal time sufficiently less than transition time in the HMM.

Consider a graph (V, E), with Vcomprising n+1nodes(vertices), and E comprising the edges in the graph. Nodes represent starting, ending, and midway stops for the vehicle, and our interest is in routing a vehicle from a source node (s) to a destination node (d). Vertices are further identified by numbers, with vertex 0 identifying the source node and $0 < i < n$ identifying possible target destinations.

The set of edges $E = \{(i,j) : i, j \in V; i < j\}$ represents the set of $n \cdot (n + 1)/2$ links between the $n + 1$ nodes. Each edge has an associated traversal cost $c_{ij} > 0$, which may be either symmetric ($c_{ij} = c_{ji}$) or asymmetric ($c_{ij} \neq c_{ij}$). Herein, this cost can be inversely proportional to a link's safety assessment.

The first constraint mandates that a stop along the chosen route is visited only once. The second constraint specifies that, except for the source and the destination, each stop has as many ingoing as outgoing traversals. The third and fourth constraint mandate single departure from the source and a single arrival at the destination.

The above formulation is an integer-programming instance, making the essential route planning problem NP-hard. Meanwhile, when engaging the computation core, as specified by the formulation above, the core is supplied with the updated "costs" and the "capacities" of the edges.

6.RESULTS AND VALIDATION

We validate the work through a case study based on data availablefor New YorkCounty, NY, USA. Mapsand shapefiles were sourced from Open Street Maps (OSM) [6], United States Census Bureau [7], and David Gleich's US Roads extracts [14].

Safety level was graded into four levels. The HMM was initialized with uniform distribution.The shortest path algorithm followed the description provided in Section .

6.Conclusions

This work illustrates the viability of an economic road safety monitoring and assessment solution through exploiting advances in the Internet of Things (IoT) Indeed middle-income countries represent 72%of the world population,80% of road traffic deaths and 47%of registered motorized vehicles,while high income countries are leaders in development of connected vehicles.

Acknowledgments

This paper contains the results and findings of a research project that is funded by King Abdulaziz City for Science and Technology (KACST) Grant No. GDRG – 37-278.

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