Collison Detection and Prevention in Smart Traffic Lights

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ABSTRACT: *In this paper we have introduced a software model for a collision detection and prevention of smart traffic light. The aim of this work is to enable to prevent car collisions and incidents at road intersections. We have developed an eCall system, that will work for block box for vehicles. We have proposed strong architecture and design for the proposed model.*

Keywords: Prevention, Smart Traffic Light, Car Crash, Traffic Control System

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1. Introduction

Following is described a software model for a collision detection and prevension smart traffic light. Proposed system is based on currently developing eCall system, such as "Harmonized eCall European" (HeERO) and is an add on to provided services.

As stated an ecall "Using timely signalization and precise GPS positioning the system allows for faster and more adequate rescue force reaction, thus increasing the chance to save more people" [1].

The main purpose of such device is to serve as a black box for a vehicle. As such, it records a minimum data set (MDS) throughout the travel. This data is set, but not limited, to vehicle ID, vehicle energy storage type, time stamp, vehicle location, vehicle direction, number of passengers and optional data [3]. In case of an incident an ecall will be automatically setup and MDS chunk will be sent to emergency center.

When and how to recognize a transport accident is defined by Veronica 2 standard (EN 15722). It uses sets of parameters that are constantly monitored and analyzed to recognize an abnormal situation. According to Veronica 2 incident is any unwanted or unintentional event or a specific sequence of such events which have harmful consequences. That is, any event that results in damage is "unacceptable" and a record for such an event should be stored in "black boxes". [4]. Before rising a trigger for an unwanted event, statistics of two or more parameters are in consideration – longitudinal acceleration, lateral acceleration, vehicle speed, vehicle roll angle, engine throttle, engine speed, ABS activity, steering wheel angle, brake status, frontal airbag status, safety belt status, etc [2].

Thus, using the existing HeERO device as a platform, a new functionality is added, relaying on already proven concepts. In this way proposed system contributes additional help to clarification process of an accident.

2. Software Principles

2.1. Control Unit – Record Structure

On figure 1 is shown what a data structure to store information, related to a traffic light on an intersection looks like.

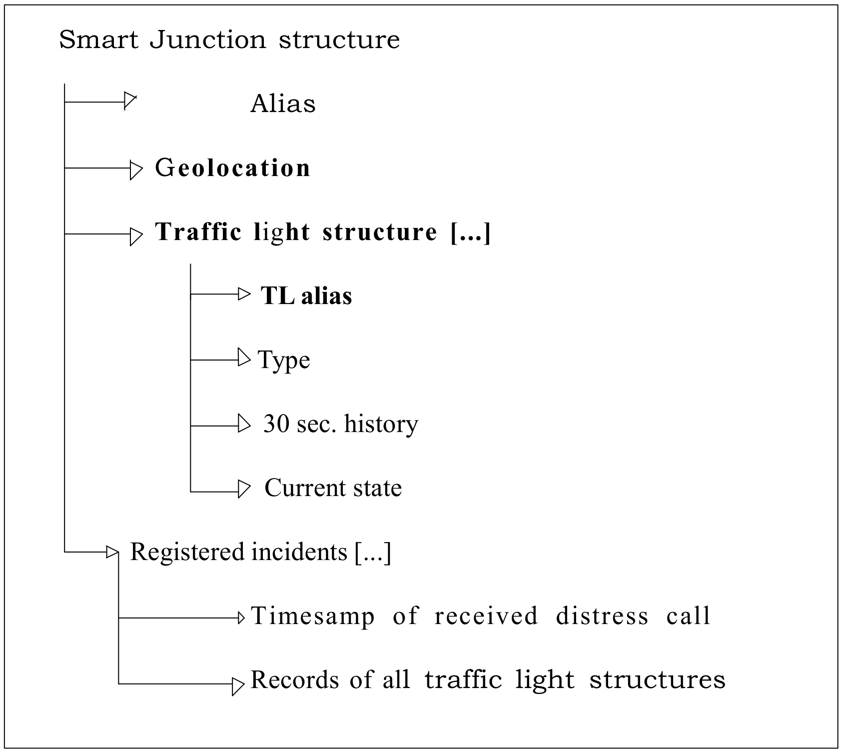

Figure 1. Showing data structure of a smart traffic light system

A road junction may have a name, that is stored in *"Alias"* . It is used to ease human operators. "Geolocation" stores coordinates of a traffic light, so the eCall operator knows the exact place of a car crash. These values, once set, are constant through the whole lifecycle of the system.

As known, an intersection consists of more than one traffic signalization devices (traffic lights). "Traffic lightstructure" is holds individual information for each and every traffic light. As many are the traffic signaling as many copies are hold. "TL alias" represents name of particular signaling device (eg, "North/South, East/West). "Current state " stores current state of the traffic light signals. The heart beat of a traffic light is one 1 Hz. That is why its current state is sampled once every second. Before that, the oldest record in history is deleted, to make room for the already "aged" current state, before resampling.

Detection and providing information about signals is the prime aim of the proposed device. That is why it should keep track of all abnormal situations that occurred. When such situation occurs, a copy of the tracked history is stored along with a time stamp of the incident. Memory that is spared would be 20 bytes. For every second a roughly 3 bit of data are spared (1).

$mem = 3\ bits/s * 31\ secs + meta = 93 + 67 = 160\ bits$

2.2. Control Unit – Control Software

Main purpose of the software is to keep track of the traffic light signals and look for distress signals. Block diagram is shown on figure 2.

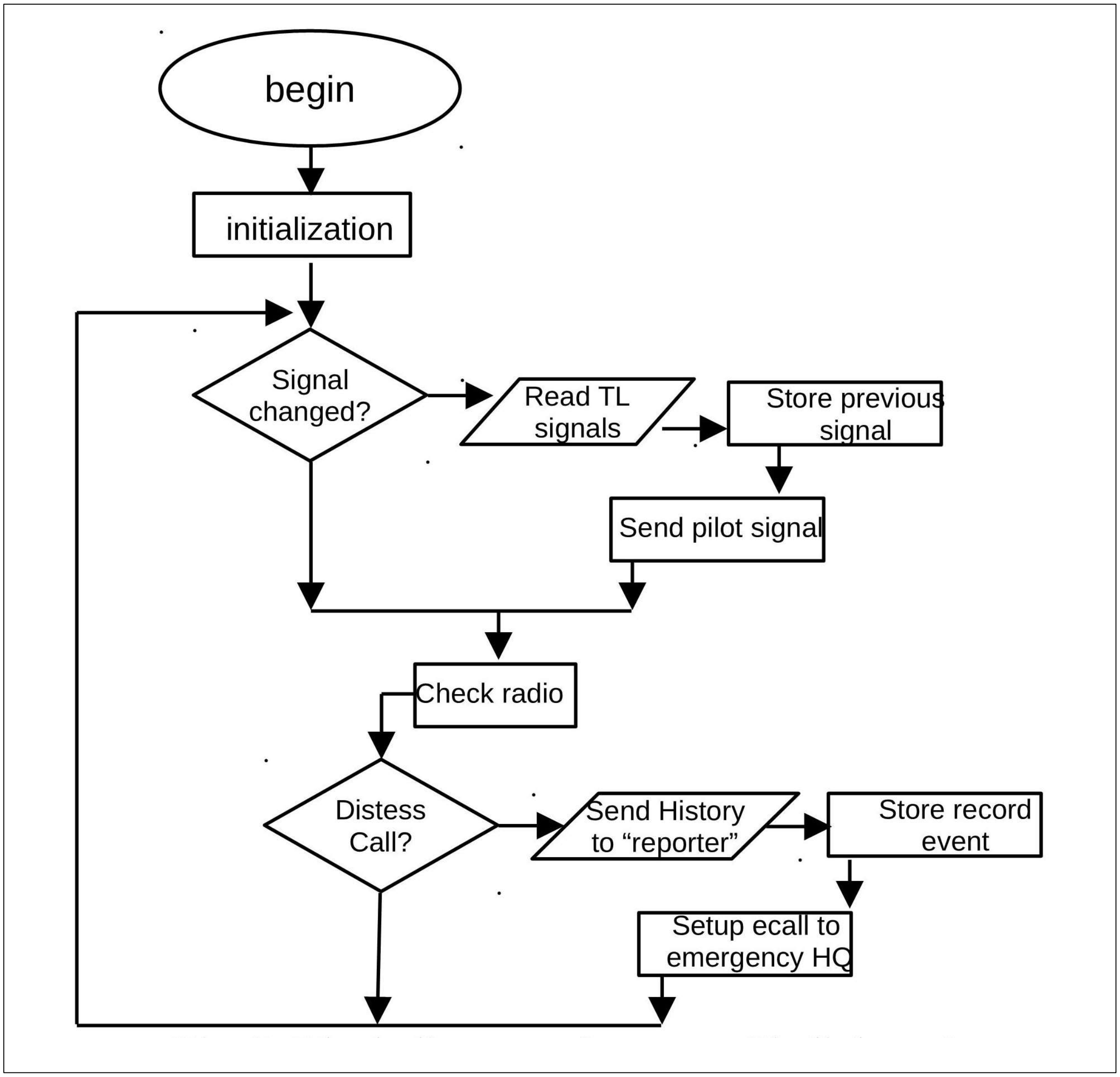

Figure 2. Block diagram of smart traffic light software

In the beginning an initialization procedure is hold. When a control unit is started alias and location data should be filled along with associating it to all traffic lights at the road junction. After that the system will start to monitor all traffic signalizations and keep 30 seconds history. In the meantime the system would broadcast a pilot signal, including timestamps and colors of the traffic lights – announcing all vehicles that the are in the boarders of a street junction. Once per second colors are reread and stored in controller's memory. The old ones are shifted to make place for the newly read one thus deleting the oldest. After that the pilot signal is resend.

Crucial moment is to constantly monitor for any distress calls send from vehicles in case of an emergency. When such event is detected, a new record with time stamp of the received distress call, current and history states of all traffic signalizations are stored into non-volatile memory.

After a that a the same record is sent to the reporter that notified the system for the car crash. In the meantime an ecall is setup. This is needed in case the on-board system is unable to notify emergency centers for the incident. It contains all data related to the traffic intersection – name, geolocational data, timestamps, etc. These records are retrievable at any time remotely from the eCall headquarter, police or investigators.

An additional feature is the ability to "replay" the situation on the junctions signalization devices themselves, thus providing better visual knowledge and further understanding of the occurred situation.

2.3. Reporter – control software

On figure 3 is shown a functional block diagram of the software of device Reporter. It's main aim is to acknowledge when a vehicle is in the limits of a traffic intersection by receiving a pilot signal from the traffic light control system.

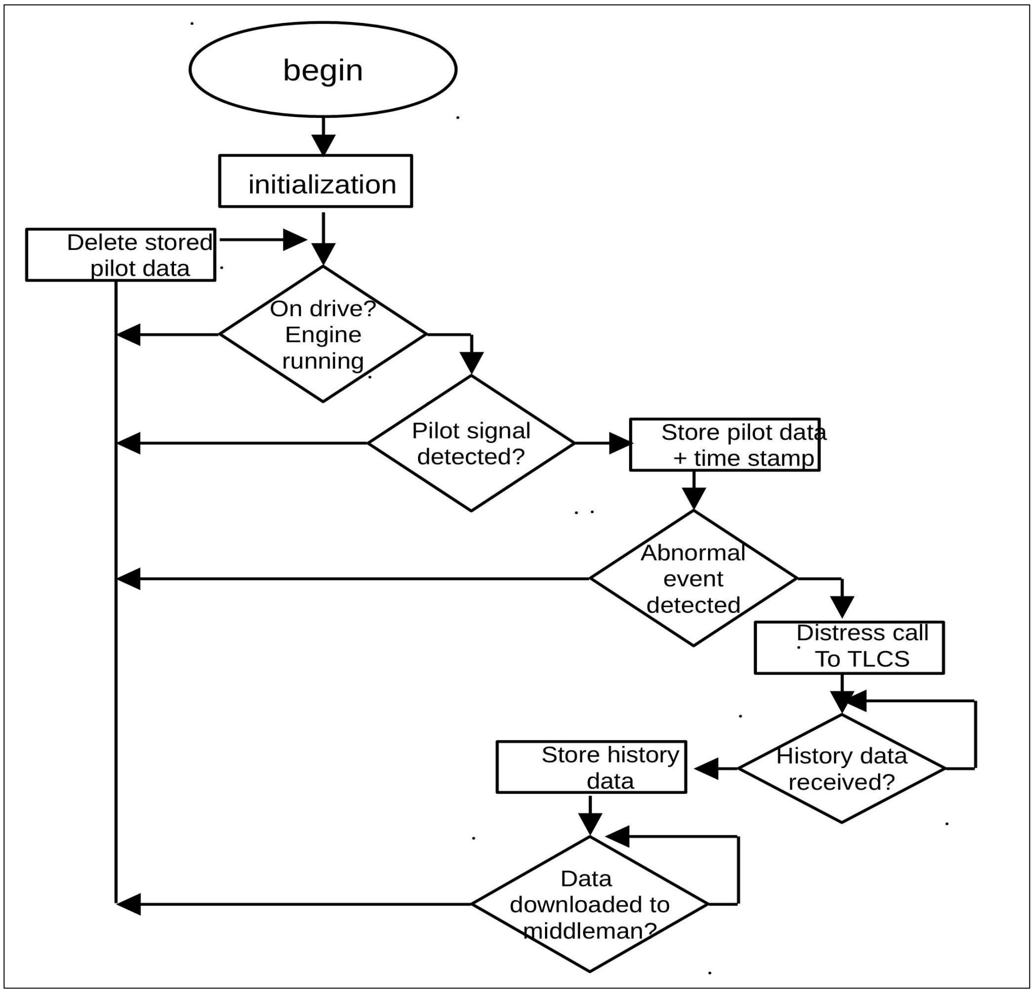

Figure 3. Block diagram of Reporter device

Device only works when the vehicle is in use - by checking number of parameters – one of which is if the engine is working.

If the vehicle is in use (on drive), device constantly monitor for any pilot signals sent by a junction. Pilot signal carries information about the traffic signals and timestamps that are crucial for synchronization with internal monitored parameters by the HeERO device.

When a pilot signal is detected, *reporter* understands that it is within the limits of a junction and starts to record all incoming traffic light data. When the vehicle is no longer in junction's limit (junction is passed without any trouble), this information becomes useless and so deleted.

If an abnormal condition is detected by the HeERO device *reporter* is acknowledged and a distress call is sent to smart traffic light control system and waits for a response, containing all traffic light history. After it it is received, it is stored into non-volatile memory along with all received pilot signals and timestamps.

Meanwhile and ecall is setup by the onboard HeERO device. *Reporter* will wait for a connection and stored data to be downloaded by a *mediator* device, in posession of reinforcement law.

2.4. Communication Protocol

On figure 4 is shown a timeline of a typical communication between *traffic light control system* and *reporter*.

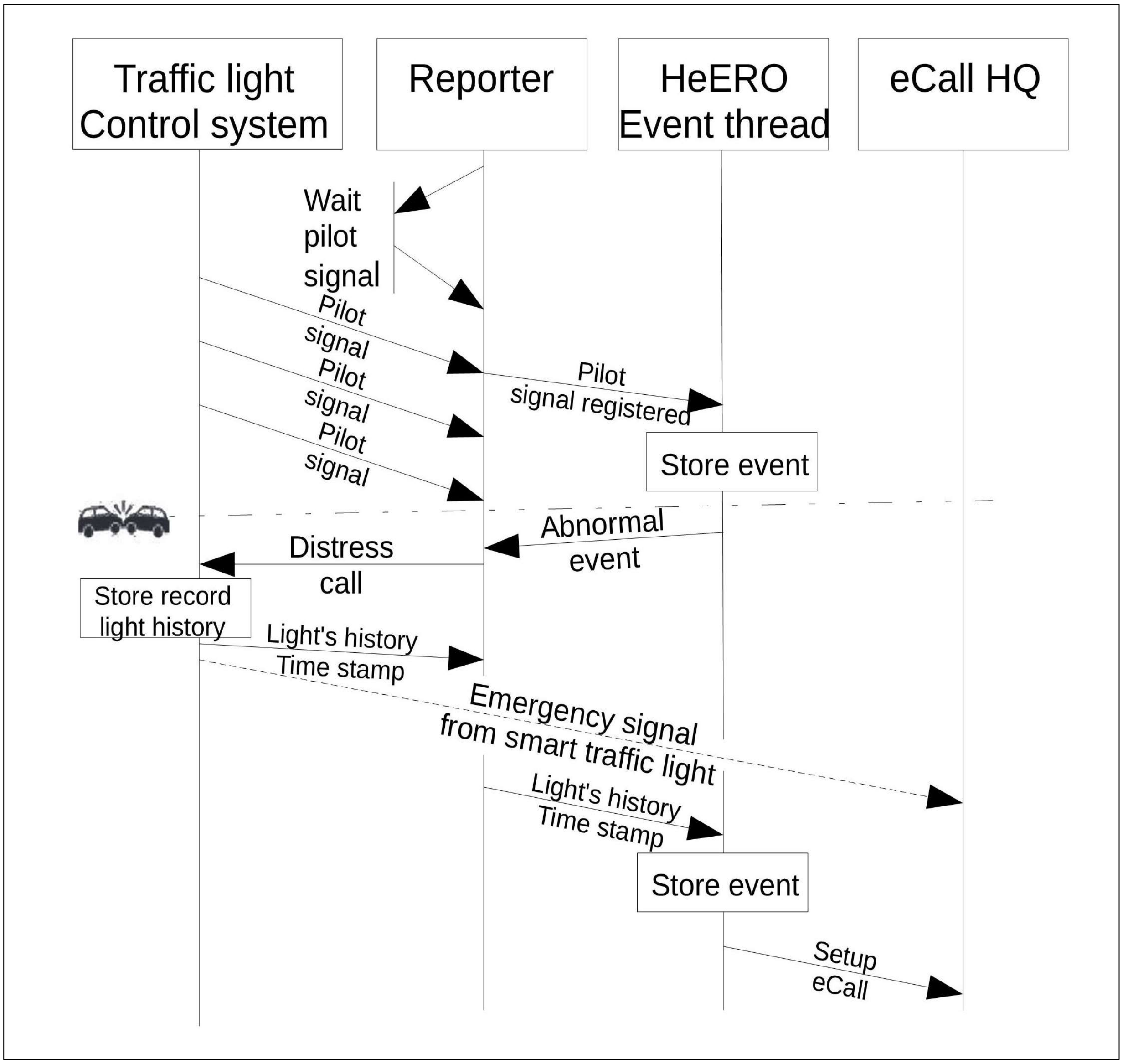

Figure 4. Communication process between traffic light control system and reporter between traffic light control system and reporter

As the figure is self-explanatory some remarks should be made. On the figure above, HeEro black box is responsible to store a record for the event occurred., in contrast explained in the upper chapter. Presented software model presented is aimed as to extend the functionality of a intelligent in-vehicle transport system. Thus, "who" willstore the event is disputable.

3. Additional Remarks

Source code of the project could be find at GitHub: https://github.com/rosenvitanov/smtTLeCall.git

4. Conclusion

Software and prototype model for a smart traffic light system, that enriches the data collected from an e-call black box, and clarifies the circumstances around a occurred road accident. This new method is in help for the investigation cOmmittee to have a deeper and richer overview of the collision.

As a future development new features shall be added that are in help to the driver itself - informing if it is safe to enter the road junction or will a fault be made if done so.

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