

Method and device for registration and analysis of car crashes at smart traffic lights. Hardware model.

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Abstract – In this paper hardware model of a smart traffic light system that prevents and registers car incidents at traffic intersections. In addition it may ease any car crash investigation by providing data on how and when it happened, revealing the one holding responsibility for it.

Keywords – *Smart traffic light, Car crash, Traffic intersection, Car crash investigation.*

I. INTRODUCTION

Undeniable is the contribution of cars in the history of mankind. From the 1885/1886 year, when Karl Friedrich Benz invented the first automobile [1], development of this industry is unsettling, closing the roads and making the world lesser and smaller. Individual becomes able to travel great distances, more often and cheaper.

In the city of Ohio, in 1891, the first car crash was registered. James Lambert crashed into a tree [2]. Since then the number of road accidents is growing rapidly. According to statistics for 2007, Bulgaria is ranked 12 in number of deaths per 1,000 people - 131.7 [3]. For 2013 became 6759 total accidents with 577 killed and 8491 wounded, 557 were accidents at traffic light intersection. For 2014 these statistics area 6736 road accidents, 615 deaths, 8358 wounded, 581 at road junctions [4].

II. SMART TRAFFIC LIGHT SYSTEM

A. Overview

The proposed system is an additional method for preventing and resolving disputes arising at road intersection due to car accidents. Its purpose is to provide information about the configuration of traffic light signals emitted before, during and after the crash. Thus easing and speeding investigating authorities to resolve a traffic accident. Modularity is the basis of the design. Proposed system may be used with other traffic monitoring systems or can be mounted on traffic lights as a standalone device.

Smart traffic lights emit a pilot signal with the current state of lights. This information is received by all cars at the intersection. Based on previous coordinates and current

status, the vehicle detects its direction of movement and filters required data. Upon collision of two vehicles, the system generates a distress call for an accident and the smart traffic light stores the state of light signals at the current time and up to 30 seconds back. This is sent to all cars, involved in the crash. The other participants are signaled to pass with caution.

B. Block-Diagram

A block-diagram of the proposed system is shown on Fig.1. It is composed of three stand-alone devices that may exchange data using wireless radio communication – a smart traffic light control system, a reporter and a middleman.

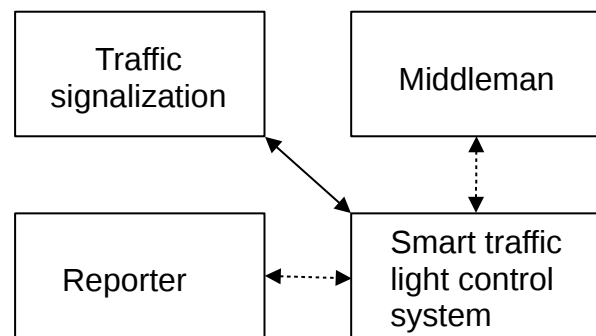


Fig. 1. Block diagram of traffic light accident control and resolve system.

C. Smart traffic light control system

Smart traffic light control system is a system that supervises and stores in its memory information about signals that were shown on the traffic signalization. Each intersection has its own supervising system that is constantly active to retain consistent data. It sends on a pilot channel data, related to the current state of the intersection to all traffic participants. Supervisor may not detect a incident by itself. It relays to a different device called *Reporter* to acknowledge an emergency. In case of a collision, a record will be stored on internal non-volatile memory with the current state, up to 30 seconds of signal history, up to 5 seconds of proceeding signals, including day and time of the accident, with additional it may report to all vehicles at the intersection to be very cautious when passing. This new data will be sent to all participants in the accident. Records may be recalled by authorities at any time when needed.

As shown in Fig.2, smart traffic light control system consists a total of 7 modules – power supply, real-time clock, non-volatile memory, wireless communication module, traffic light signalization interface, communication interface and microprocessor.

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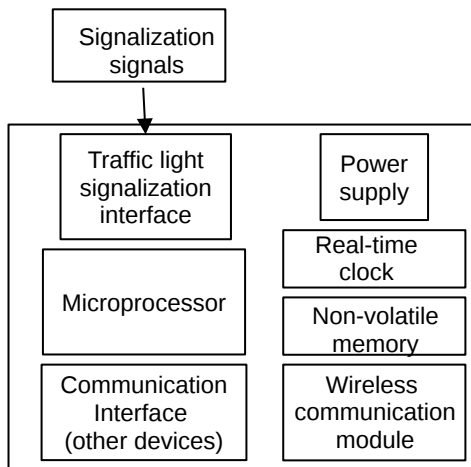


Fig. 2. Block diagram of Supervisor

Wireless communication module provides connection between all three modules. In this case, is used MRF24J40 by Microchip, working ant 2,4GHz. *Real time clock* is used to keep up date/time. *Traffic light signalization interface* is connection between the traffic light itself and the control unit. It parses received signals from the traffic signalization to usable information. *Non-volatile memory* is used to store records for every car crash, including systems settings and metadata. A generic SecureDigital card may be used as a mass-storage device.

Microprocessor is hearth of the system. AtMega328p is used. With current hardware implementation and selected components can be tracked up to six three-segment traffic lights or 9 two-segment. When selecting a suitable controller such as MEGA2560, the functionality and traffic light count may be increased several times.

D. Reporter

Reporter is a extension to HeERO project, that reports an accident to the traffic light control system. A block diagram is presented on fig. 3.

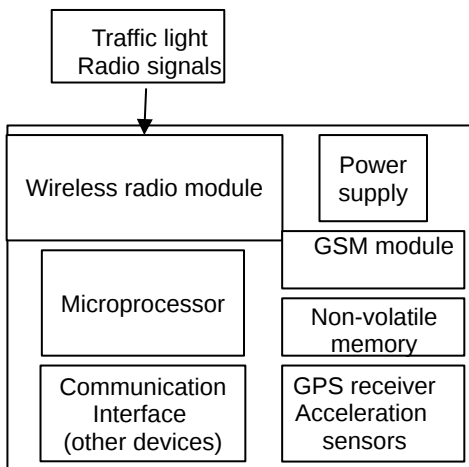


Fig. 3. Block diagram of Reporter

This device is situated in vehicles and constantly monitors for any pilot signals from traffic intersections. If any detected, it will be stored into memory.

It consists of seven different modules. Power supply is self explanatory, but should be kept in mind, that the source of power is limited to a vehicle's battery, thus it should be designed with emphasis to power saving.

- A Wireless radio module is to setup and a connection with traffic light control system.
- A GSM module is responsible to retain a connection to a cellular network, and in case of an emergency to make an e-call to the headquarters that are responsible to take care of the accident.
- Non volatile memory could be a traditional microSD card or a flash memory chip. It is used to store the collected information from sensors (from the HeHero project), the traffic light signals and records of any abnormal situations.

E. Middleman

Middleman, also known as mediator, is a device that connects wirelessly to "Supervisor" and "Reporter". Its purpose is to read the information for the intersection - name of intersection, traffic lights status, car crash records archive, date and time and condition the signal system at each received signal. It may be a separate device, computer terminal or phone with Android based OS . When selecting a traffic accident on the device's screen to visualize the status of the traffic lights in the respective colors, the exact time of the accident. It also may be used to control and operate the traffic light – enter new settings, date and time, delete data, format memory, etc.

In addition, if *Reporter* is still online after the car crash, it may connect to and download from it all available data that was stored and is unreachable for the control system. This data may be stored trajectory, differential time between vehicle goes and incident.

F. Prototype model

On the picture shown (fig. 4a & 4b) is a top and bottom view of a prototype model of presented model of a smart traffic light system for monitoring, prevention and reporting vehicle collisions.

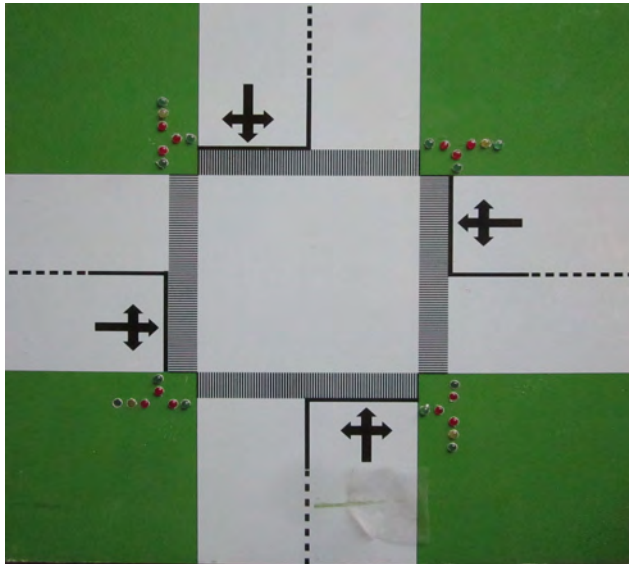


Fig. 4a. Prototype model – top view.

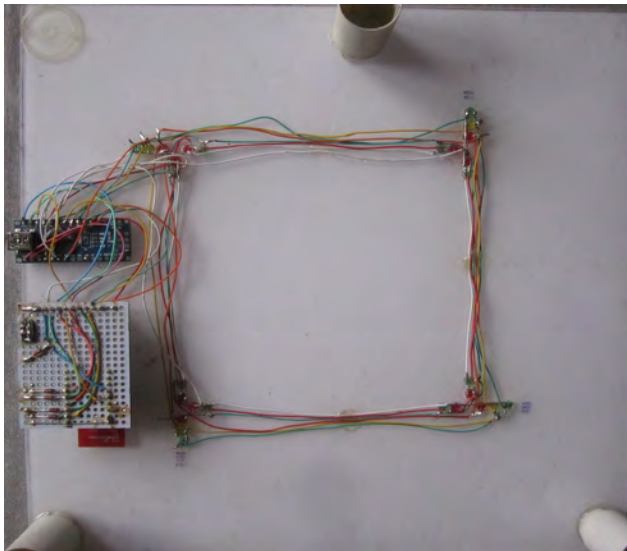


Fig. 4b. Prototype model – bottom view.

III. CONCLUSION

In this paper presentation of hardware model of a smart traffic light collision detection and prevention system, that may help in investigation of a car crash.

REFERENCES

- [1] Library of Congress, "Everyday Mysteries", <https://www.loc.gov/rr/scitech/mysteries/auto.html> .
- [2] Ohio History Central, "World's First Automobile Accident". 2006. <http://www.ohiohistorycentral.org/entry.php?rec=2596> .
- [3] State-Public Consultative Commission on the Problems of traffic safety on the roads, "World Statistics", 2015.
- [4] State-Public Consultative Commission on the Problems of traffic safety on the roads, "Statistics driver's fault", 2015.
- [5] Ordinance № 17 of 07.23.2001 "Regulation of traffic signals with lights", 2001 .

Presented is an early alpha version of the prototype with many of the features still in development or may not provide reliability. For testing purposes in-vehicle device is has only touch-sensitive switch and is not fully functional.

As a result the reporter can detect when it is in the premises of a road junction. In case of a crash it may send adistress call and receive a response from the traffic control system.