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A Novel Design Based Internet of Things to Counter Lone Wolves Threat – Application for Intelligent Transportation Systems

[1]Dr G Vijay Kumar, [2]Y Anjani
[1]*Professor-CSE and Principal, VKR, VNB & AGK College of Engineering, Gudivada 521301, Krishna Dist., AndhraPradesh. Cell No:09849748772, E-Mail ID:vijayg.teja@gmail.com*
[2]*Asst. Professor-CSE, VKR, VNB & AGK College of Engineering, Gudivada 521301, Krishna Dist.,Andhra Pradesh*

Abstract:*This paper proposes a new design methodology for Intelligent Transportation Systems, which uses existing smart techniques in transportation systems and human behavior detections to counter lone wolf threats and driver violations. The design can be attached to vehicles as an intelligent embedded system. In this design, the electroencephalogram analysis techniques are used to detect the irregularity in driver behavior which can be categorized into threatened or violated behavior. In threaten behavior like deliberate run-over accidents, the system will stop the vehicle as soon as possible and inform the security agency to ensure a speed response.Tominimize the consequences of the vehicle fast stopping, it proposed to green the next traffic light signs. By applying this system in vehicles a lot of accidents can be avoided, in particular those caused by lonely wolves like deliberate run-over accidents or stolen of vehicles.*

Key-Words:-*Intelligent Transportation Systems, Internet of Things, Deliberate Run-Over Accidents, Berlin Attack, Lone Wolves Threats.*

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I. Introduction

Nowadays the world is suffering from the lonely Wolves (LW) threats. LW uses a new tactics called low-cost attacks. These tactics are including the vehicle ramming, which was represented in the 2016 Nice and Berlin attacks. Since LWs are individuals that act independently, their identification and detection at any given stage of the attack is extremely difficult. Kaati etal. [2] used a machine learning approach to identify potential LW based on their written communication. This work aims to capture the psychological warning behaviors in written text and identify texts written by LW.

Therefore, to counter the Vehicle ramming terrorism effectively, it should be countered in the act of ramming, where it appears that programs such as PRISM have failed in stopping terrorist attacks more than 80% of the time [3]. Depending in this idea, the study in [4] was proposed a novel design approach to prevent the LW's attacks like 2016 Nice attack, where the offender is the truck legal driver. Now, this paper propose a new design approach (called PS_2) that using the existing techniques in Intelligent Transportation Systems (ITS) based Internet of Things (IoT) to prevent the other LW's attacks like 2016 Berlin attack, where the attacker is the truck illegal driver.

The PS_2 design methodology, requirements and the vulnerabilities of the existing ITS in LW countering will be shown in the following Sections. Section 2 states the motivations for PS_2 design. Section 3 states a survey of the existing techniques which can be used in the PS_2 design. The PS_2 design methodology is presented in Section 4. Section 5 presents and discusses the expected behavior of the PS_2 in LW attacks and in the hazardous materials transportations. Finally, the conclusion is stated in Section 6.

II. Motivations For Proposed System Design

To show the importance and the motivations for the PS_2 design, Berlin attack scenario will be analyzed. Also, the corrective actions of Berlin attack will be investigated. These Investigations will present the required design criteria of the PS_2.

Investigation in Berlin attack

On December 19, 2016, the offender intentionally drove the stolen truck through a Christmas market at Breitscheidplatz in Berlincity, killing 12 people and injuring 56. The truck had been hijacked based on its GPS coordinates. The original driver of the truck had been killed by the perpetrator of the attack. However, police investigation reports have indicated that the truck was brought to a stop by its Advanced Emergency Braking System (AEBS) [5]. The death toll in the Christmas market attack in Berlin could have been much higher. But the truck's AEBS, adopted by the EU in 2012, stopped the vehicle after just 70 meters, according to reports.

III. Existing Techniques

Following subsections states the existing techniques which can be used in the PS_2 design.

Intelligent transportation systems based internet of things

Traffic monitoring is conducted by sensing capabilities, GPS installed on modern vehicles and a mixture of air quality sensor and acoustic sensors along the given road. In the security of the smart cities, IoT with smart surveillance can monitor people's actions to find any violent act, where smart surveillance systems can alarm in case of any event of interest occurs. also, camera surveillance systems can detect abnormal situations like vehicles going in a wrong direction and truck driving in abnormal style (as in Berlin attack) by running motion detection algorithms to extract video information, aggregating several frames for performing route detection.

Electroencephalogram techniques

The PS_2 aims to capture the psychological warning in driver behaviors which can be detected by Electroencephalogram (EEG) brain waves. So the existing EEG techniques for drowsiness and fatigue, person identification, epileptic seizure detection system and drunken driving detection are mentioned.

IV. Proposed System

Now cause of LW threats, the transportations systems should be modified to counter the LW terrorist. The following design is a trial that can be used to enhance the LW countering.

4.1Design criteria

The PS_2 should be designed to perform the following function to effectively counter the LW. The functions are:-

- Remotely response, i.e. the PS_2 should be called to do its functions remotely by using the wireless technique.
- Changing the Traffic light states when the vehicle is in an emergency state and will stop suddenly. The system takes that decision depending on:

1) The surrounded traffic density which can be evaluated like Ghazal et al. [21]by using a microcontroller and IR sensors.
2) The existing state of the next Traffic light which can be known by the V2I message.
   That contains the measurement of the distance between the emergency vehicle and an intersection using visual sensing, vehicle counting and time sensitive alert transmission within the sensor network. The emergency vehicle information is delivering to the traffic authority with less delay so the emergency vehicle is quickly served.
1) Preventing the driver to control the vehicle based on:The EEG's PID signal.The distances between the vehicle and objects depending on AEBS sensors.

- Message broadcasting to other vehicles and the traffic or security authorities.
- In the case of none communication links or if the driver doesn't respond appropriately to the PS_2 orders, the PS_2 shall control the vehicle.

4.2 System architecture

The PS_2 is an embedded system as shown in Fig.1. The signals are divided to:

- Incoming signals which are the GPS Road location and EEG driver monitoring unit that detect DDD, DHD, DAD and the PID.
- Dual communications signals like surround traffic signals (V2V, V2I and V2X); security and traffic authorities; AEBS' initiation/deactivation; and driver's alarm/deactivation.
- Output signals which are the next traffic sign greening (NTSG); Holding the driver (HD); Interlock the ignition (II); and the ambulance informing signal.

The PS_2 central processing unit (CPU) program's performs the desired function according to the flowchart that shown in Fig.2. In Fig.2 (a) the driver is alarmed depending on DDD or DHD modules signal. If the driver deactivated the alarm that means the driver is in good state but if the alarm doesn't deactivated the CPU will process the functions in I branch. Also, the processes in I will perform if the driver is alcoholism, Fig.2 (b).

If the driver is changed, the EEG PID will detect that so the CPU will perform the II branch processes, Fig.2 (c). Also, Fig.2 (c) used to enforces the driver to attach the EEG sensors (e.g. EEG cap or hat) where if the driver take off the EEG sensors cap then the EEG PID signal will be equal to zero and the PS_2 will be processed the functions in II. Depending on the GPS signal if the approved road is changed, the CPU will ask the security authority for permission, if there is no permission the II functions will be processed, Fig.2 (d).

The objective of the PS_2 is to prevent the driver from attacking the lives and property by using the vehicle. Modern systems to detect and prevent

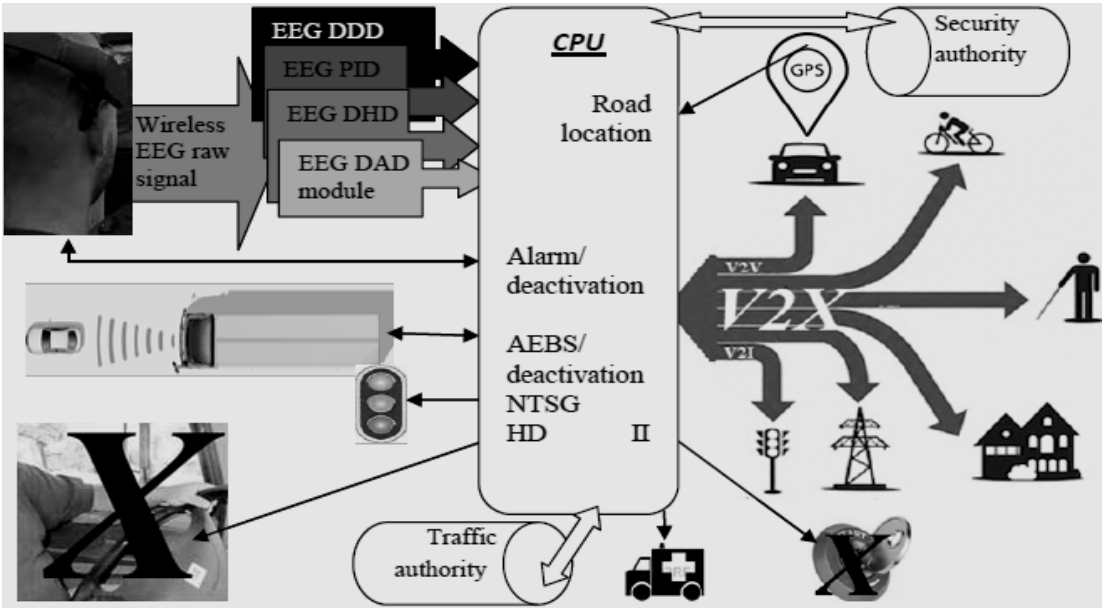

Fig.1. Proposed system architecture

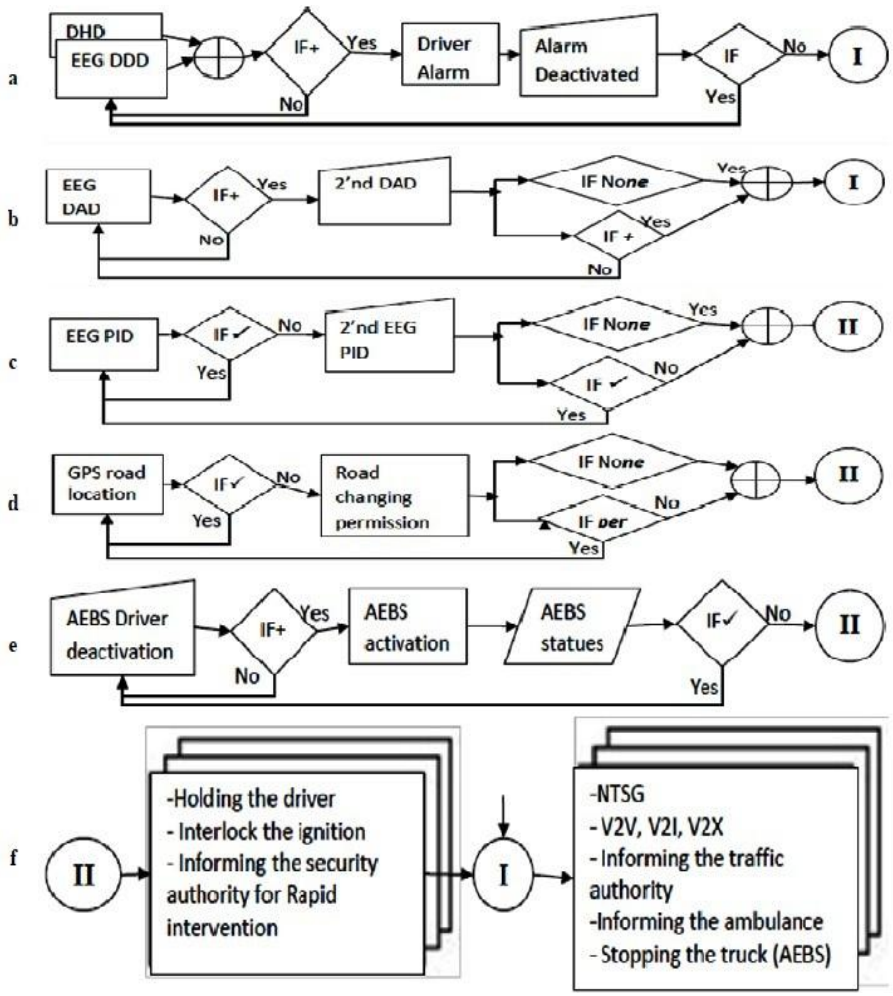

Fig.2. Proposed system flowchart

accidents (like ABES) can perform this objective, provided that the driver doesn't deactivate these systems. Therefore, the PS_2 prevents the driver to deactivate those systems and if the driver tried to deactivate its, PS_2 performs the functions in II, Fig.2 (e)

Finally, Fig.2 (f) states the processes which performed by the branches I and II. The most important processes are holding the driver, interlocking the ignition and Stopping the vehicle. These processes don't need any activation from the out world or the existing of communication links.

The "IF None" statements used in the flowchart to deal with the states when the driver doesn't input the required action or there is no communication links between the PS_2 and the other input systems, so the PS_2 will depend on itself. The 2'nd DAD and 2'nd EEG PID are other techniques to detect DAD and EEG PID respectively, used to increase the PS_2 reliability.

V. Case Study For Lone Wolf Attacks

This section will show the response of the PS_2 if it is applied in two LW attacks scenarios and nuclear materials transportations. Also, the discussion will briefly give the recommendations for the regulations adaptation to facilitate the LW countering.

5.1 Results of PS_2 response in LW attacks

The two most LW's attacks scenarios that are truck legal driver and truck illegal driver. In The first scenario, the driver is an operator or an employee. While the second scenario, the offender is illegal have a truck. The PS_2 will have a good response in the two scenarios.

5.1.1 Truck legal driver

- **The scenario:**In this scenario, the driver under study is the legal driver of the truck and has a good reputation throughout his career history and also has no criminal history or violation of the law. Without previous criminal indications and because of his accessing to terrorist websites, this driver becomes a terrorist (i.e. lone wolfterrorist).
- **PS_2 detection:** in this LW attack, the driver is the legal driver of the truck. So the flowchart Fig.2 (a, b, c and d) branches can't detect the attack. Because the LW drives deliberately into crowded street with a high speed, the AEBS system will sense that and it will decelerate and brake the truck, hence the driver will try to deactivate that system, then the PS_2 will prevent the driver to control the truck and it will stop the truck, Fig.2 (e).

5.1.2 Truckillegal driver

- **The scenario:**The offender has a truck either by stolen, armed robbery or by Peaceful ways as driver numbing.
- **PS_2 detection:** in this LW attack, the perpetrator is illegal driver of the truck. So the PS_2 can detect the LW attack by Fig.2 (c and e) branches.

5.2 Hazardous materials transportations

The most LW harmful attacks were by trucks, admittedly the destruction will be severely increased if the truck was loaded with nuclear or hazardous materials where one of the terrorism aims is to spread the hazardous materials and create panic and disruption. The following lines will show the response of the PS_2 if it is applied to the transportation of the hazardous materials.

The ARG-US Remote Area Modular Monitoring (RAMM) units can be mounted in a freight truck carrying hazardous/sensitive material. In the case of a spill or transit incident, RAMM would allow first responders to not only know the position of the incident but also the nature and severity of the spill or accident before approaching the scene of the event .

VI. Conclusion

In this paper, a system to counter the LW attacks by vehicles is proposed. The system can detect the abnormal behavior and identity of the driver based on the EEG techniques and collision prevention systems like AEBS. In case of a driver violation the proposed system will alert the driver but in a LW threats it (by itself) will prevent the driver to control the vehicle, stop the vehicle and inform the security authority. For collision mitigations the proposed system wills greening the next traffic signs and alerts the surrounds by V2V; V2I; V2X via wireless communications. The proposed system should be attached to hazard materials transportation casks or trucks.

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