Vehicles Auto Collision Detection & Avoidance Protocol

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Abstract
The automotive industry is motivated to provide more and more amenities to its customers. The industry is taking advantage of artificial intelligence by increasing different sensors and gadgets in vehicles machoism is forward collision warning, at the same time road accidents are also increasing which is another concern to address. So there is an urgent need to provide an A.I based system to avoid such incidents which can be address by using artificial intelligence and global positioning system. Automotive/ smart vehicles protection has become a major study of research for customers, government and also automotive industry engineers In this study a two layered novel hypothetical approach is proposed which include in-time vehicle/obstacle detection with auto warning mechanism for collision detection & avoidance and later in a case of an accident manifestation GPS & video camera based alerts system and interrupt generation to nearby ambulance or rescue-services units for in-time driver rescue.

Key words: *A.I: Artificial Intelligence, GPS: Global Positioning System, FCW: Forward Collision Waring*

1. Introduction

Automotive production and sales are increasing day by day in every part of world. Mechanical industry is facing hurdles to meet human requirements with the exponential change in technology. Along with this massive change, another concern to automotive industry is driver safety and amount of road accidents that might occurred during a ride which are also increasing. Humans lose their lives in nasty accidents in huge amount of number on daily basis. Automotive industry along with law enforcements agencies had taken number of steps to reduce such events but stills there are loop-holes in the system that must be addressed. Motor vehicle position is an important and hectic task to perform, especially when vehicles are on busy roads and while they are communicating with different towers and also with bye-crossing vehicles. Automotive industry is adopting technology to ensure the safety and efficiency of the autonomous driving. Engineers are taking advantages of A.I technology which is helping automotive industry to minimizing such events in different ways.

Road collision detection is crucial part of the smart traffic control system, which should regulate expected vehicles incidents over the road and process that information well in time, this can be achieve by using artificial intelligence “AI”, reinforcement learning “RL”, machine learning “ML”, conventional neural network “CNN” etc. of network devices. Above mention techniques have different benefits as well as limitation. In line for the carefulness and convolution of the road environment. So, in time vehicle detection is key which decrease incidents.

In this paper, the protocol for the transport layer of TCP/IP protocol is proposed. The protocol which is been proposed contains some extra functionalities that will enable the vehicles to avoid accidents automatically. The study of image processing is been used for the same purpose. Live video from a digital camera that is connected with a radar system is used inside the vehicle. Our proposed system generates an interrupt for the vehicle owner/driver and warns him/her about the expected situation; if there might be a risk of any type of collision followed by the driver action; if the driver fails to respond according to the current situation timely, then proposed system will react automatically and take some necessary action for vehicle driver these will be:

- Apply auto brakes of vehicle
- Turn "On" automobile light headlights with full strength
- Particular warning alarm for the other object coming in front of the vehicle.

Now proposed radar system which should be installed over the suspect vehicle will come into action and performs following two tasks:

- Identify the object/ obstacle in front of the vehicle
- Calculate distance from the vehicle.

Afterwards, the installed live camera will determine the type of the object then the steps specified below will be performed according to conditions these are: If an accident occurs, the proposed system automatically engage GPS with the synchronization of MODEM to inform the rescue team nearby or another team that

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might be working for a rescue. The rescue team will collect the location coordinates, find the location and will rescue the passengers.

2. Literature Review

[1, 2] Vehicle overtaking solution by using algorithm. To avoid collusion. Martingale is used to calculate risk probability. The algorithm will predict accident avoidance probability, proposed mechanism simulated experiment.

Auto brakes implementation:

i. Alarm to the driver regarding auto brakes.
ii. Vehicle driver failed to perform any avoidance action.
iii. Autobrake will implement.
iv. An alarm is triggered for the vehicle driver.
v.

[3, 4] The proposed mechanism is very slow and less accurate, at the same time techniques used are also not reliable with respect to accuracy. To provide protection to pedestrian collision avoidance by calculating average risk and impact protection system by suggesting action are proposed. Critical study NCAP and GTR based solution of pedestrian protection from automotive products that are designed and equipped with collision detection and mitigation systems. Pedestrians' protection using auto brakes:

i. A vehicle running with approx. 38 to 40 km/h can avoid collision this may result in trifling injuries.
ii. A vehicle running with approx. 70 to 80 km/h cannot avoid a collision this may result in demise.

The study is focused on NCAP and GTC standards for vehicles regarding pedestrian's protection, it deals with limited research and conclusion that impose all responsibility to the pedestrian. [5, 6] An anti-collision detection system of micro electro-mechanical with ARM and alert creation via GSM model and position detection using GPS. Analysis of multi-discipline sensors in making vehicles experience more innocuous on the road. This includes vehicle speed detection by using an accelerometer later nanotechnology-based micro-electro-mechanical sensors with generating signals to advanced RISC machine "ARM" for accurate speed measurement. Feather continuous communication for vehicle detection mechanism with globalization system management "GSM" modem to for exact vehicle position Global Positioning System "GPS". Proposed model is an anti-collision detection and prevention system for vehicles safety.

i. Detect looming collision and generate an alert.
ii. Search appropriate space for vehicle parking also find alternative path ways to available parking space.
iii. Alert generation for pedestrian walking close by.
iv. An infrared transmitter and receiver transmission mechanism assembled with audio/video to alert vehicle's driver and pedestrian.
v. ARM censor transmit streams of radiation which retract after interacting with other objects, calculate probability of collision and generate precaution alert for both driver and closing object.
vi. GSM modem is used for communication with rescue teams near buy.
vii. GPS is used to locate the collision location form rescue team approaching.

Proposed system is limited in scope as infrared has limited range to calculate object on high speed. As GSM/GPS is not allowed in few countries that also minimize the overall scope of proposed system. [7, 8] Capturing useful knowledge with data mining: going beyond simple trajectory analysis: Data mining algorithm based collusion detection with accept able accuracy with the help of auto-robot which predict and perform action on static mean. An artificially intelligent system collect data of surroundings objects and their characteristics and predict safe ride routes and expected collision prediction and avoidance.

i. Proposed mechanism improve overall situation awareness and automate understanding of intersections by datamining.
ii. Time to time prediction of different safe ride trajectories.
iii. Results are provided with computer based simulations.

Proposed system and result seams promising but as comparison of real life event with computer based simulation one should not risk his/her life with the system and for accurate prediction datamining required high computing power and with real time data these are question which should be answered. [9, 10] A safety protocol is provided by combining an algorithm and data mining. This will alert the motorist, and the motorist gets an intelligent automotive acquaintance of the circumstances and take expected actions according to the observed situation. The automotive robot takes decisions mostly at static

means they take action if the consistency has come before a robot. Regardless, this determination must be taken dynamically for a vehicle because distinct circumstances can occur at that time. 1st: the motorist is publicized, and then the automotive measures are taken if the motorist gives no response. 2nd: It can automatically nominate its path before collision occurrence. 3rd: All the steps are taken for the safety of humans and to minimize the loss of lives. [11, 12] Train accidents occur due to safety infringements that are compelled by human errors or impediments. Microcontroller-based and wireless-based anti-collision systems have been introduced to avoid the collision that occurred between the trains. Two running trains can be stopped if they are at a distance of about one kilometer, coming in opposite directions at a speed of 120 kilometers per hour with complete auto brake applying if this system is introduced. The precious lives can be saved, which can minimize the loss that a country has to face after the accidents. [13, 14] Gross Positioning System "GPS" based collision detection agent is used for the deviation of collision that might occur between two or more moving objects. To support GPS around 77 satellites work for NAVSTAR-GPS and approx. 31 satellites are orbiting around the earth. GPS is an American navigation system on the same time few other countries has also developed their own positioning systems (i.e.) BeiDou by china, Galileo by Europe, GLONASS by Russia, IRNSS by India and QZSS by Japan. They are mostly used for military purposes. [15] This facility of GPS is also provided to the civilians free of cost, with the accuracy of 500-30 cm or 16-0.98 ft. The vehicle that uses GPS-based technology finds the location of another coming vehicle in front of it by longitude, latitude, and altitude with perfect accuracy. The server informs one vehicle for coming in front of it, and then it takes steps to avoid the collision. For remote applications, chances of collision become more so this system is efficient for that kind of application. [16, 17] Crash between two cars or other automobiles occurs predominantly due to the motorist inattention because the new generation is bacchanalian, and then it becomes convoluted for a driver to control the car. Some motorist snoozes due to long drive and therefore every year about 23% of all car crashes in America. Two approaches are used for transforming the distance in time. There are two approaches for forward collision warning system "FCW" 1st: the time to collision, and it means the time that the two cars will take to collide. 2nd: is the temporal headway that is the time a car will take to reach the position of the leading car. The motorist is trained, and in this way, they are enabled to control the vehicle, and the chances of collision occurrence become less because the driver takes the safety step to avoid collision occurrence.[18] iPhones are used to detect accidents. Smartphones use an accelerometer and other such applications to detect accidents. Most promising one is mobile crowd-sensing "MCS". At the time of misfortune detection, MCS contact a dedicated server and provide information about calculated mishap detection, and they also send the photograph according to the situation. So, according to that situation, decisions are taken on how faster the rescue team should be there. This means smartphones are also be used for situational awareness and forward collision waring. GNSS is a general system that is effective to calculate position of an obstacle, navigate that obstacle and timing of the location "PNT". Study shows it reduces the response time up to 6%.

3. Detection & Avoidance Protocol

TCP/IP is a layered representation approach that explains the ideology of protocol stack which means protocol suites is nothing but a stack of layers. Among different layers, the transport layer protocol was developed to take user data from an application layer and send it toward another application layer of TCP/IP protocol where data is expected to be received, hare a header is also attached with the sender-data or the message sent to the transport layer. The purpose of attaching the header, trailer, and the sigma was to minimize the error rate and improve overall security [19].

[15, 20] GNSS based GPS consists of around 77 satellites that work for NAVSTAR-GPS and around 31 satellites orbiting around the earth for real-time localization, positioning and time. These satellites are divided into 06 groups, each group containing the 4 different satellites. Each group travel on a different but fix orbital track. The satellites orbit about 20,000miles above the earth with their radio transmitter that covers most of the possible area. With the help of GPS, tracking of location become much more accessible. Satellites operate every time so that the location can be found at any time. GPS is used within the vehicles for navigation, localization, positioning and time.

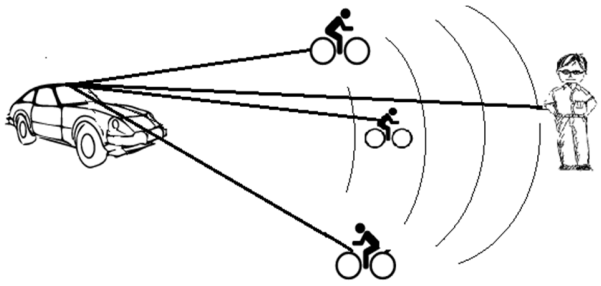

Figure 1. Radar Based Camera System

Figure 1 demonstrate basic mechanism of the radar based camera system. The radar will determine the expected obstacle/ vehicle and its expected distance from the user vehicle. The camera will determine what type of object it is. So, decisions will be taken according to that identified obstacle/ vehicle. The real purpose of this clinching is what type of object is approaching. Sometimes the system is programmed for the safety of pedestrians and pedestrian-only. So the system will then observe the object if it's human, and there might be a probability that the accident will occur. The system automatically applies the brakes and initiate security-related functions.

4. How the protocol work

A pseudocode for the TCP/IP protocol is provided below, which will work over the transport layer. Here each function is assigned a sigma value of (1, 2) code at transport layer in this protocol.

```
111 = probability_of_collision_occurrence ();
112 = alarm_to_alert_the_driver ();
121 = auto_brake_apply ();
122 = fully_headlight_on ();
211 = collesion_accure ();
212 = alarm_the_rescue ();
221 = switchoff_the_alarm ();
```

A class for the transport layer is written which will perform assigned functionality.

```
class transport
  {
   probability_of_collision_occurrence ();
    {
     if (probability<50)
       Continue;
    else if(probability>=50)
     {
      alarm_to_alert_the_driver ();
      if (action==yes)
       probability_of_collision_occurrence ();
      elseif (action==no)
       {
        auto_brake_apply ();
        fully_headlight_on ();
        collesion_accure ();
        if (collision==no)
         probability_of_collision_occurrence ();
        else
         {
          alarm_the_rescue ();
          if (passenger_injured==yes)
            continue;
          else
            switchoff_the_alarm ();
         }
        }
       }
    }
  };
```

When a vehicle's engine starts then “and after fix time period”: it will check the probability of collision occurrence, if the possibility is less than 50% then no action will be taken and if the probability is equal to or greater than 50% then probability_of_collision_occurrence (); function will generate some interrupts to perform necessary activities.

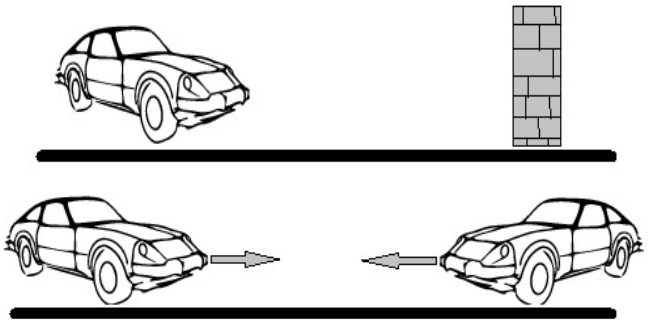

Figure 2. Probability_of_Collision_Occurrence

Figure 2 can be divided in to two scenarios: 1st part shows a car with some unknown speed moving toward an obstacle/ wall, in 2nd part of the figure two cars are shown those are approaching each other with

unknown speed both are traveling on single road in opposite directions. In both of the cases, the probability of collision might be is 80% to 90%. In such situations our proposed pseudocode with specific functions come into play, 1st: the driver will be alarmed through an audio alarm through alarm_to_alert_the_driver(); function. If the driver is attentive or already forewarned of the situation then no action will be taken and program will go back to the function; probability_of_collision_occurrence(); and will again perform its functionality from the start. If no action was taken by the driver then the two functions: auto_brake_apply(); and fully_headlight_on(); will be provoked.

The auto_brake_apply (); function will automatically involve the auto brakes to avoid anticipated collision and the fully_headlight_on (); function will turn ON its full headlights automatically. These headlights were turned ON to alert the driver in the other vehicles coming in front of the infected obstacle/ vehicle. If rather of a vehicle a wall appears then auto brakes will be applied only.

If after performing these functions no collision occurred then the passengers were safe and the program will go back to the initial stage of probability checking by calling the function: probability_of_collision_occurrence (); and if a collision had occurred then the police or other rescue providing services will be alarmed by using GPS modem through alarm_the_rescue (); function. One alarm will be in the colliding car and the other will be in the rescue office they will track the location by using GPS. If the passenger/ vehicle rider were not severely injured then he/ she can turn OFF that alarm to save the important time of the rescue team.

Figure 3. Collision Occurrence

Figure 3: symbolizes the collision that just occurred between two cars that have been vandalized by colliding with each other. The proposed system will help to minimize such incidents by up to 75% to 85% and also improve the overall rescue team response time to perform rescue operations by minimizing up to 6% to 8% overall response time.

5. Flow chart

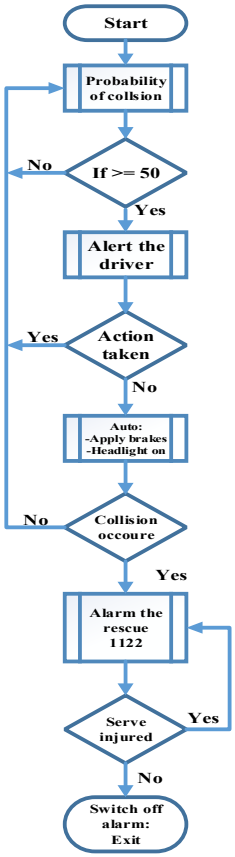

Figure 4. Flow Chart

The flowchart given above demonstrates the workflow of the TCP/IP protocol works. First of all, when the vehicle starts the auto collision detection system starts working each time it checks its probability if its probability exceeds the limit then it means chances of collision has increased. Then first of all system try to alert the driver and if the driver does not take any action then take some steps by itself as we have already mentioned all this.

At the receiving flank, the transport layer will remove the header, trailer, port number and sigma value that it had been added at sending side of the transport layer. And if garbage values were added they will also be deleted so that the same data as sender have sent at the sending flank of the transport layer will receive the same data. Moreover, the sigma code that was used for each function will then be converted to the original function that was used as sigma code. And at the application layer of receiving flank, the

header and trailer that were attached to sending side will then be removed. Finally, the data or message will come in its original shape in which it was sent.

6. Conclusion &Future work

In future, our proposed system can also be used with conventional neural network "CNN" or machine learning "ML" based algorithms to control or observe the traffic control signals. It can also be implemented with RL based approach where it learns how to react at different traffic lights. This will reduce overall road accidents. Moreover, using an auto-brake system and headlights ON this will improve vehicle and driver safety dramatically. In this paper, a simple protocol for auto collision detection and avoidance is provided. This helps in reducing road accidents and preventing precious human lives. It will provides the functions for the vehicle that will helps in avoidance of collisions and add a useful mechanism for rescue in the shape of GPS if any misfortune event occurred.

References

[1] E. Coelingh, L. Jakobsson, H. Lind, and M. Lindman, "Collision warning with auto brake: a real-life safety perspective," *Innovations for Safety: Opportunities and Challenges,* 2007.

[2] Y. Gao, F. J. Jiang, L. Xie, and K. H. Johansson, "Risk-Aware Optimal Control for Automated Overtaking With Safety Guarantees," *IEEE Transactions on Control Systems Technology,* 2021.

[3] R. W. Anderson, D. J. Searson, and T. P. Hutchinson, "Integrating the assessment of pedestrian safety in vehicles with collision detection and mitigation systems," in *Proceedings of IRCOBI conference*, 2012, pp. 751-760.

[4] H. Hamdane, "Improvement of Pedestrian Safety: Response of detection systems to real accident scenarios," 2016.

[5] V. Goud, "Vehicle accident automatic detection and remote alarm device," *International Journal of Reconfigurable and Embedded Systems,* vol. 1, p. 49, 2012.

[6] S. P. Shubham, M. Kumar, and S. Jain, "A Survey on IoT based Automatic Road Accident Detection," in *2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS)*, 2021, pp. 1-7.

[7] I. C. Ijeh, "A collision-avoidance system for an electric vehicle: a drive-by-wire technology initiative," *SN Applied Sciences,* vol. 2, pp. 1-20, 2020.

[8] A. M. Zungeru, "Development of an Anti-collision Model for Vehicles," *arXiv preprint arXiv:1212.5440,* 2012.

[9] S. Ren, Y. He, N. N. Xiong, and K. Guo, "Towards Class-incremental Object Detection with Nearest Mean of Exemplars," *arXiv preprint arXiv:2008.08336,* 2020.

[10] F. D. Salim, S. W. Loke, A. Rakotonirainy, and S. Krishnaswamy, "U&I aware: A framework using data mining and collision detection to increase awareness for intersection users," in *21st International Conference on Advanced Information Networking and Applications Workshops (AINAW'07)*, 2007, pp. 530-535.

[11] P. Arun, G. Sabarinath, S. Madhukumar, and P. Careena, "Implementaion of zigbee based train anti-collision and level crossing protection system for indian railways," *International Journal of latest trends in Engineering and Technology,* vol. 2, pp. 12-18, 2013.

[12] S. Banerjee, S. Mondal, A. Chakraborty, and S. Chattaraj, "Global Positioning System Based Automated Railway Level Crossing," in *2020 International Conference on Computer, Electrical & Communication Engineering (ICCECE)*, 2020, pp. 1-4.

[13] J. Lee, Y. Hwang, and K. Yang, "Intelligent Collision Prevention Technique for Construction Equipment using Ultrasound Scanning," *Korean Journal of Construction Engineering and Management,* vol. 22, pp. 48-54, 2021.

[14] A. Oloufa, M. Ikeda, and H. Oda, "GPS-based wireless collision detection of construction equipment," *NIST Special Publication sp,* pp. 461-466, 2003.

[15] A. Anil, V. K. Shukla, and V. Naranje, "Tracking Vehicles through GPS Module and Arduino UNO," in *2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO)*, 2021, pp. 1-6.

[16] A. Ben-Yaacov, M. Maltz, and D. Shinar, "Effects of an in-vehicle collision avoidance warning system on short- and long-term driving performance," *Human Factors,* vol. 44, pp. 335-342, 2002.

[17] M. Zhu, X. Wang, and J. Hu, "Impact on car following behavior of a forward collision warning system with headway monitoring," *Transportation research part C: emerging technologies,* vol. 111, pp. 226-244, 2020.

[18] J. White, C. Thompson, H. Turner, B. Dougherty, and D. C. Schmidt, "Wreckwatch: Automatic traffic accident detection and notification with smartphones," *Mobile Networks and Applications,* vol. 16, pp. 285-303, 2011.

[19] L. Parziale, W. Liu, C. Matthews, N. Rosselot, C. Davis, J. Forrester*, et al.*, "TCP/IP tutorial and technical overview," 2006.

[20] G. GOV, "Control segment," ed.