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Artificial Intelligence based Automatic Decelerating Vehicle Control System to avoid Misfortunes

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ABSTRACT

The source of the occurrence of accidents in four wheelers happens due to the failure of decelerating systems. Accidents occur if brake is not applied instantly when there exists an obstacle. Negligence of driver, malfunction in the linkages of decelerating systems, twist and turns of road, unmanageable speed at that instant and fatigue of driver are the reasons of accidents. In today's world, where traffic is heavy, it is mandatory to control brakes through electronics devices automatically in order to minimize the accidents near accident prone zones. This paper proposes an effective technology to control the decelerating system automatically by proactively sensing the accident-prone zones and preventing the occurrence of accidents. This technology uses Arduino, L293d motor driver and ultrasonic sensor, Machine Learning techniques, RFID and RFID protocols for effective control of decelerating system. This system needs to be embodied in to the dashboard of a vehicle, supported by secured RFID and machine learning techniques for effectively controlling the decelerating system. In order to minimize the occurrence of accidents, the driving pattern of the driver under various conditions are studied with the help of Car Trips data log and acelerolinear_terra dataset. The trained data are used in the development of a mobile app which when fitted into the windshield of the car helps the driver in controlling the decelerating system thus by avoiding accidents and rash driving.

Key words: Deceleration, Sensors, RFID, RFID Protocol, AI, Machine Learning.

1. INTRODUCTION

The number of road accidents is increasing day by day. IoT and the intervention of smart city will provide tools and assistance for the drivers in handling the situation of potential crashes and thereby reducing the causalities that would result after that. Smart cities can provide informal decisions to the drivers about the traffic and thereby optimizing the route. As a result, smart cities can get the advantage of resulting with decreased causalities, optimized routing and providing "green" transportation.

Internet of Things(IoT) is a networking paradigm designed to connect any devices for pervasive object identification, data capture and intelligent information processing. According to a recent survey around 1,50,000 traffic accidents occurs in a year and half a million Indians die due to accidents in highways. In order to avoid the occurrence of accidents the highway department has placed the signboards. But, accident occurs if signboards are not properly traced. In order to intimate the driver about the zones and the speed limit automatically, the ultrasonic technology can be used.

According to a survey released by Cisco, by 2020 around 50 million things will get connected with the Internet. Also, there is a prediction that, the IoT can project profits and costs around $19 trillion. Collecting and analyzing the real-world data in the IoT environment, assists in decision making. In order to illustrate the functionality, consider a self-driving car. Important functions like maintaining the pressure, observation of the temperature and working of components inside the car are done with the sensors those are available inside the car. These sensors guide the driver to take immediate action in cases of emergency.

2. SMART CITIES

A smart city is a city-wide core infrastructure which can communicate with one another for unified and synchronized operations and information dissemination. Integration of various connectivity features such as cellular, Wi-Fi, Ethernet with upcoming ones such as Bluetooth Low Energy (BLE), DASH7, Insteon, IEEE 802.15.4, etc.

A sensor detects (senses) changes in the ambient conditions or in the state of another device or a system, and forwards or processes this information in a certain manner. In order to illustrate the functionality, consider a self-driving car. Important functions like maintaining the pressure, observation of the temperature and working of components inside the car are done with the sensors those are available inside the car. These sensors guide the driver to take immediate action in cases of emergency. They perform some input functions by sensing or feeling the physical changes in characteristics of a system in response to a stimuli.

In this modern world people are attracted by the Google's self-driving car. Self- driving cars can interact with transportation system and provides vital live data to the riders in order to travel safely. This concept of sharing bidirectional

data with the transportation is termed as connected roadways. With the aid of sensors and Internet of Things IoT(IoT), the driver will be able to observe, interpret and make some critical decision in terms of emergency.

Sensors features are quantitative in nature. A temperature sensor does not deal with the color or light. Instead it measures only the temperature of the environment.

2.1 Characteristics of Smart Cities

(i) Efficient, scalable and associated architecture
(ii) Unambiguous naming and addressing
(iii) Abundance of sleeping nodes, mobile and non-IP devices
(iv) Intermittent connectivity

3. SIGNIFICANCE OF SECURITY IN IOT

As much as the advancements in technology is growing up, so is its adverse effects. There are certain seen evidences of malicious attacks or vulnerabilities. The impact and frequency of cyber-attacks has increased significantly in recent times. The field of Information Technology field has lots of challenges to protect data and network from hackers and unauthorized users. The security system that is to be applied for IoT requires careful technicalities such as authentication, encryption, portability , privacy preservation capability that can understand the structure of industrial protocols and behave in response to the critical situation. For improved security, IoT need to:

(i) Understand and detect the entities required for IoT service (Home networks, Personal connection, connected devices, Gateways)
(ii) Data that is shared between the connected devices with the back-end applications need to be encrypted
(iii) Data need to be protected by following the legislation laid by local data protection.
(iv) Enforce policies based on rule-based security

Many of the IoT sensors existing are intended for a single task and they are inexpensive. That is, these sensors which does a single task has limited processor, memory and they transmit less data at times than what is required. When the number of sensors used for an application increases, the network may produce lossy data as well as results in poor data transfer rates. IoT devices produces big volume of data. The data often generated is in unstructured form. Using Big data analytics tools, it is possible to constraint the data, drill down across, filter and generate data of interest and patterns to the users.

4. LITERATURE SURVEY

Autonomous Emergency Decelerating (AEB) along with Forward Collision warning (FCW) monitors the cases of emergency and prevents the automobile from direct collision, If the vehicle is detected at a speed of 80-180 km/hour, AEB can reduce the speed where as in the remaining cases, it can stop the vehicle [1]. In anti-lock decelerating system, wheel lockup may end up with skidding and result in vehicle instability. This would reduce the ability to change the vehicle direction. This situation can be overcome by the ABS system, in which the drive can brake hard and bring the system under control. But ABS have certain restrictions. It cannot work during rainy as well as snowfall season. Also, if driver has not applied ABS at right time, then it may be a nightmare. The vehicle with ABS is expensive[2]. Honda CMBS is excellent in detecting vehicles of light and heavy weight , in the centre of the lane or side of the lane etc. But the major drawback of this system, the sensor cannot identify if the vehicle moves in less than 15km/hr. Light vehicle parked at the side of a road cannot be detected. When the inter-vehicle distance is small, the system cannot function [3].The intelligent decelerating system of Nissan uses laser radar sensors to avoid the risk of collision automatically. According to a report, given by FORD, a camera technology is used for detecting a direct collision of an obstacle with a vehicle. On meeting a collision an alert message is sent along with a warning message. The Intelligent emergency of Nissan alert the driver visual and audio alerts in cases of applying brake. A camera attached in the top portion of the windshield detects the movement of other vehicles and obstacles[3].AEB of Nissan uses radar technology to monitor the closeness of the vehicle with any obstacle and provide instruction to the driver to take necessary action [4]. Pre-collision assist uses camera technology to scan the entire movement of the vehicle on road. Pre-collision assist along with AEB can apply brake automatically if collision is made [5]. Bhaskara et al (2018) has presented a case study on automated decelerating control system. The experimental setup is performed with Arduino. ABS is designed in order to proactively stop the vehicle in order to avoid any untoward accidents[7]. Chen Chao and Xia Qin (2016) has proposed emergency decelerating system based on traffic accident data statistics [8]. According to Eung Soo Kim et al (2008) auto decelerating system is simulated using VHDL and it shows prevent intelligent cars from collision by tracking the obstacles using sensors[9]. A. Ferrara (2004) has proposed a collision avoidance and if not to apply automatic decelerating system[10]. G. Sankar and S. Saravana kumar (2006) and Meghna Madhava et al (2016) has proposed an artificial intelligence based decelerating system in train [11, 19]. Fuzzy-logic controller is used for providing artificial intelligence. The micro controller controls all sensors. The distance between a vehicle and the following vehicle is controlled by ultrasonic transmitter-receiver.

Haruhiko Iizuka and Kunihiko Kurami (1994) has got patent for automatic decelerating system. The system has a speed sensor and a distance sensor. The speed of the vehicle is monitored by the speed sensor whereas the distance between a vehicle and the following vehicle is measured by a distance sensor. The system also monitors the marginal time in which the following vehicle may collide with the vehicle proceeding [12]. Ian Fletcher et al (2003) has suggested a intelligent control strategy for driver's comfort while activating ABS. The ABS system of Honda helps the driver to prevent collision by applying distributed decelerating. XC60 SUV of

Volvo is designed with a decelerating system assisted by laser. When a vehicle is about to collide, the driver become panic and will not apply brake properly, which results in accidents most of the cases. This problem can be avoided by ABS with the help of sensors and micro controllers [13]. Jan Eilbrecht et al (2017) has suggested a framework for model-prediction [14]. Joshué Pérez et al (2019) describes RFID-based Intelligent Vehicle Speed controller. The RFID tag reads the active traffic signals and applies decelerating [15]. Kenji Kodaka and Tomoyuki Shinmura (2001) has adopted relative lateral position between a vehicle and any obstacles by providing safety control system for automobiles. The sensors functions based on the information collected using the Radar unit. The block diagram is depicted in Fig.6. This system senses where there is any object along the direction of the vehicle. This is carried out by calculating finding object detection means and by calculating the relative lateral deviation means. Relative lateral deviation means is calculated based on the distance between vehicle and the proceeding vehicle. If this estimation, can be carried out at the proper time, to avoid untoward accidents[16]. Kinoshita et al. (1997) has devised a patent namely Drive Assist System for Vehicle. An approach namely Active Drive Assist System is proposed. This system studies the environment and give warning if there exist some danger situations [17]. "AI-Based Adaptive Vehicle Control System" is a technique being invented and patented by Kunihiko Adachi, Norikazu Endo, Hironori Miyakoshi, all of Susono Toyato, Japan. This system is designed in such a way that, it can control the speed of the vehicle according to the driving pattern of the driver. Also, the vehicle is controlled based on the parameters such as speed, obstacle in front, wheel alignment, steering position, etc. The probability of occurrences of accidents called danger index is by calculated using fuzzy membership functions based on the above said parameters with the driver's state of mind [18]. MohdAzlan Abu et al (2012) has proposed a artificial neural network based automatic decelerating system to provide safe parking. It avoids collection between the vehicle with its preceding one by varying the pressure in decelerating until it reaches a closest safe distance. This concept can be achieved using ultrasonic sensor being placed at the back bumper. The system has used the back-left sensor, center sensor, back right sensor as input parameters and decelerating pressure as the output variable. By increasing the decelerating pressure, collision can be avoided [20]. Rupesh Kumar Sinha Et Al (2017) Arduino Uno Microcontroller for the implementation of Automatic Decelerating system. The sensor present at the front end of the vehicle observes the ultrasonic wave, estimates the distance between the obstacle and vehicle if any obstacle is detected. The reflected wave from the ultrasonic receiver regulates the decelerating circuit which in turn stops the vehicle, whereby reducing the occurrence of accidents[21]. Tetsuro Butsuen et al (1995) has supplied a patent to Mazda Motor Corporation, Japan. The system estimates the distance between a vehicle and a following vehicle and transmits a warning signal if the actual distance between both the vehicles are more than the desired distance. Detecting the movement of the vehicle and the obstacles present are monitored by radar unit [22].Xiang Cheng et al (2019) describes the era of intelligent vehicles [23].Yoshiyuki Etoh in 1986 has implemented a patent for Nissan Motor Company, Limited. This system controls the speed of the vehicle by calculating the distance between the vehicle followed by the preceding one [24]. Zong Chang-fuet al (2011) proposes a control strategy in order to improve the decelerating performance. The speed of the movement of decelerating pedal is used to determine the emergency of the driver [25]. The Antilock Decelerating System (ABS) equipped in automobiles uses different types of sensors to detect obstacles in a proactive manner and prevent the occurrence of accidents [26, 27]. Table 1 depicts the various patents filed on various types of automation engines.

Table 1 : Automation Engines with their function

Automation Engines	**Sensors / Components Used**	**Functions**
Automatic Proximity Detection	Distance sensor, Speed sensor, Wiper sensor, Steering sensor, Brake Sensor, Turn Indicator sensor, Acceleration sensor, Seat Belt sensor, Selector, Ignition switch	The readings from the sensors are read by the microcontroller, which are then passed to the actuator which raises an alarm when an obstacle is detected.
Travel Safety System	Radar Information Processing Device, Electric Power Steering Device	Object detection is done by estimating Movement Locus means. Relative Lateral Deviation calculating means, steering state detecting means, Contact-possibility determining means, Contact-avoiding means
AI-based Adaptive vehicle control system	Sensors	Calculates degree of danger by Fuzzy membership function, Calculates relative distance between vehicles and appropriate manipulated variable
Automatic Brake Control System	Velocity Sensor, Steering angle sensor, G Sensor, Road surface sensor, Radar Unit	A Control unit obtains the input and sends warning means.
Controlling Vehicle speed	Inter Vehicle Distance Detector, Vehicle speed sensor	I/O port acts as an interface between the sensors and CPU and a cruise control device after getting sensor data transmits alert

5. METHODOLOGY

In the existing systems, the automatic decelerating system is not implemented commercially. Car manufacturing companies like Audi, Nissan and Volvo have implemented automatic decelerating system but it is made to function only on emergency situations. Audi and Nissan car has ultrasonic sensors with a camera so it detects hidden objects and stops. But, this technology is expensive and also jerks occur when brake is applied suddenly. Volvo's decelerating system seems more legit than all these since it has a radar and it assess the speed of the vehicle coming on the opposite direction but it does not have a RFID or GSM. Renault has been researching on RFID technology and have invested 500 million dollars in this system. But they will only make a prototype only by 2020.

Intelligent vehicles is a terminology that is applied to safety car systems. Intelligent vehicle technologies provide instantaneous information to the rider who needs best means of journey. This section proposes an effective methodology for automatic control of decelerating system to avoid accidents near places like accident prone zone, schools, markets and hospitals. This technology uses Arduino, L293d motor driver and ultrasonic sensor, RFID for effective function of decelerating control system. This system is fixed on to the dashboard of a vehicle. A common example for self- driving car is cruise control (CC), which can maintain a constant user-preset value.

5.1 Proposed Method

This concept presents an automatic decelerating system which is affordable with less impact. The intensity of brakes is set based on the perimeter of object encountered. Arduino works as a brain and L293D works as the heart. If any obstacle is detected within a perimeter (30cm) the brakes will start to function and eventually it will be applied at full strength within a cringe distance (8cm). The RFID will detect any sensitive area like Hospital and it will disable horn will

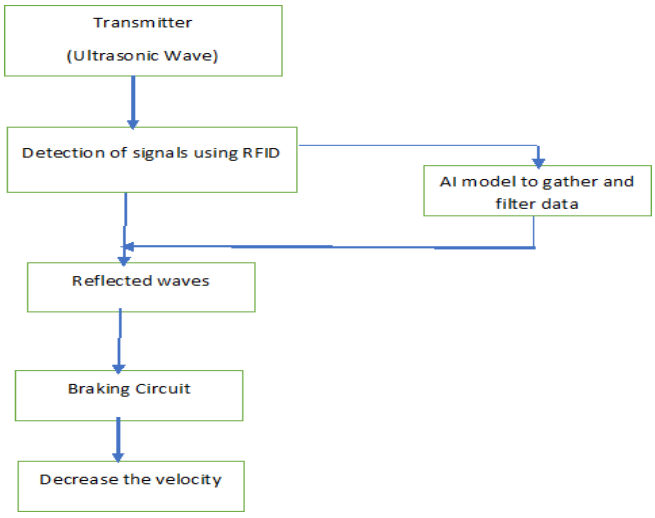

Figure 1: Overall Architecture

make the driver to maintain a speed limit. Similarly, it also slows down when it detects the school using artificial intelligence. The RFID sensors can detect the objects because of the tags will be fixed on a smart board. And if any damage occurs to vehicle then message will be sent to driver's close associates. So, this decelerating system with artificial intelligence scores a good mark in emotional quotient. Blending of RFID and ultrasonic sensors helps the proposed decelerating system to function with artificial intelligence.

Thus, this proposed system is a one of a kind of effective decelerating system dedicated for a sociable cause prevent in accidents. This is also ideal for electric cars in a futuristic purpose. And thus, this Artificial Intelligence based decelerating system will be a revolutionary decelerating system. The overall architecture is depicted in Fig. 1. Arduino, Intelligent decelerating, Ultrasonic sensor, At mega 328p Microcontroller, L293D Motor Driver, LCD display, GSM, RFID, and RFID tags are the components used for this approach.

6 OBSTACLE DETECTION

For the automatic decelerating system to work it is required to know the distance of the objects in front of the vehicle. Only using the distance, it is possible to control the timing and force of the brake. Thus, an accurate and feasible method to find the distance is required. Ultrasonic sensor is a commonly used sensor for calculating the distance between objects. Ultrasonic sensors give accurate result and are not affected by external factors. For these reasons the decelerating system uses ultrasonic sensors. The decelerating system has an obstacle detection unit in which the basic sensor to measure distance is the ultrasonic sensor. To find distance in all direction multiple ultrasonic sensors are to be used. Only if the sensors are placed in all directions, threats can be identified from anywhere. The sensors can monitor an angle of 45 degrees and so one is sufficient to sense all objects in the front. The obstacle detection unit is capable of finding not only the distance between the cars but also the bends in roads, due to its wide range. The purpose of the ultrasonic sensor is to detect incoming obstacles accurately. Ultrasonic sensors can calculate the distance of all nearby objects from the sensor to the object. The waves are first emitted from the sensor .These waves bounce off objects and return to the sensor. The waves are received by the receiver in the sensor. Ultrasonic waves travel at constant speed and if the time of emission and receiving are known, then time-difference between the emission and receiving time of the waves are calculated to find the distance of the object. After calculating this distance, it is sent to the Arduino board where the distance input is further processed. The distance is constantly calculated without a break. Even after long term use, the ultrasonic sensor maintains its accuracy and provides reliably data. It is not affected by rain and harsh climates due to the penetrating power of Ultraviolet rays. Ultraviolet rays can detect humans and thus reduce risk of pedestrian getting

involved in the accidents. Ultraviolet rays can detect objects up to 50 meters. It can be increased or decreased by changing the power of the sensor chosen.

6.1 Decelerating System

Majority of road accidents occur due to negligence of drivers and delayed decelerating of the drivers. This accident claims the lives of countless lives in India but with the automatic decelerating system these common accidents can be eliminated. The distance is calculated from the obstacle detection unit using ultrasonic sensors and is send to the Arduino board. This data must be used for smart and controlled decelerating in the vehicle. There are two distances that are checked in the automatic decelerating system. They are the warning distance and the danger distance. After the distance from obstacle is obtained it is checked if it has reached the below any of the threshold distances as coded in the Arduino board. The warning distance is the distance at which the speed of the vehicle is limited. Even if the user wants to go above the imposed limit it is not possible unless he manually overrides the command. The user can at times manually override the limit for his convenience but it not necessary for proper driving of the vehicle. If the speed is over the warning limit it is slowly brought under the limit with slow amount of brake applied. If the vehicle attains danger distance, then the vehicle immediately applies the brakes and tries to come to an halt. When the danger distance is triggered distress, signals are sent to family and close friends with the help of GSM module. If the brake is successful, the vehicle is saved from the accident and can be started again. In automated decelerating system occurrence of accidents can be minimized. The value of the warning and danger distances can be set by the user in the Arduino. The car comes to halt only when an object is approaching the very close to the vehicle, so it does not affect the driver driving the vehicle with sudden brake or there is indicator when the vehicle is speed limited. When the vehicle is speed limited further acceleration is reduced and the limiting speed is slowly attained. The other parameters such as limiting speed and rate of deceleration can also be easily customized by the user. The user can set it to his own convenience for a better driving experience.

6.2 RFID Tag

RFID tags are used to identify to exchange data to the RFID reader using radio waves. If they RFID tags are placed in school areas, hospitals and accident-prone zones then it can alert the vehicles to slow their speed and also reduce to reduce the horn sound in hospital areas so that the patients are not affected. The RFID tags must be placed in said special zones in the form of small strips on the roads so that whenever a vehicle with the automated decelerating system passes the zone it senses the tags using the RFID sensor present in the vehicle's decelerating system uses these RFID tags to limit its speed in danger zones and school zones. It also reduces the horn sound in hospital zones. This is made possible using the combination of a RFID tag and IOT technology. RFID sensors can sense the data from the RFID tags. The RFID tag contains information about the zones and gives instruction to slow down or reduces volume of horn. Till the vehicle leaves the zone it is speed limited or has low horn sound depending on the instruction in the RFID tag. After it leaves the zone it automatically reverts to its normal state. This is yet another useful functionality of the automatic decelerating system. However it required RFID tags to be placed in the roads.

6.3 GSM Module

The GSM module can connect the Arduino board with cell phones. It can send predefined message to a registered mobile phone number. It can be modified and send its current location also. The automated decelerating system also has the GSM module which can connect the car to a few mobile phones. After storing the mobile phone address the GSM module can send SMS to the registered mobile phones. The GSM module to send the location of the vehicles to close friends or family in case of an emergency. For example, when an abrupt brake occurs the location of the vehicle is immediately sent to the mobile numbers registered in the GSM module. This will help alert people in case of accidents and help in recovery operations. The exact location of the vehicle is sent in Google maps so when received it is easy to identify and arrive at the location.

6.4 Data Storage

All the decelerating history and relative object distances can be constantly stored in a secondary storage. This can help in analytical studies. The approximate rate of fuel consumption or calculate speed of the vehicle using this data can be calculated and analyzed if any accident was to occur to obtain more information about time, place of the crash and speed of the vehicle. One of the major challenges of RFID systems is collision occurs due to simultaneous tag responses. When several tags are connected with a RFID reader, it would result in an increase in identification delay a reduction in bandwidth and energy. This tag collision problem can be resolved using anti-collision protocol. Protocols can be classified into Space Division Multiple Access (SDMA), Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA) and Code Division Multiple Access (CDMA). Among all protocols TDMS covers majority of anti-collision protocols.

7 . CONCLUSION

The secured RFID based automatic decelerating system can avoid accidents near the critical areas are prohibited saving life. Accidents in highways can be eradicated thereby saving millions of global citizens every year. If the device didn't get any reply from the user it will automatically send the current location to close associates. No jerks will occur since it will

alert and start decelerating gradually within a perimeter (30cm). Artificial Intelligence decelerating system will be an apt one for future smart city models. The security threat that is existing for an RFID tag will be minimized with the usage of Anti-collision protocols. Machine Learning techniques play a major role in providing only essential data to the sensor for smart decision making.

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