International Journal of Research in Advent Technology, Vol.5, No.11, November 2017
E-ISSN: 2321-9637
Available online at www.ijrat.org

Divider Collision Avoidance System

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Abstract- The transport sector in India is growing at a huge rate in terms of both traffic and infrastructure. It caters to the transport needs of 1.1 billion people [1. Today there are high traffic accidents that lead to fatalities. A system must be developed to prevent accidents as much as possible. Machine learning applications come useful in predicting collisions. The main cause of accidents is the collision at the intersection. This system needs to be built in several steps. The first step would be to create a cloud based network of all components of the system. This would include bringing all vehicles (cars, buses, trucks etc.), all electronic components (traffic lights) and even static components (like dividers, intersections, traffic signals, curbs etc.) on the cloud. All these components will be interconnected on a giant mesh network. This will enable a vehicle to vehicle communication, as well as communication to a central cloud hub. The information transmitted will not only be analyzed at the hub, but also every RF module will learn and make intelligent decision based on its communication through neighboring RF modules. It can hence then not only predict accidents but also prevent it.

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Index Terms- ***Machine Learning, Mesh, RF, Cloud, Vehicle to Vehicle, Decision Tree.***

[1] INTRODUCTION*

The proposal aims to connect all vehicles in a network and enable them to communicate with each other as well as to a central hub. For this purpose, a Radio Frequency transmitter/receiver (RF trans-iever) is installed in every component of the mesh based network. The mesh based network consists of vehicle clusters that interact with each other using RF communication and self-organizing time division multiple access (STDMA) which provides promising results with similar highway simulation scenarios [4]. DSRC (Dedicated Short-Range Communication) wireless technology for vehicle-to-vehicle (V2V) and vehicle-to-roadside (V2R) communications is promising to dramatically reduce the number of fatal roadway accidents by providing early warnings.

08/Nov/2017.
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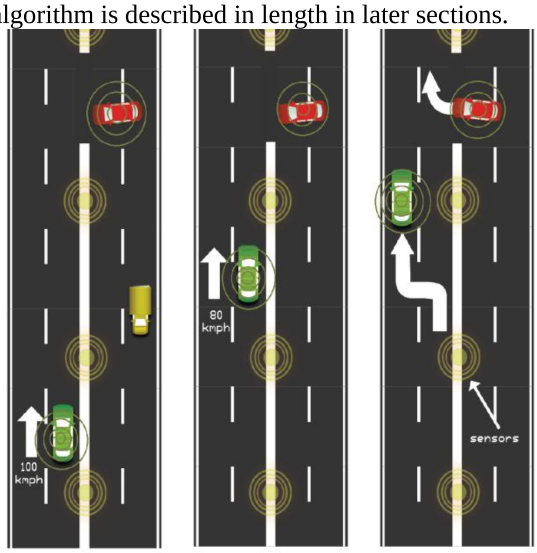
1. IDEA

The basic idea behind a accident avoiding system is developing an intelligent transport system where vehicles can communicate with each other. While this would include a large umbrella of vehicle to vehicle communications, this technology focuses on accidents that happen at divider ends. Once an accident like situation is detected both the vehicles are warned and if the warning is ignored, the vehicles are stopped. The ability of vehicles being controlled through an algorithm is subject to vehicular capability and is part of an ongoing research . For example, consider the case of road accidents that happen at divider gaps, where the vehicle coming straight at a high speed cannot see an incoming vehicle and collision occurs. This can be prevented using DCAS (Divider Collison Avoidance System). (Fig 1)
The dividers are lined with proximity sensors and accelerometers. As soon as the divider senses that the

vehicle is speeding straight while another vehicle is coming in, it will calculate and monitor the distance and the speed of both the vehicles(V2R) and give appropriate warnings. (Fig. 1). The figure shows clearly how the vehicle can navigate in order to avoid the accident. This is one of the many cases that can occur and an efficient algorithm must include all cases that can happen and possible solutions to avoid conclusion or at least minimize impact. Such an algorithm is described in length in later sections.



2. COMPONENTS USED

The basic technology used in this system would be sensors and raspberry pi modules to take input from these sensors. The sensors that need to be used are accelerometers, proximity sensors and some RF modules for communication. The communication mode will be DSRC (Dedicated Short-Range Communication). The algorithm that will be used to avoid the collision will be a machine learning algorithm called the decision tree algorithm. When these technologies are brought together we get an intelligent transport system that can predict and prevent road accidents.

2.1 DSRC

Key goals of the design of highway and transportation systems are to reduce the occurrence of accidents and alleviate congestion. Tools such as vehicle sensors, speed radars, traffic cameras and other state-of-the-art technologies are frequently deployed to combat these problems. In 1999, the Federal Communications Commission (FCC) allocated 75 MHz of licensed spectrum, from 5.85 to 5.925 GHz, as part of the Intelligent Transportation System (ITS) to use for Dedicated Short Range Communications (DSRC)[4].

The IEEE 802.11 p standard (or, DSRC) is a variant of the IEEE 802.11 a standard. While keeping the key design and specification almost the same as IEEE 802.11a, a number of parameters in the IEEE 802.11p physical-layer specification have been changed to adapt to outdoor automotive environments [2]. For example, IEEE 802.11 p operates in a different frequency band near 5.9GHz. Also, the channel bandwidth of 802.11 p is about 10 MHz compared to 20 MHz in 802.11 a. However, the suitability of DSRC technology for automotive environments is still under technical evaluation.

It is anticipated that DSRC will be used for both vehicle-to-vehicle communications as well as vehicle-to-infrastructure communications. The spectrum is seen as particularly useful for V2x communications because it can support very low-latency, secure transmissions; fast network acquisition and in general, the ability to handle rapid and frequent handovers that are inherent in a vehicle environment; as well as being highly robust in adverse weather conditions. ITS also notes that it is tolerant of multi-path transmission[3].
The DOT has identified more than 40 use cases for V2I technologies, such as the ability to pay for parking and tolls wirelessly, identify when a car is approach a curve too quickly and alert the driver; adjusting traffic signals to accommodate first responders in an emergency; and alert drivers of conditions such as road construction, among others

According to a report published recently [4] on the connected car by the Government Accountability Office, the US DOT "plans to provide up to $100 million through its Connected Vehicle pilot program for projects that will deploy V2I technologies in real-world settings" over the next five years.

2.2 Sensors

2.2.1 Distance Sensors:
A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.
A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred

to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target.
The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Some know these processes as "thermosensation".

2.2.2 Speed Radar

A Doppler radar is a specialized radar that uses the Doppler effect to produce velocity data about objects at a distance. It does this by bouncing a microwave signal off a desired target and analyzing how the object's motion has altered the frequency of the returned signal. This variation gives direct and highly accurate measurements of the radial component of a target's velocity relative to the radar. Doppler radars are used in aviation, sounding satellites, meteorology, radar guns,[5] radiology and healthcare (fall detection[6] and risk assessment, nursing or clinic purpose[7]), and bistatic radar (surface-to-air missiles).

2.3 *RF Modules*

The RF module (Fig 2), as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D, HT640-HT648, etc. are some commonly used encoder/decoder pair ICs[8].

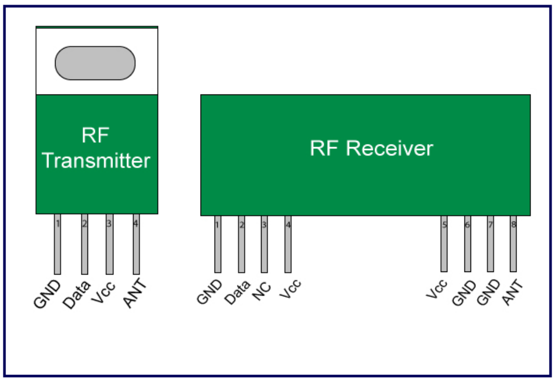


Fig 2. An RF Module

3. TECHNOLOGY USED

The basic working of this system is based on the supervised machine learning algorithm called the decision tree algorithm. Decision tree builds classification or regression models in the form of a tree structure. It breaks down a dataset into smaller and smaller subsets while at the same time an associated decision tree is incrementally developed. The final result is a tree with decision nodes and leaf nodes. A decision node (e.g., Outlook) has two or more branches (e.g., Sunny, Overcast and Rainy). Leaf node (e.g., Play) represents a classification or decision. The topmost decision node in a tree which corresponds to the best predictor called root node. Decision trees can handle both categorical and numerical data[11].
The core algorithm for building decision trees called ID3 by J. R. Quinlan which employs a top-down, greedy search through the space of possible branches with no backtracking. ID3 uses Entropy and Information Gain to construct a decision tree[9].
Entropy
A decision tree is built top-down from a root node and involves partitioning the data into subsets that contain instances with similar values (homogenous). ID3

algorithm uses entropy to calculate the homogeneity of a sample. If the sample is completely homogeneous the entropy is zero and if the sample is an equally divided it has entropy of one.

Information Gain

The information gain is based on the decrease in entropy after a dataset is split on an attribute. Constructing a decision tree is all about finding attribute that returns the highest information gain (i.e., the most homogeneous branches) [10].

The working of the algorithm is as follows. If the vehicle is at a distance less than 150 meters from the incoming vehicle and is speeding at 100kmph the DCAS will monitor its speed every 25 meters. If it does not slow down, the DCAS will reach a decision state where it will either swerve this vehicle to the next lane if it is empty, otherwise it will reverse the incoming vehicle to avoid collision. The DCAS system also factors in the weather and traffic conditions, for instance it will increase the monitoring frequency if the roads are slippery during monsoon season This system is based on supervised decision tree suggested learning.

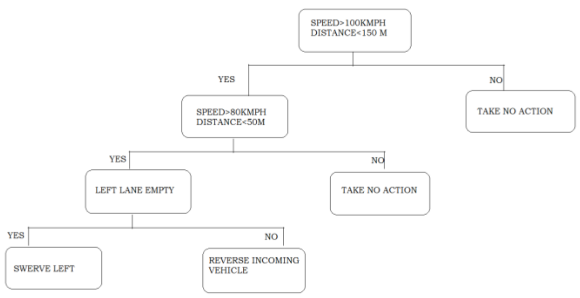


FIG. 4 DECISION TREE SUGGESTED LEARNING FOR COLLISON PREVENTION

4. DRAWBACKS

The idea is limited due to the lack of cars that can be controlled by an algorithm. Such AI vehicles are still in research phase and such a solution provides no immediate solution. The algorithm also needs to be more diverse to include many more real-life scenarios. These drawbacks can be overcome gradually as we try to implement the solution in real life.

The number of accident at intersection forms the chunk of road accidents that happen around the world. This method provides an effective way to combat this problem. Although the practicality of the method may be in question due to the technical restrictions of the vehicle, a warning message can be sent even in existing means of transport. And even a warning will go a long way in preventing accidents and will save lots of life and property.

Acknowledgments

This paper would not have been possible without the continual guidance and support of our college professors especially Dr. Rachana Dubey. We would also like to thank our technical expert at Averoft, Mr. Aveneesh Mathur for his valuable inputs every step of the way.

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