Integrating RFIDs and Machine Learning: Application of Machine Learning In Smart Traffic.

Simarjot Singh Monga

BCM Senior Secondary school, India

Contact Information:

simar5244@gmail.com

+91-7888517648
Abstract

Data industry has grown exceedingly, now finding its applications in the fields no one would have imagined a few decades ago. Data science, Machine learning and Artificial intelligence have major impacts in the national economy through a million ways. Today, we will explore one of their untapped uses: Traffic! This research document will provide methods and information regarding the possible integration of Radio-Frequency Identification (RFID) and Machine Learning (ML).

Keywords: Machine learning, Radio-Frequency Identification (RFID), Artificial intelligence (AI).

1) INTRODUCTION

Before travelling to work or school, when we say goodbye to our loved ones, there is always a probability that it might be our last ‘good-bye’. With the increasing number of road accidents and fatalities, a fear always remains in our conscience to drive safely. Although that might not be the case with everyone. The most common vehicular accidents aren't due to the driver’s negligence. Let's review these cases;

1) Rear-End Collisions[1]

Cause: sudden deceleration by person ahead (ex: 40kmph to 10kmph suddenly)
Remedy: Knowing the other driver’s vehicular behaviour and traffic situation might suggest maintaining a wide gap between your vehicles.

2) T-Bone Collisions

Cause: travelling through intersection and an Overspeeding vehicle might interject you
Remedy: If the other driver isn’t able to decelerate in due time, you can stop your vehicle. The knowledge of another vehicle coming at high speed through an intersection might be helpful.
Review conclusion: The knowledge of vehicles within a few metres of your car, whether stationary, approaching you at a high speed, or exhibiting erratic behaviour could prevent an accident, saving both: human resource and capital. This insight can be achieved through the following experiment.

2) DERIVATION OF A POTENTIAL SOLUTION

2.1) INTRODUCTION OF RFIDs [2]
Radio frequency identification system consists of an RFID tag, an antenna, an RFID reader, and a computer system. We will go through each of these components individually.

2.1.1) RFID Tags
RFID Tags operate on radio waves to communicate information. They have a receiver which interprets the waves emitted by the reader. These are further classified into two types: Active and Passive. Active RFID Tags have their own energy source but can store less data than Passive RFID Tags which lack an energy source and are only able to respond because of the energy received via waves emitted by the RFID reader. For our project, we would use an Active RFID Tag.

2.1.2) RFID Reader
RFID Reader transmits radio waves and understands the radio waves received for tags and sends the data to a computer system attached to it. Sometimes, they might have an antenna embed in them already or may need one if not. An antenna performs the basic function of receiving the radio waves from tags.

2.1.3) The computer system attached to the reader receives the data which might be further used for multiple purposes.

2.2) INTRODUCTION OF DATA SCIENCE AND MACHINE LEARNING.

Using scientific methods, complex algorithms, knowledge can be recovered from heaps of structured or unstructured data. This knowledge finds its application across a broad range of domains.

2.2.1) Choosing the right data set of right size: A particular insight is useful for a particular issue.

2.2.2) Choosing the right algorithm to apply to the data set: can be achieved by organizing and understanding the right group. If not organized, prefer using an ‘unsupervised algorithm.’
2.2.3) The Machine learning Algorithm we will be working with in this project is an ‘Anomaly detection algorithm’: One class support vector machines (SVM). N dimensional data (N is the number of features.) is being read through by the SVM to determine the ‘Normal.’ However, we will determine the ‘New Normal’ to a fixed value for certain reasons described ahead. The SVM then inserts the data across a hyperplane, and the deviation through the hyperplane is recorded.

2.3) PROCEDURE

An active tag is assigned with a unique EPC or electronic product code. We attach an active tag to a car. The data of the vehicle and its dimensions, build year, etc. are to be written in the tag’s code. An RFID Reader is installed on a pole near the road. The reader broadcasts several waves across the road and the waves are received by the RFID tag which back-scatters the wave. Instead of using traditional programs, we use a Time-of-flight sensor, mounted on the reader, with adjustments made in its program to calculate the additional distance between the reader’s emitter and time-of-flight sensor. On receiving the back-scatter, the information is received by the computer system. The information here consists of: relative distance of the vehicle from the pole, the dimensions of the vehicle, and some other details. This information is then fed to a program which plots the 3D location of the vehicle on the road with accurate
dimensions. The program also has information about other infrastructure on the road, such as lane dividers, etc.

Now multiple vehicles on the road are attached with RFID tags, and the program plots their 3D real-time location on road, creating a virtual traffic map, with the exact vehicular information, which would entail; the distance between bumpers of any two vehicles, the distance of a vehicle from lane divider, etc. This program will record the vehicular behavior of the vehicle, i.e its proximity to other cars, its speed on straight lane and near the U-turns, or intersections, unusual speeding across the road, proximity to road edges and other infrastructure to which it might bump into, etc.

We will set up a special ‘New Normal’ for our SVM abiding by the conventional road driving rules. For example, a vehicle generally slows down from 60 Kilometers per hour on high-ways to 30 Kilometers per hour near U-turns or to less than 5KMPH near 4 lane intersections. After setting this new normal, we will feed the behavioral statistics of our vehicle, which the SVM will plot across a hyperplane, providing a score: Crash probability and Safe distance or CPSD. A new program will suggest the distance needed to maintain to avoid rear-end collisions, for example.

To further specialize the program, the driver will wear a wristband containing a RFID tag, which would also transmit the information about the driver of the vehicle (his driving behavior recorded, his violations of law, for example: the driver could have little or no regard for red lights and might cause accident.s) along with the vehicle itself. The vehicular RFID containing its build year, might suggest an old vehicle which might breakdown on a highway, or if the vehicle history is uploaded to the RFID, the information regarding poor/loose brakes, poor engine etc. can also contribute to the ‘New Normal’ line of the plane. Thus many additional parameters can help perfect the CPSD to a high accuracy.

Further this information can be available on your vehicle’s infotainment screen and/or a third party application which might trigger a warning if you are in proximity of a driver with a high Crash probability or high CPSD score, and it would suggest you the minimum safe distance to maintain from that vehicle/driver.
2.3) CHALLENGES AND SOLUTIONS

2.3.1) Multiple objects in the line, generally cause measurement of an average.
2.3.2) Insufficient range of IR.
2.3.3) Solution: Using a modulated sinusoidal wave, and measuring the path difference of initial wave and the back-scatter.
2.3.4) Multiple RFIDs received by the antenna.
2.3.5) Using Anti collision logic algorithm, RFIDs can be isolated [3].

ADVANTAGES OF THE CPSD SYSTEM

The estimated damage caused by motor vehicle crashes is 1 trillion dollars. Using cheap infrastructure like RFID tags which might already be present in some vehicles, in this potential program with a high initial accuracy and prevention rate could save many lives.

2.4) CONCLUSION

The loss of capital and human resources in a super-economy is calamitous. As the number of motor vehicle crashes continue to rise, it has become clear that new ways of preventing these have to be devised. The increasing usage of artificial intelligence and machine learning can provide a possible solution to this problem. By integrating common technology like
RFIDs with machine learning to provide a statistical value of crash probability to every driver can help to reduce this number.

References

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