Internet of Vehicles (IoV) for Traffic Management

Tej Tharang Dandala [1]   Vallidevi Krishnamurthy[2]   Rajan Alwan[3]

[1,2,3]SSN College of Engineering, Anna University, Chennai, Tamil Nadu, India

E-mail: vallidevik@ssn.edu.in[2]

Abstract—**Internet of Things (IoT) is a world-wide network connecting all the smart objects together. It is the way in which all things are enabled to talk with each other. Whenever those smart things being connected over internet are restricted to only vehicles, then it is called as Internet of Vehicles (IoV). With continuously increasing urban population and rapidly expanding cities, vehicle ownership has been increasing at an exponential rate. Hence, traffic management has become a great problem in our day today life. This paper provides IoV based traffic management solution to overcome the problem that is prevailing in our daily life.**

Keywords—Internet of Things; Internet of Vehicles; Traffic Management; Monitoring; Communication, Server

I. INTRODUCTION

The internet in today's world is a global phenomenon. With more and more devices becoming internet friendly, traffic management in transportation working with the internet becomes easier. As vehicle ownership has been increasing at an exponential rate, more traffic management problems arise. It is logical that the monitoring of speed limits, pollution checks and emergency response to road accidents should also be taken care to make life easier.

The traditional solutions offered to this problem are periodic pollution checks, monitoring of vehicular speed through CCTV cameras and speed trackers. While being the obvious choices, these strategies do tend to fail when it comes to monitoring of a huge number of vehicles i.e. when the number of vehicles increases, the effectiveness by which a road transport authority can handle the incoming breaches of vehicular code decreases. This is where Internet of Things (IoT) [3] comes into play.

Out of the many proposed methodologies with wireless sensor networks [4] in traffic management, the prospects of Internet of Vehicles (IoV) stand out. This paper mainly focuses on discussing the methodology, advantages and hindrances in creating an IoV.

The basic concept of IoT in traffic management has been widely accepted and is being put to use in the construction on smart cities' infrastructures [5] [8]. The deployment of this concept proposes significant advantages in handling traffic. The connection of CCTV cameras, traffic lights and speed trackers to the internet as well as their interconnectivity enables to take decisions via pre-embedded algorithms. Some instances are

1. When a traffic signal violation occurs, the speed cameras immediately take pictures of the driver and the credentials of the vehicles and report them to a centralized repository.
2. When a CCTV camera records an accident, the traffic signals work in a way to clear the route, for an emergency response vehicle to come through.

While these instances are helpful in demonstrating the usefulness of IoT in traffic management, there are some instances where this system is trumped such as:

1. Monitoring individual vehicles in the traffic and alerting the vehicles that are 500 meters away from the place of traffic, to be redirected.
2. Keeping pollution check on all the vehicles on road so that the air pollution could be controlled to certain extent.

Therefore the objective of this paper is to demonstrate how IoV can be an effective strategy in dealing with the drawbacks of conventional IoT deployment techniques in traffic management.

II IoV BASED TRAFFIC MANAGEMENT SYSTEM

For the prospects of Internet of Vehicles (IoV) to be a reality, the vehicles need to be able to work and communicate seamlessly. Communications in this proposal are as follows:

A. Communication between the vehicles and the vehicle owners
B. Communication between vehicles.
C. Communication between vehicles and a centralized server
D. Communication between server and third parties like police patrol, ambulance, fire-engine, etc.

A. Communication between vehicles and the Vehicle Owners

Few attributes of the vehicle like the vehicle speed and fuel level are directly reported to the users in the vehicles,

only when the vehicle is in use. However, to enable the user to receive active updates even when the vehicle is not being used and when the user is away from the vehicle, an *onboard processor* is useful.
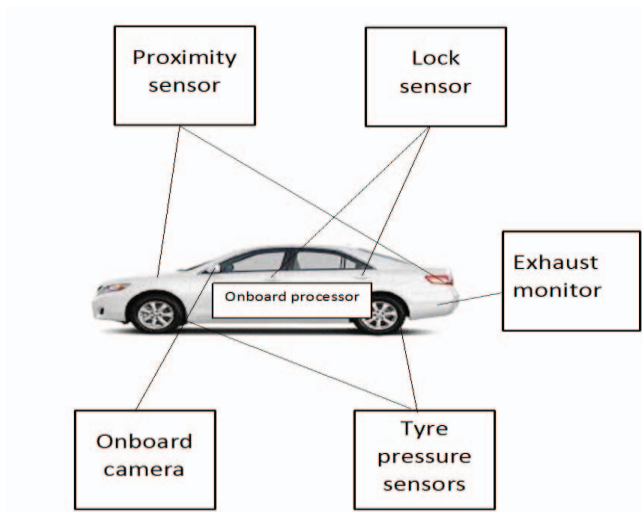

Figure 1: Vehicle to its Owner Communication

The active updates mentioned may involve
  a. security alert about the vehicle,
  b. damage alert about the vehicle
  c. the attributes like proximity, tyre pressure and vehicle lock

The sensors and the *onboard processors* in the vehicle are shown in Figure 1.

B. *Communication between vehicles*

Figure 2: Vehicle to Vehicle Communication

Communication between vehicles involves the sharing of these data:

  1. Proximity between the vehicles

  2. Monitoring of the immediate surroundings of a vehicle through *onboard cameras*.
  3. Speed of vehicles within a particular radius of the vehicle under consideration.
  4. Tyre burst related accidental information

When a vehicle is on the road or even when a vehicle is parked, its proximity to other vehicles in its immediate vicinity can prove to be crucial in avoiding accidents and damage to the vehicle.

Being able to know the speed of the vehicles surrounding a particular vehicle can help in issuing a warning to the nearby vehicles on the road about a fast approaching vehicle. Thus the vehicle which receives the warning message will alert the driver regarding the problem next to him.

C. *Communication between vehicles and a centralized server*

The data monitored from the vehicle is relayed to the nearest *communications node* via an *onboard computer*. The node in-turn communicates the data via a *satellite* to the *communications node of the server* which monitors breaches. The server stores the data in the database and analyzes the data for the breach. It then provides a suitable solution to the vehicle through the same channel from which it received the messages which is shown in Figure 1.
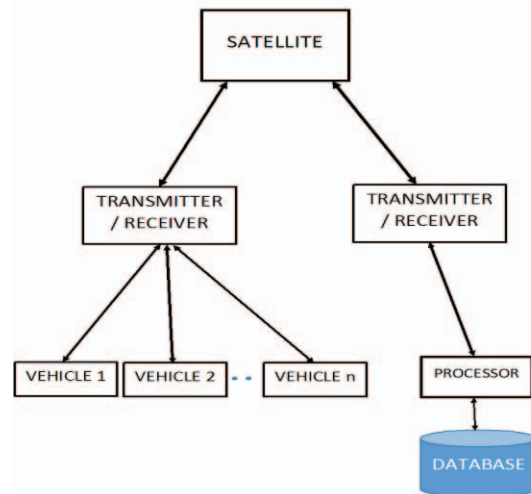

Figure 3: Vehicles to Centralized Server Communication

To monitor the metrics of the vehicles, a number of sensors are deployed on each vehicle. IoV make these sensors work in unison to be able to derive reasonable inferences from the data generated.

It is not uncommon for automobiles to have sensors in-built [6]. However, with the vast amount of data that needs to be analyzed, sensors are to be standardized to have effective

results. The metrics of the automobile that need to be monitored are:

- Tyre pressure
- Fuel level
- Speed/ velocity reading
- Exhaust gases' contents
- Vehicle lock

Sensors are fixed at their respective positions to continuously monitor the data being generated. All these localized sensors are to be set with threshold values. When breached, all the data regarding the breach are to be sent to a *processing and communications device on-board* [7].

The processor will basically be a *mini computer* on board, powerful enough to handle the processing of the incoming data and the *communication modules* implemented on board.

Use of a *raspberry pi processor* [8] on board has been tested and proven to be successful and can be extended to vehicle management as well. It offers some significant advantages in terms of power consumption and speed of processing and it is used as a *communications device* [9].

D. Communication between Server and Third Parties

This mode of communication occurs between the server and the third parties including:

1. Emergency response like ambulance, fire-engine
2. Pollution control
3. Police patrol

Data deemed to be of primary concern are the data regarding vehicular collision, temperature spikes, theft etc. When these data are reported from the *onboard processor* on the vehicle, to the *server,* they are forwarded to the respective third parties.

These third parties then correspond directly with the vehicle under consideration and take measures to provide necessary assistance. Deciding when the third parties need to be triggered is up to the centralized server. Information regarding how to classify the incoming messages is of primal importance and is to be pre-fed into the server's decision making algorithm.

III ADVANTAGES OF IoV IN TRAFFIC MANAGEMENT

There are few advantages of using IoV in traffic management. They are :
1. Traffic control

The *onboard processors* on the vehicles relay data directly to the traffic signal thereby helping it decide which lane to clear faster and how much time a green signal is to be allocated to each lane. Also, the approach of an emergency response vehicle can help the traffic signal clear the route for those vehicles.

2. Human proximity detection

The *proximity sensors onboard* detect the body temperatures of humans on the road or on the pavement. The visibility of humans or wandering animals on the road is greatly reduced during night and this may lead to fatal accidents. To prevent this, the sensors detect human presence on the road and immediately reduce the speed of the vehicle or apply emergency brakes depending on the proximity to the vehicle.

3. Theft avoidance

The *sensors onboard* are designed to identify keyless entry, breaking of window panes and forceful start of the vehicle. In this case, the *onboard processor* will immediately lock down the entire vehicle, prevent it from starting and alert the police patrol.

4. Accident avoidance

The vehicle to vehicle communication on road can help to detect when the vehicles are going to collide or if a single vehicle might lose control due to the attributes like overspeed, tyre pressure and lane deviation data [10].

5. Emergency response

When a vehicle undergoes collision or detects a collision to a nearby vehicle the emergency response vehicles like ambulance, fire-engine are immediately sent for and the exact GPS coordinates of the accident site[11] are relayed to it. This in unison with the traffic control help in reducing loss of lives on road.
6. Vehicles – autonomous

Basic attributes of vehicles - speed, tyre pressure, fuel level, condition of the tyres, oil level in the engine are monitored and a warning is issued to the user in case the mentioned attributes exceed or drop below preset threshold values.

IV. DRAWBACKS OF IoV IN TRAFFIC MANAGEMENT

There are few drawbacks identified when using IoV for traffic management. They are:

1. Security

Security in wireless communications [12] can be a major concern in the concept of Internet of Vehicles (IoV). With such an overwhelming number of vehicles on the road, there are a number of links to a number of *nodes* and all of these connected to a *central server*. Hackers pose a major threat to this system.

The vulnerabilities might lie in any point in the system, be it the *processor* on the vehicle, the *router* or the *central server* itself. A single loop hole anywhere in signals or the nodes might result in the exploitation and thereby crash the entire system.

2. Failure of networks

The very concept of IoV [13] requires every vehicle on the road to be installed with a *processor and sensors*. While this might be a herculean task, a bigger drawback is the load generated by so many vehicles.

Unless the *servers* and the intermediate *processes* are all able to handle the load efficiently, the existence of such a system might not be of much use.

While the concept of IoV may be appealing, realizing the idea is still very hard. With such a huge number of vehicles on the road, making sure that all the owners comply with this system is difficult and may involve legal issues.

Organizing the infrastructure required, namely the *server farms,* making the equipment involved internet friendly and having them all work in unison can pose significant challenges.

V. SCOPE FOR THE FUTURE WORK

Enabling internet in each and every vehicle on the road can pave way for complete automation of vehicles and traffic [14]. The concept of Internet of Vehicles (IoV) can be extended to all modes of transport making a significant difference in the way that communication occurs between different media of transport.

VI. CONCLUSION

This paper identified the potential advantages posed by the concept of Internet of Vehicles (IoV) over the tradition Internet of Things (IoT) in traffic management. This research is intended to suggest a much efficient way of traffic management and in making road travel better for everybody. This study can also be used in bringing up better architectures and strategies for road traffic management and to make an impact on the effectiveness of monitoring and emergency response to traffic incidents.

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