

Idle Vehicle Detection and Traffic Symbol Analysis using Artificial Intelligence and IoT

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ABSTRACT

The emerging development in smart vehicles has improved transportation seamlessly. This paper deals with incorporating the modern technologies like Artificial Intelligence and Internet of Things(IoT) with the traditional transportation system. It states how AI algorithms can be integrated with IoT powered vehicles to manage and avoid crashing with idle vehicles on a speedway and assists for safer driving using the traffic symbol analysis to reduce accidents. Several communication standards for data transmission between the vehicle and control system has been stated. It also provides additional features like emergency or assistance for vehicles in speedway. It uses complex learning and analysis algorithms to improve the efficiency of driving and reduce rear-end collisions. This paper hence gives a comprehensive survey of the enabling technologies, protocols, and architecture for IoT powered transport.

Keywords: Internet of things, Wireless Sensor Network(WSN), IR sensor, Wireless data transmission, Radio frequency Identification, traffic symbol analysis, idle vehicle.

1. INTRODUCTION

The increases in number of vehicles have led to new problems in the aspect of transportation. Traditional traffic monitoring and control systems fail to meet the great demands of the current scenario. To handle such critical situations we use Artificial Intelligence algorithms with the support of IoT powered devices to monitor and take necessary actions. In particular, the rear-end collisions are a major problem in any highway. These occur majorly due to idle vehicles or vehicles that are parked at the leftmost lane. The misconception of drivers is the major cause for rear end collisions which stands 3rd in the index of accidents. There is no proper method to prevent or control such accidents. Almost every year 40% percentage accidents occur due to this. The proposed system reduces such accidents by continual vehicle monitoring. Another cause for accidents is the unawareness of traffic symbols. Out of 600 drivers 500 of them never mind the traffic symbols which not only cause accidents but may also end in fatal injuries and vehicular damage. All such defects in driving can be assisted by intelligent systems which assist in driving. The automation in transport has been approved by several countries and their governments. For example, Germany Federal Highway Research Institute And US National Traffic Safety Association promote 2-level automation, which allows the driver to analyse several driving and safety factors of the vehicle.

1.1. Internet of Things

In its most basic form, the Internet of Things (IoT) is built on a network of distributed micro-devices embedded with various sensing abilities, which are used to monitor the environment and send the information between devices and end users. The Internet of Things (IoT) uses embedding electronics, software, sensors, and actuators and other physical devices, such as vehicles, buildings, and a wide range of smart devices. Network connectivity is the backbone of IoT devices in collecting and exchanging data. The Internet of Things (IoT) shall be able to communicate transparently and seamlessly with a large number of different and heterogeneous end systems, while providing open access to selected subsets of data for the development of new integrated and smart systems. This has allowed IoT to evolve with a high diversity of uses which extend beyond sensing abilities to include actuators which can control aspects of the environment. IoT has been extremely popular and the corresponding systems are widely deployed to assist people's everyday life. IoT technologies have been and will be deployed in many scenarios to provide better services and support advanced management, scaling from smart home to smart cities. Applied IoT Technology can be seen in industrial predictive maintenance, connected health and translational medicine, smart transportation, asset tracking, smart cities and many other instances. For example, in the Intelligent Transport System (ITS) domain, IoT contributes to smart parking, autonomous vehicles, smart traffic control, smart routing, traffic light sequencing, smart road lighting, bike sharing and public transportation. It is likely, the uses of IoT in this domain will increase further as new application cases are proposed. The use of IoT in ITS demonstrates the quantity of IoT devices within a single domain. Although there are overlapping use cases, problems and solutions, typically new IoT devices and systems are deployed for each solution. There is no connected infrastructure or attempt to share of resources and data. Many other domains have also adopted IoT as a means to solve their problems. It has already been estimated that there will be over 50 Billion IoT devices operating within the next 3 years . As the proliferation of IoT within the single domain of ITS has been demonstrated, it is now time for us to step back and carefully examine current IoT deployment and question the problems that the IoT flood introduces while we propose ways to prevent the flood advancing.

1.2. The Evolution From WSN To IoT

A WSN is a network composed of autonomous wireless micro-devices, which can monitor the surrounding environment, record the data and transmit the information back to a central server or to the cloud . WSNs were originally proposed for military applications and monitoring. However, due to the complexities associated with establishing and maintaining WSN, only limited usages and applications were available to the public. In Intelligent Transport System, the sensors act as an interface between the system and the object under study. It plays a pivotal role in analyzing the changes in the environment with regard to the vehicle and takes necessary actions. The number of applications of WSNs or more specifically IoT increases, the popularity of the technology will improve, which will encourage more IoT devices and services.

1.3. Artificial Intelligence

Artificial Intelligence is the mechanism of teaching the machines or physical devices the thinking and reasoning capabilities of human beings. This is done in order to evaluate the system with better results than the traditional systems which does most of the work with human intervention. It models the activities of human brain and tries to replicate it. In Intelligent Transportation System, the sensors and algorithms work hand-in-hand to perceive the environment and take necessary actions. The goal-based approach facilitates analyzing the architecture and act accordingly as per the agent driver program. The actions triggered are only based on the current percept. In ITS, expert system algorithms are used to take actions that are

arrived after analysing similar previous situation data. The agent searches for a particular scenario that resembles the current problem space. It is majorly due to the expert systems, which are complex systems designed to solve hard problems with excellent intelligence levels. They can understand and respond in a large scale. In ITS, they are used to instruct and pre calculate the results and predictions.

2. IDLE VEHICLE DETECTION

This system focuses on reducing the rear end collision by analysing the vehicular movement over the lane of the highway by sensors(proximity) placed at frequent intervals. The sensor gets triggered when an vehicle blocks the signal. It is to be noted that the intervention of vehicle might be due to some driving reasons like a crossing or braking. So the system triggers the action only after a certain period of time. It means that when the vehicle interrupts the signal, the sensor unit waits for certain period of time for the vehicle to clear and if not the actions are triggered. Each vehicle is given a unique Id that is burnt during the registration of the vehicle into a RFID tag. So the roadside kit contains a RFID reader (RF M522)module which gets the identification of the vehicle. So after the sensor trigger the response along with ID is sent to the central control unit placed at each toll gate. The Id and the response is given to control unit. Also the roadside kit contains RF or Bluetooth modules (HC-05) which probes the user of the vehicle to move away and park in lay by. If there is any issues with the vehicle or medical assistance needed the user can interact using a smart screen usually available in vehicles. The control system incorporates AI powered algorithms that take human-like intelligent decisions and takes necessary actions by calling the emergency services. Since the sensors are a part of the WSN, the location of each triggered sensor is well-known to the control center. Supposedly if the vehicle moves away after the trigger then no actions will be taken as the RF module uses synchronized data transfer that checks the sensor state every few seconds.

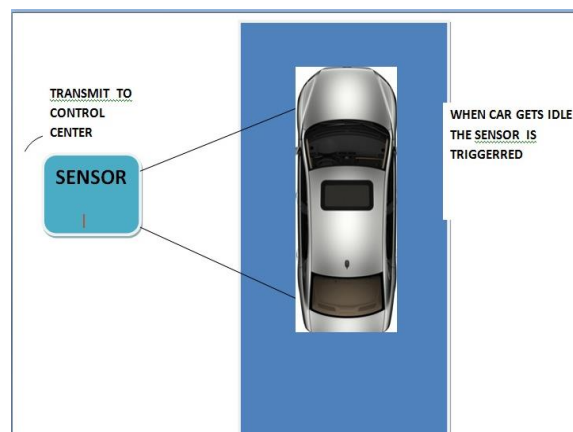


Fig 1. Idle Vehicle Detection

2.1 Emergency Services

When the user selects emergency services the control system calls the nearby patrol and ambulance to the spot. The location of each triggered sensor is well-known. This can prevent a lot of near death casualties. If the user is unconscious or unable to interact, the expert system checks the road data and previous occurrence data and take a well-defined decision.

2.2 Technical Assistance

Most of the idle vehicles in the highway are broke-down of faulty ones. And it is tedious for the driver get local assistance within the stipulated time. This system helps them get assistance real quick.

2.3 Working

The system takes cognitive modelled decisions that are obtained as a result of analysis on a huge set of similar data. This results are most accurate and hence there is no failure.

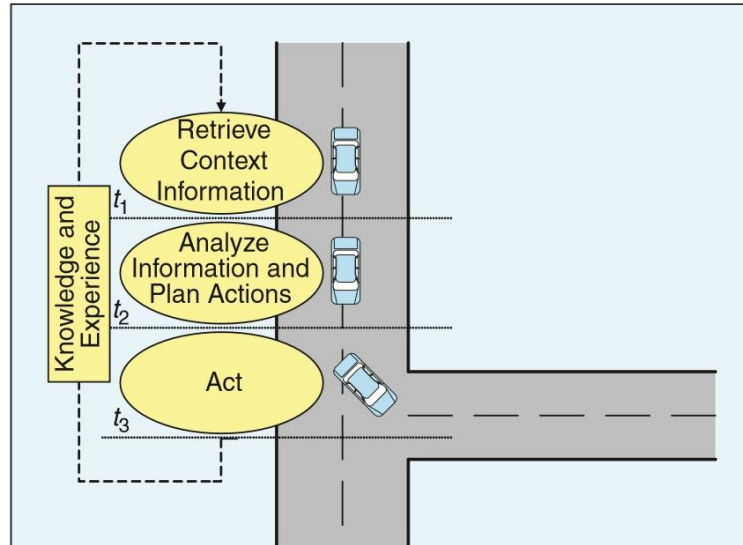


Fig 2. Cognitive decision making

2.4 Algorithm

- If sensor_value==HIGH then
- Get vehicle data using RFID
- Warn user to move
- If user moves, end
- Else show emergency window
- Send user selection to centre
- Show the response to user
- Trigger emergency services

3. TRAFFIC SYMBOL ANALYSIS

In this system, the driving of user is assisted by voice guided systems. The traffic data like traffic symbols, real-time traffic are delivered as voice-based instructions to the user. Traditionally, a driver tends to relax a traffic symbol which may lead to fatal accidents. So the system focuses on rendering high-accurate traffic data. The road has a RFID tag at every 200metres and the tag contains details of the traffic symbols and any road diversions within those 200meters. When the car crosses a tag the data is automatically loaded to the car's navigation system and it is given as instructions to the user by the system. It uses probabilistic algorithms for predictions of obstacles that are upcoming. For example, if there is a speed breaker at a distance of 30metres from current location, the AI powered system calculates the braking distance at current speed and quickly alerts the user thereby assisting in seamless driving.

4. RESULTS

The experimental results were satisfying as expected. A series of real-world test cases were given to the system and the output accuracy was noted.

4.1 Idle Vehicle Detection Results

The sensor trigger was as expected. The vehicle and sensor interaction was successful and the triggers were raised accurately. The system suffered slight malfunctions but was able to overcome the same. The accuracy was 90.2% which is way high than the existing systems. It is estimated to reduce the rear-end collisions by half the rate within few months of implementation.

4.2 Traffic Symbol Analysis Results

The RFID tag was read properly and the data was accurate. The voice data suffered slight issues. The navigation assist was better. The AI algorithms worked flawlessly in distance calculation and speed-braking distance ratio calculations.

5. POWER CONSUMPTION MANAGEMENT

The power in an IoT environment plays a major role. Since all the sensors run 24x7 , the power management has to be taken into account. Overpower will kill the circuit and less power will result in inefficient usage. So the power for data transmission has to be monitored frequently. The power relation is given as,

$$P(C)=P_{idle}+E_b C$$

$$P(C)=P_{idle}+(P_{max}-P_{idle}/C_{max})*(C_{bgt}+C_{IOT})$$

Where, E_b is incremental energy,
 P_{max} is the power at max load C_{max} ,
 P_{idle} is no load power,
 C_{bgt} is background delay in bit,
 C_{IOT} , is delay due to IoT network

6. DATA PRIVACY CONCERNS

As the European General Data Protection Regulation (GDPR) 14 came into effect on the 25th May 2018, protecting user data and securing user privacy are urgent issues to be solved in many IoT applications. Users' data cannot be detected nor captured without their awareness. Privacy has the highest priority for all existing and future application development, including IoT systems. The IoT makes it extremely difficult to determine how the data will be collected and how they will be used. According to GDPR, users' personal identities must not be identifiable nor traceable. Under the new legislation, data processing must have a lawful and legitimate purpose. Arbitrary IoT device deployment should be forbidden. The data collection needs to be minimized and efforts are required to limit the storage and discourage unnecessary data redundancy and replication. Over collecting data through densely deployed IoT systems should be prohibited. In addition, the data needs to be accountable and liable. Massive deployment of IoT systems with unaccountable devices will be regarded as a violation.

7. STANDARDS AND REGULATIONS

In order to achieve the ITS goals, it is necessary to promote energy efficient sensors and reduce the number of sensors deployed through a set of regulations and standards. The standards can be part of the International Organization for Standardization (ISO). The following should be considered: energy efficient sensors and applications: Energy efficient communication and processing from hardware, Medium Access Control (MAC) layer, networking layer and application layer. Sensors should have the capability to support plat- form/data sharing and promote re-usability. IoT platforms should follow the similar pattern of cloud service and data centres, encouraging centralized management and hardware sharing for the purpose of reducing

the number of sensors. Each system should be able to provide well defined interfaces for interaction from hardware and software levels with others. Regulations should be carried out for centralized organizations to refer to when authorizing licenses for IoT devices. If an IoT device can only be deployed with a license, the number of sensors will be well managed and the data collected will be well controlled. IoT is flourishing now, it is urgent to regulate and control the market from a centralized management manner for deployment, data collection, storage and usage.

8. FUTURE WORK

The enhancement to the system includes the addition of an integrated WSN where all the sensors will be intact. An accident detection module can be extended that is integrated with the collision sensor of the car which triggers the airbag. This might be tedious to implement but has its own advantages and improves the safety of the users.

9. CONCLUSION

In this paper, we discussed about the deployment of ITS for idle vehicle detection and traffic symbol analysis. Both the systems will reduce the rate of accidents and will provide the user with seamless driving experience. The accident rate is estimated to reduce by 48% on the successful implementation of such intelligent transportation systems. We believe that it is the rise of the smart transportation systems and the future systems in the same domain will boom out. Most of the system functionality are in development phase and yet require more involvement and technical support. The above system will assist the user for safer driving.

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Conflict of Interest

None of the authors have any conflicts of interest to declare.

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