Applications of the Intelligent Traffic Management System

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The intelligent traffic management system (ITMS) is primarily used in the management of traffic in four distinct regions of traffic scenes by using imaging technology.

intelligent traffic management system (ITMS) vehicle detection vehicle tracking

1. Introduction

The rapid speed at which urban growth is proceeding is the primary cause of the increasing traffic congestion on city roads. Because of this, vehicles can be standing for a long time. Long-term standing affects the environment in the form of vehicle pollution, which causes human health issues related to breathing and delays in emergency situations such as accidents that may cause death. Stopping development to reduce traffic congestion may not be the solution; there are many other factors, apart from development, that contribute to traffic congestion. One of the factors is the increased number of vehicles, which can be worked on. So, it is very important to develop an intelligent system that can be used to reduce traffic congestion by addressing the number of vehicles. Nowadays, various types of technologies for advancement are being developed. These include the Internet of Things (IoT), machine learning (ML), microcontrollers, wireless sensor networks (WSNs), and fuzzy logic (FL), which are used to better control traffic in complex situations. ITMS has many applications, some of which are environmental impact assessment, electronic toll collection, anomaly detection, illegal activity identification, security monitoring, and traffic signal management systems. These ITMS applications are slowly becoming a necessary part of human life and are being used to effectively improve human quality of life issues.

2. Traffic Software Applications in ITMS

The next component is traffic software applications in ITMS. There are different traffic software applications, such as Waze, Google Maps, Navigator, TomTom GO, TomTom GO, HERE WeGo, MapQuest, INRIX, Citymapper, Waze for Cities, TransNav, OptiMap, TransModeler, Vissim, Aimsun Next, PTV Visum, PTV Vistro, PTV Map&Guide, PTV xServer, TomTom Traffic, TomTom Maps, HERE HD Live Map, and so on, that employ the generated data in real time. These applications provide navigation, real-time traffic information, route optimization, and other features to the intelligent traffic management system (ITMS) to help drivers make informed decisions on the road. They are constantly updated to provide the latest information and new features to improve the driving experience. It is challenging to determine which traffic software application is “better” because it primarily relies on

personal demands and preferences. Some of the previously mentioned traffic software applications, which will be covered in the next section, have received a lot of positive feedback for the precision of their data, the real-time traffic updates that they provide, and the user-friendly nature of their user interfaces.

The crowdsourced traffic information that is Waze is GPS navigation software that employs user-generated data to give drivers real-time traffic updates and navigational assistance. It can be used to give data on traffic flow and congestion as a part of an intelligent traffic management system (ITMS). Waze data may be evaluated and utilized to optimize traffic signals, enhance road layouts, and provide information for other traffic management choices. Waze is a useful tool for ITMS to increase traffic efficiency and safety since it can inform users about road closures, accidents, and other occurrences. Z. Lenkei [1] talked in the form of a case study; the opportunities and limitations of using spatial crowdsourcing technologies to detect non-recurring occurrences were investigated, and insight into the geographical and temporal aspects of the Waze data was offered. Zhuhua Zhang et al. [2] discussed the exploration and assessment of crowdsourced probe-based Waze traffic speed in the article.

Both Google Maps [3] and HERE WeGo [4] have garnered a lot of positive feedback for the comprehensive mapping and routing features that they offer. It is possible to employ Google Maps and HERE WeGo as components of an intelligent traffic management system (ITMS), which may then be used to deliver real-time traffic information and assist in the improvement of traffic flow. The app receives its traffic updates, which may include information on levels of congestion, accidents, road closures, and other occurrences, from GPS-enabled devices that provide the data in real time. This data may be studied and put to use in various ways to enhance road designs, traffic lights, and other aspects of traffic management. In summary, Google Maps provides valuable data and technologies that can be used to improve the efficiency and safety of traffic systems, making it an essential component of an ITMS. Supiya Naiudomthum et al. [5] used the Google Maps API, called the distance matrix API, to estimate the average speed on various road sections in Bangkok. This API provides details of the duration and distance between two points on any road section (starting node and ending node) from the Google Maps application. They used this API to determine the average speed. Together with a traffic model, the near real-time traffic data provided by the Google API was used to make predictions about the volume of traffic and to aid in the selection of speed-related emission factors that were suitable for the development of a near real-time traffic emission inventory in Bangkok. In addition, the map data provided by HERE WeGo can be utilized to support advanced traffic management systems. Some examples of these advanced traffic management systems include dynamic routing, incident management, and traveler information services. Because of the app's real-time traffic statistics, as well as its API and mapping capabilities, ITMS can make better use of it to increase both the flow of traffic and the efficiency of its operations.

TomTom [6] also provides companies and government agencies with a variety of mapping and traffic services, such as data on real-time traffic conditions, historical traffic trends, and traffic forecasts. TomTom's services include these features. This information may be included in ITMS in order to enable more advanced traffic management systems, such as dynamic routing, incident management, and traveler information services.

INRIX also provides companies and government agencies with a package of traffic analytics and management services, such as traffic prediction and simulation, dynamic routing, and incident management. This information

may be included in ITMS in order to enable advanced traffic management systems, enhance traffic flow, and make traffic management more efficient. A. Sharma et al. [7] discussed the potential and limitations of using INRIX data for real-time performance monitoring and historical trend assessment.

Traffic software applications face a number of difficulties as well. The accuracy and dependability of technologies such as GPS, traffic sensors, and real-time traffic data are essential to the operation of traffic software systems. It is possible that the efficacy of traffic software applications will suffer if these technologies do not work as expected or are not widely available. There are privacy issues that might arise as a result of certain traffic software applications' collection and usage of personally identifiable information such as location data. The precision of traffic software applications may be contingent on the data provided by users, which is not guaranteed to be current or correct in every instance.

3. ITMS Applications

Here covers a wide range of ITMS applications that all serve to highlight the effects of video-based network vehicle monitoring systems, including environmental impact assessment, safety monitoring, and Traffic Signal Control Systems.

- **Anomaly detection**: Traffic congestion and vehicle accidents are both made more likely by driving in a way that is against the law. The use of video surveillance allows for the detection and enforcement of a variety of driving offenses, including taking an incorrect turn and failing to stop at a red light. Rajeshwari et al. [8] presented a survey article in which numerous techniques to manage and locate vehicle accidents on a street using a surveillance camera are examined, and the research also includes a brief assessment of various autonomous road and street accident detection methodologies.

- **Security**: A network-based surveillance system can record a vehicle's trajectory across the road network to track a specific vehicle of interest. In combination with online streaming of real-time video, this technology helps law enforcement agencies benefit from monitoring and preventing criminal activity. By addressing the issue related to security, Fedotov et al. [9] discussed a method based on the processing of video and audio that is going to be used in an effort to determine whether people have committed crimes. This will trigger an alarm at the nearby surveillance station, which may already be in control of a large number of CCTV images from neighboring places. The security personnel who are responsible for keeping an eye on multiple screens at the same time will find this to be beneficial.

- **The collection of vehicle tolls**: The planning, execution, and dissemination of information concerning the autonomous operation of the vehicle selection system are the primary focuses of the ITMS. The vehicle toll collection device locates passing vehicles and compiles toll data that can be read by video sensors that detect the features of a vehicle, particularly its license plate number, as it passes through charging ports such as highway exits and entrances or parking lots. Nowadays, RFID-based toll systems [10] are used for collecting tolls without human intervention.

- **Road construction and transportation planning:** A monitoring system can detect bottlenecks and other anomalies in traffic flow by tracking traffic patterns. Real-time traffic data, the existing road network, and the planned road network are the three components that are used to develop an intelligent transportation system for roads. There are many examples of intelligent planning and research on urban congestion in the transportation sector. One of the things conducted by Zhu et al. [11] was to address the congestion issue.

- **Environmental impact assessment:** Since quite a few years ago, the development of environmentally friendly transportation systems has been seen as one of the most significant approaches to addressing environmental issues such as climate change and the impacts of greenhouse gases. On a worldwide basis, the transportation industry has emerged as one of the most significant contributors to the aforementioned environmental issues. Hassouna et al. [12] discussed the environmental implications that are already happening and those that will happen in the future because of the transportation sector.

- **Traffic Signal Control Systems**: Traffic information in real time should be made available to drivers as quickly as possible to manage congestion efficiently. Because of the significant progress that has been made in recent years in the fields of CV and ML, it is now technically possible to design intelligent traffic signaling systems that do not require human monitoring. These systems can function without human intervention. In order to program traffic lights, you need to know the factors that characterize the traffic, such as the number of cars, how frequently they enter and exit the area, and so on.

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