Overview of IoT Solutions for Sustainable Transportation Systems

Ramiz Salama[1], *Chadi Altrjman*[2,3], and *Fadi Al-Turjman*[2,3]

[1]Department of Computer Engineering, AI and Robotics Institute, Research Center for AI and IoT, Near East University, Nicosia, Mersin 10, Turkey
[2]Artificial Intelligence Engineering Dept., AI and Robotics Institute, Near East University, Nicosia, Mersin 10, Turkey [3]Research Center for AI and IoT, Faculty of Engineering, University of Kyrenia, Kyrenia, Mersin 10, Turkey

ramiz.salama@neu.edu.tr, Fadi.alturjman@neu.edu.tr, Fadi.alturjman@kyrenia.edu.tr

ABSTRACT : While big data analytics aids in the analysis of vast data sets, the Internet of Things is all about data, devices, and connectivity. The Internet of Things (IoT) involves attaching real world things to the Web in order to build sophisticated frameworks and offer global mobility. This is accomplished by innovative initiatives like the Smart Transportation Framework (ITS). IoT solutions greatly enable the global IoT in the creation of Intelligent Transportation Systems. Istio introduces a new era of communication based on the Internet of Things for automobiles by integrating data analytics with the storing, processing, and computation of sensor data in order to efficiently manage the Traffic system. Roads, trains, airports, and ships are automated by an Internet of Things-based intelligent transportation system (IoT-ITS) to improve how customers perceive how things are moved, tracked, and delivered. A case study of an intelligent traffic management system that is based on big data and the Internet of Things and will be used to improve traffic solutions for cities. The ITS-IoT system is made up of an eco-system of sensor, monitoring, and display systems. This case study will also discuss a few of the system's hardware and software components. There will also be a focus on how concepts like conjoint analysis, cluster analysis, multiple regression analysis, multiple discriminant analysis, logistic regression, and other big data analytics approaches may be combined with IoT and support the growth of IoT-ITS. Additionally, the case study will show some outcomes of big data analytics and how they relate to smart transportation systems. Due to the huge number of drivers of private automobiles, transportation has developed into one of the most common aspects of daily life. Additionally, this has made city traffic very difficult to navigate. This is due to the numerous negative effects of the severe congestion, such as a rise in the consumption of fossil fuels, pollution, unforeseen collisions, and lost downtime. Because technology is capable of handling a wide range of features, including organizing, monitoring, trying to identify, and informatics, it has quickly put in place an adequate and effective traffic management system, particularly for road transportation. The smart management tools that have emerged to aid in IoT-based traffic congestion reduction are highlighted in this article.

Keywords: Internet of things, data analytics, smart traffic, IoT, traffic management.

1. Introduction

The complexity and congestion of the world's road infrastructure have grown along with the popularity and adoption of personal mobility among civilian populations. An efficient traffic management system is needed to lessen accidents, pollution, and lost time because of the extreme traffic congestion caused during peak hours (Almalki et al.,2021). Apparently, the Web of Things is expanding quickly. Through the use of the cloud and a variety of machine learning techniques, the Internet of Things (IoT), a vital and quickly developing technology, has contributed in effective traffic control. The significant role and expanding significance of intelligent transportation systems (ITS), particularly with regard to vehicle-to-vehicle (V2V) communication, have changed every industry, from business to healthcare**.** Mixed media content is now well known to be present in autos, and this change in perspective has further improved how each scenario is presented. The rising mobility of automobiles has harmed the quality of service (QoS) for multimedia products over smart cell phones and portable IoT devices, despite the fact that technological advancements have improved the lives of the typical person. In reality, increased portability lowers sustainability (high power consumption), manageability (short battery life), and accessibility, making it a significant challenge that must be successfully overcome. The wireless link's received signal strength indicator (RSSI) at the base station also varies more (i.e., has less coverage). Because portable devices at the edge of Internet of Things (IoT)-based computer networks (i.e., ambulances) are resource-constrained, it is particularly difficult to satisfy user demands while viewing video content of emergency patients in cars. Greater vehicle mobility actually has a significant impact on network performance (i.e., quality of service), user perception, and degree of satisfaction while transferring sensitive and important data. The general public will have access to the mechanism's grievance remedies. The Internet of Things (IoT) enables continuous and digital connectivity for everything with an ON/OFF switch. It describes a scenario in which physical items and living things can communicate with digital data and settings. Making commonplace items like watches, vehicles, refrigerators, and railroad tracks sentient is one of the objectives of the Internet of Things. A lot of data is generated as more devices are connected to the internet. This enormous amount of data must be managed and converted into useful information in order to create efficient systems. Big data analytics significantly speeds up the process of extracting useful information from the created data. The term "big data" was in use before the Internet of Things (IoT) was used for analytics. Massive information is characterized as data that exhibits precision, speed, variety, and quantity. Both structured and unstructured data are abundant in this instance. Accordingly, the terms "velocity" and "veracity" refer to the degree of data uncertainty and the pace at which data are processed. The data from IoT devices is contrasted with the big data that comprises this information. Manufacturing, transportation, consumer electronics like smartphones and wearables, as well as smart homes (IoT), will soon be impacted by the Internet of Things. In accordance with WSNs, the idea of the web of things (IoT) was established. The term "internet of things" was coined by Kevin Ashton to describe digital representations of separately identifiable objects housed within a "internet-like" framework. They could be massive buildings, machines, products of any type, businesses, or even the physical remains of people, animals, or plants. Mathuramalingam is one among the remaining 280. WSNs and the Internet of Things will be used in this study to create an intelligent transportation system. Transportation is changing as a result of the Internet of Things (IoT). The development of people and goods as well as the economy, public safety, and the environment will all be enhanced by modern, intelligent transportation networks. Smart transportation systems will revolutionize passenger experiences, change how cargo and goods are tracked and delivered, and automate our roads, railways, and skies. System integrators, independent software vendors (ISVs), service providers, and other solution providers will greatly benefit from the significant business opportunities presented by smart transportation systems. In today's big cities, there are numerous transportation-related issues due to the overburdened urban transportation infrastructure, including issues with energy waste, noise pollution, and air pollution. Urban traffic congestion and clogging have increased as a result of urbanization, motorization, modernism, the urban population, and the increasing speeds of vehicles. Due to the current trend toward information technology development and globalization, as well as the fact that conventional means of transportation technology no longer meet the requirements of economic and social development, intelligent transportation is the only viable option for the development of urban transportation. It represents a revolution in methods used to move people throughout cities. The "Internet of things," smart transportation, and intelligent transportation for modern urban transportation appear to have outstanding opportunities to grow as a result of developments in the intelligent transportation industry. The "new generation of intelligent transportation" technologies have a significant positive impact on networking technology, the

Internet of Things, and the attainment of real-time, accurate, safe, and energy-saving intelligent transportation goals. Today's population growth in metropolitan areas necessitates the need for more advanced transportation systems. IoT-capable devices in the millions are required to develop smart and intelligent transportation. The Toronto Intelligent Transportation Systems Centre and Testbed created a system called MARLIN-ATSC (Multi-agent Reinforcement Learning for Integrated Network of Adaptive Traffic Signal Controllers) to use smart signals that locally analyze traffic information to optimize traffic flow. When the framework was tested at 60 busy midtown Toronto crossing points, deferrals decreased by up to 40%. The test also revealed a 26% reduction in travel times. Singapore has implemented a smart transportation strategy and system. It has one of the least crowded large cities, with an average vehicle speed of 27 kph on major roads, compared to 16 kph in London and 11 kph in Tokyo. The Electronic Road Pricing system in the city adjusts the tolls based on the volume of traffic. Drivers are alerted to severe road events by an Expressway Monitoring and Advisory System [1–5]. Additionally, GPS tracking and reporting capabilities are included in city taxis. The Intelligent Transport System's Operations Control Center combines data from each of these systems to give the general public access to real-time traffic data.

2. Related Works

The analysis environment for ITS (Intelligent Transport System) analysis and optimization systems is covered in this work. This situation makes use of co-simulation, which is advantageous for modeling flexible systems. The potential for virtual ITS is realized by picking components that can be used at various stages. These components are replicated using existing bundles that each use the shortest time stamp possible or objects with the same time stamp. The recommended method is brilliant since it avoids the need for continual computing. The proposed integrated system analysis environment helps ITS in the seamless integration of many models, and it performs substantially better than the models currently in use. Additionally, it completes the present framework. The simplified system integration procedure makes it simple to construct ITS infrastructure across the nation. Time can be taken into account in the recommended co-simulation application for ITS, making it a time-based simulation. The best possible transportation system is suggested, and a genetic algorithm is used to evaluate the stochastic data in order to develop an effective traffic light system. Computing the aggregate for each route after each traffic signal has been programmed, handled, and the information processed determines the ideal state. The simulation makes use of the vehicle's average speed and the distance covered. The simulation aids in determining where the suggested traffic lights should be placed in order to accommodate the most vehicles. The simultaneous study of numerous things using a statistical measure is possible with multivariate analysis. Multiple variables can be analyzed simultaneously using this methodology. Various approaches to multivariate analysis can be used, depending on the circumstance. This study suggests a prototype car that can communicate with both the car's internal electrical devices and other vehicles parked along the route. The projected on-board device's numerous components are also covered in detail in the model. Numerous applications could use this technique to guarantee effective operation. The suggested article provides a summary of the several requirements for developing a successful ITS system. The recommended framework's accuracy is assessed using MATLAB-based replicas in light of the current situation. The observations demonstrate that the suggested environment is useful for finding the car in various settings. When evaluating the algorithm, execution time and finding accuracy are taken into account. In order to improve mobility, the study develops a ground-breaking system that combines the Internet of Things with intelligent transportation systems [6–10]. The gadget tracks the weather using its sensors, and the observing system uses this data to advise drivers of the device's location and other details. Therefore, passengers are informed of the bus's present route. When evaluating the effectiveness of the suggested method, this system takes the number of tickets collected into account.

Table1: A cutting-edge transportation system that incorporates IoT and the Internet of Things.

Ref. No.	Publication year	Proposed technique	Traffic safety	Energy efficient	Merits
1	20019	Pollution-free transportation	No	Yes	Handles traffic in an efficient manner
2	2018	Pollution-avoidance transportation	Yes	Yes	Reduction in emission of CO_2 by using electric vehicles
3	2017	Green transportation	No	Yes	Traffic handling with sustainability is given importance
4	2019	Safe and sustainable transportation	Yes	Yes	Traffic congestion is handled efficiently
5	2018	Green transportation	Yes	No	Proposes a pollution free technique which helps in vehicular movement
6	2019	Collision-free transportation	Yes	No	Determination of braking response time and steering response time
7	2020	Collision-free transportation	Yes	Yes	Safe system design with collision warning
8	2021	Congestion avoidance transportation	Yes	Yes	Time of arrival (TOA) based localization, using automatic braking for collision avoidance

3. The Internet of Things (IOT)

The Internet of Things (IoT) is a system in which linked items, such as actuators or computing units, interact with one another to perform activities. The authors claim that 85% of networks are fragmented, which prevents data from communicating with other networks or the cloud. On the other hand, the term "Internet of things" refers to an endeavor to establish connection by connecting physical objects online in order to collect and analyze data as well as a strategy for promoting connectivity. Devices designed for the Internet of Things should be independent and able to access information from a Web server. Almost everything today has the pervasive Web of Things (IoT), which is essentially a form of dynamic inclusion (Joo et al., 2013) [11–15]. Figure 1b illustrates how IoT technologies make use of processing units, sensor nodes, and actuators to connect the real and virtual worlds.

IoT and smart cities

Intelligent urban communities use a range of innovations to raise the comfort levels of its residents in the areas of water, energy, transportation, education, and health. This entails reducing costs, conserving resources, and engaging with their community more successfully and actively. Big data analytics is one of the newest technologies with a lot of potential to improve smart city services. Data collection has generated enormous volumes of data that can be applied in a variety of valuable application sectors as digitalization has invaded every part of daily life. Smarter infrastructure, which is the foundation of smarter cities, can assist governments in creating smarter cities in a number of ways. Enhancing transportation-related services, such as parking, transit, and traffic management, is one tactic. Information and communication technology (ICT)-enabled smart cities have improved control over and insight into the many systems that affect residents' daily lives. However, there isn't a single, agreed-upon definition of what a smart city is. "Smart transportation," which refers to the incorporation of cutting-edge technologies and management practices into transportation networks, is one of the most significant vertical uses of the internet of things. Users will be better able to use transportation networks in a safer and "smarter" manner as a result of these technologies' mission to supply cutting-edge services connected to various modes of transportation and traffic management.

Intelligent transportation systems are made possible by the Internet of Things, which increases capacity, improves traveler experiences, and makes moving anything safer, more effective, and more secure. The employment of intelligent traffic management with these sensor networks enables the city's police, emergency services, and other governmental entities to respond to crises quickly and ease congestion. The Smart City concept, which aims to integrate cutting-edge and potent communication technology for municipal management and residents, is served by IoT-based intelligent transmission networks. There are several issues that cities must address, and outmoded traditional planning for transportation, environmental pollution, financial management, and security observations is insufficient for smart cities. Modern technology and dependable infrastructure are essential for the development of the smart city framework. Globalization and urbanization have put pressure on contemporary cities to raise the living standards of its residents. The advancement of Internet of Things (IoT) technologies and the rise of big data have both contributed significantly to the success of smart city initiatives. The Internet of Things (IoT) facilitates the integration of sensors, radiofrequency identification, and Bluetooth into the physical environment by utilizing highly networked services. Big data gives communities the opportunity to learn valuable lessons from a wealth of data obtained from different sources. Big data and the Internet of Things have provided new and fascinating challenges for the realization of the vision of future smart cities. These new challenges typically focus on business and technology issues that assist cities realize the core characteristics of a smart environment in order to achieve the vision, principles, and objectives of smart city applications. In the context of smart cities, this study makes use of the most cutting-edge communication technology and smart-based applications. By focusing on how big data may significantly impact urban populations at different levels, the principles of big data analytics to support smart cities are investigated. A summary of the technological and commercial research challenges is also provided, along with a proposed big data business model for smart cities. In the context of big data, this study can serve as a starting point for future enhancement and development of smart cities. Innovative applications called intelligent transportation systems are designed to provide special services for different types of transportation and traffic management. They also give diverse users the information they need to use transportation networks in a way that is safer, more efficient, and intelligent. Expiry combines cutting-edge analytics to a variety of Intelligent Transport System technologies, such as automatic license plate recognition, message-variable signs, container management systems, traffic signal control systems, and speed traps. Expiry's analytics are especially helpful for complex applications that integrate data from a variety of various sources with real-time data, like parking guidance and information systems, weather forecasts, and bridge de-icing systems The Intelligent Transportation Systems (ITS) are defined by the European Union as "where information and communication technologies are applied in the field of road transport, including infrastructure, vehicles, and users, as well as in traffic management and mobility management, as well as for interfaces with other modes of transport" in 2010. Smart transportation uses a range of technologies, from screen applications like security CCTV systems to more sophisticated applications that include real-time data and input from numerous other sources. Car navigation, traffic signal control systems, container management systems, programmed number plate recognition, and speed cameras are examples of fundamental artificial intelligence systems utilized in smart transportation. Users are able to use the transportation network more efficiently as a result of ITS technologies. In order to satisfy future demands, these technologies also pave the way for the creation of smarter infrastructure. Thanks to the advancement of intelligent transportation systems, transportation managers now have access to a wider range of technology options that can be used to operate and maintain the systems more effectively and boost performance.

The Intelligent Transportation Society of America claims that ITS technology enables:

- To determine the optimal course given the circumstances, use a navigation system.
- Quickly warn other drivers of potentially hazardous conditions to prevent collisions.
- Use a smart sign to find a parking spot that is unoccupied.
- Step onto a bus as soon as the incoming traffic signal turns green.
- Recognize traffic incidents and act quickly.
- Reroute traffic when bad weather or deteriorating road conditions are present.
- For travelers, real-time traffic and weather updates.
- Enable drivers to control their fuel usage.
- Consider the situation at hand while adjusting speed restrictions and signal timing.
- Improve efficiency and safety while increasing tracking and inspection of freight.
- Promote and enhance the use of public transportation.
- Keep an eye on the stability of the infrastructure, including bridges.

Austria's Autobahn and Highway Financial Stock Company (ASFiNAG) leveraged Cisco's Connected Roadways solutions to integrate the "internet of things" with its roadside sensors, showcasing the benefits of implementing smart transportation technologies. The end result is a road that can navigate itself, inform users, and anticipate traffic to maintain clear lanes.

Big Data and the Internet of Things (IoT) seem to provide huge possibilities for cost reduction and new revenue generation across a variety of businesses. In the first two briefings of the IoT series, researchers provided an introduction to IoT and discussed how it affects the industrial sector. The usage of IoT to provide intelligent citations will be highlighted in this short. The Internet of Things is a system in which actual physical objects and their sensors are connected to the Internet using wired and wireless network connections. The Internet of Things will connect both living and inanimate objects. The Internet of Things (IoT) will connect everything, including automobiles, utility meters, medical devices, and everyday objects.

A Brief history of car IoT components

According to SAE's vehicle levels, connected and autonomous vehicles—which include those that are "vehicle to everything," including "vehicle to cloud," "vehicle to infrastructure," "vehicle to device," "vehicle to network," "vehicle to pedestrian," and "vehicle to vehicle"—are currently a representation of the technological age of the twenty-first century. They acquire entry to participating in a larger system. Vehicles communicate with one another, their environment, and other drivers. Smart automobile applications (assistance for steering, velocity, and brakes) have gradually lessened a variety of infrastructural issues by assisting with driving. 2019). Because there are fewer concerns about traffic congestion and more modern automobiles, the International Society of Automotive Engineers (SAE) contributed to the definition of vehicle innovation by utilizing the levels in Fig. 3.

IoT is changing logistics in many different ways.

The Internet of Things (IoT) is transforming our lives on a constant basis. Two uses for the Internet of Things are environmental preservation and transportation networks. For the automotive industry, which has produced some of the most important inventions, this is especially true (Belli et al., 2020). The automotive industry and our roads are being impacted by the Internet of Things in the following significant ways: According to Dheena et al., driving reduces traffic congestion, enhances highway safety, and reduces pollution and trash production. 2017). improved roads, transportation and environmental apps, and spending

Intelligent traffic management system

Intelligent traffic control solutions based on the Internet of Things come in three varieties. This phrase refers to a collection of resources, including software, hardware, and communications technology,that can be used to improve the effectiveness and security of the transportation system (Mohamad et al., 2020).

1. The Smart Traffic Data System's defining features are its agent technology, IR ray sensor, RFID, and WSN. This study outlines a communication and interaction architecture for a sizable number of different, geographically dispersed, autonomous IoT devices. Agency technologies are integrated with IoT.

Intelligent traffic management system obstruction

1. A flexible traffic control system is being developed. LabVIEW, Thing Talk, the Arduino board, HTTP, and MQTT protocols were used to conduct efficiency testing. The Raspberry Pi, the Arduino board, and cameras are among the more simple devices (Diorite et al., 2021). The importance of lane markings is emphasized by the HW model. MATLAB support is already implemented on Thing Talk.

2. The Internet of Things (IoT), an active radio-frequency identification (RFID) system, and WSN

enable the following applications: The Internet of Things and agent technologies were combined to build the IoT in order to handle clear communication and interactions among a great number of diverse, strongly dispersed, and distributed devices. (2012) (Xiang et al.).

3. IoT-based smart traffic signal system and smart road congestion control scheme for urgent vehicles are being implemented on the right: Wi-Fi sensor node using ultrasound (Lalit et al., 2020). The traffic density monitoring module was used to fulfill the following tasks: determines the operation time of the signal using measures of traffic congestion.

4. According to Ejaz and Anpalagan (2019), the performance characteristics of smart traffic and vehicle monitoring include ATMEGA, GPS, IoT, traffic management, Ublox-Neo 6 M, Zigbee, RFID, and blue tooth. The tracking module is run by a NodeMCU, while the attention to detail is handled by an ATMEGA series microcontroller. Additionally, they have opened up the data to the general public via a cloud data stream known as "MTech track."

5. An IoT-VANET-based ambulance traffic control system in a smart city; performance criteria based on an algorithm due to the system's Internet connection; Lane monitoring is possible at any time (Batrachia et al., 2018). Information from different lanes is gathered and tracked centrally by the traffic control office.

6. The GPS Neo 6 M, Arduino UNO, and Ambulance Traffic Management System were all Internet of Things-based devices. the conditions for success Jiawei et al., IoT-based Ambulance Traffic Management System with SIM 900A, Arduino UNO, and GPS Neo 6 M to make a path to one or more ambulances. 2019). A GSM 900A installed into the ambulances was powered by 12 V, 1 A, and a 10 V Arduino board was integrated into the fuse board to create an Arduino-based traffic control system.

7. A Case Study of an IoT-based Smart Traffic Signal Framework in Bangladesh: Advanced Traffic Monitoring Granular and pervasive computing, the OWL Urban Traffic System (UTS), and the Zigbee protocol are used to calculate traffic density. Highway details and traffic light clusters are integrated using Web 2.0 features (Singh et al., 2021). Smart intelligent transportation systems/Internet of Things based on cognition and traffic control systems/IoT Network Cognition and Performance Parameters include eight sensors, CCTV, fuzzy logic, and pedestrian sensors. (2018) (Hassan). The Traffic Light Framework for Savvy City Traffic Light is a fluffy-based solution for intelligent intersection steering at traffic light intersections.

8. Self-driving automobiles, Arduino, an ESP8266 Wi-Fi module, and ultrasonic sensors are used in conjunction with the Internet of Things (IoT) and an ultrasonic sensor (Jitendra et al.,2021). The ESP8266 module, which works with any opensource Internet of Things platform (Ramji et al., 2021; Tirumala and others, 2019), uses Wi-Fi to send sensor data. For accessing information, HTTP is used.

9. KNN algorithm-based traffic monitoring system In an IoT model using the KNN algorithm, TMS extensively makes use of IRs in three key areas:
1) Android software;
2) interaction with the user;
3) communication between the server and the client (Kaur and Malhotra, 2018).

4. Challenges of Big Data

The emergence of a brand-new phenomenon known as "Big data" was prompted by the massive amounts of data that must be managed at specific rates and periods. Massive information advancements capture, store, analyze, and decode the information in a distributed environment. The subsequent Social Information base Administration Framework constraints were what sparked the beginning of huge information [16–20].

• When the volume of data increased rapidly, RDBMS found it difficult to handle such a large amount of data.
• RDBMS increased the number of processors and memory to meet this demand, which increased the cost.
• In addition, the RDBMS cannot process about 80% of the unstructured and semi-structured data.

Big data has unique characteristics with many dimensions. The next paragraphs provide an explanation of the four big data dimensions. The size of the data is the first dimension. Big data jargon refers to this concept as volume. The amount of data being produced and processed keeps rising dramatically. The main data sources include social media, internet banking, and automobile sensors. Given the rising data volume, a highly scalable and dependable storage system is needed. The Internet of Things will be impacted by the processing of this data because of the enormous increase in the number of cars. Variety describes the range of data types that big data may accommodate. Structured, semi-structured, and unstructured formats of data are examples.
Data that is set out as lines and sections in tables is referred to as "organized information". Semi-structured information is information that is both arranged and disorganized. Data that is semi-structured cannot be stored in tables. Additionally, it contains tags for classifying data fields. Unstructured data lacks a clear framework, including data from automotive sensors. The analysis of vehicle data in terms of velocity and various parametric structures simplifies the setup and use of intelligent transportation. The rate at which data is generated also rises as data volume does. The big data era makes it challenging to collect and interpret data due to its frequent arrival. For instance, Facebook sends 3.3 million posts and 3.1 million searches to Google in a single minute. Determined by the data's velocity in vehicle systems. Veracity implies that the data are atypical and unclear. This is due to the contradictory data. To produce precise findings from analysis, data must be trustworthy [28].

Problems with Big Data Technology

• Managing a large amount of data might be difficult since some of it—such unstructured material like movies and photos—cannot be stored in standard tables. Even though these data may be managed effectively when handled separately, merging data from several sources presents

significant challenges. The greatest difficulties are listed below:
• Data must first be formatted because it is heterogeneous and comes from a variety of sources.
• Issues can arise if data that are gathered for analysis is incomplete or lacking. In these cases, it is necessary to replace the missing values with null values to prevent them from impacting the rest of the data and to guarantee a successful outcome.
• In the age of big data, managing a sizable amount of data is the most pressing issue. The processing will take longer as there is more data present.
• Real-time data processing at a faster rate of arrival is challenging because of the higher velocity of big data.
Big data storage should be designed to be scalable in the event that the volume of the data grows at an exponential rate. In addition to being scalable, the data must also be trustworthy and fault-tolerant.
• As data volume increases, data privacy becomes a more pressing concern. Strong access control measures must therefore be implemented across the whole life cycle of huge data. To ensure that the accessible data can be used to collect the necessary business knowledge, data sharing should be restricted to a minimal. Even though the data will be used for analysis, sensitive information should be protected before processing.

The Central Server, RFID device, sensors, lighting control unit, and EBOX II are necessary components for an effective intelligent transportation system. In the event of a system failure, the Central Server dramatically improves resilience. EBOX Ditags, data-transmitting antennae, and data-decoding scanners make up this RFID device. RFID enhances data flow and information exchange between vehicles.

Design specifications for an ITS system

- The RFID tag operates at a certain frequency. Future ITS systems will require ultra-high frequency.
- The power required for the RFID device and lighting control unit to operate is supplied by additional chargers. This aids in identifying data at a reasonable distance of 4-6 meters.

Design Objectives

When developing a new ITS system, the following elements are taken into account. The s-ITS system needs to keep up with the rapidly growing bigdata industry. The settings must be easy to access from a distance and the data must be portable.

5 . Intelligent transport system proposed model

• Dependable
Because the smart transportation system is intended to function independently, dependability is essential. Additionally, it should be structured to effectively handle any unanticipated circumstances.

• Easily navigable
The user is not required to understand every detail of the implementation. Instead, the administrator should have control over server-side issues and the user should be able to access the initialization with only one click.

Laboratory Design

The intelligent design of an intelligent transportation system that can address issues in real time is at the heart of the smart intelligent transport system (SITS) that has been proposed.

The following modules are addressed by the intelligent system:

(a) Tracking the location of vehicles

(a) An automated parking system for vehicles

(c) Internal communication in a VANET

(d) Mining big data from vehicles.

Localization of the s-ITS vehicle flow

The recommended methodology aids in selecting the most precise routes. The benchmark for evaluating the model's performance is the lower bound accuracy value. Since there are now enough effective paths and all less linked paths have been deleted, the model has succeeded in obtaining the target accuracy larger than the lower bound. The proposed paths are insufficient, though, if the lower bound is higher than the anticipated accuracy rate. The collection is further expanded to incorporate the required paths for efficient vehicle localization. The vehicle restriction computation predicts the area of the vehicle at time l. This also includes storing the set and producing an estimate later, if the projected set's count is more than 5. It is then decided what Fisher value is. If it is less than 5, the fisher value is not computed, and additional connections are built to make sure they are included. The lower bound accuracy derived from the Fisher matrix in line with the flow is then used to compare the anticipated value to. More connections may be lost if the projected accuracy value rises. As a result, the suggested method has the advantages of simplifying location estimation and accelerating vehicle path selection.

(b) Intelligent parking system for vehicles

In this module, sensors play a significant role. They assist in gathering information on the location of the vehicle, parking lot availability, specifications of the vehicle, information from prior reservations, parking location, and current traffic statistics. Big data is essential in this situation due to its real-time uses and capacity to build an intelligent transportation system.

Outcome factors, such as the occupied or free factor, determine where to park an automobile. The location is designated as such if there is free parking there. However, if there are any cars there, the location is marked as occupied. The application of the result value, which will be updated over time by sensors, serves as the foundation for the parking decision. The server then updates the decision. In order to come to a final determination regarding the parking space, the attributes are contrasted with the specified threshold value.

3 Openness within a VANET

The sensors monitor the current location and condition of the car in the traffic flow with the aid of the vehicle's device and previous registration. Data is exchanged and shared between automobiles via IoT sensor systems, assisting in traffic avoidance and ensuring a safe ride.

Big-Data Mining for Vehicles (c)

The building is designed to offer view of traffic patterns and potentially dangerous street conditions. It should also be equipped with information to manage unforeseen incidents and scenarios so that moving cars can be forewarned in advance for safe driving. A vast amount of previously similar data must be used as a foundation for the signals, which must be given to the vehicles, as well as the current traffic scenario.

Implementation

As part of the implementation of s-ITS, the proposed system must carry out transportation intelligence through localization and traffic avoidance using big data techniques. Using Chennai as an example, different highways' traffic volumes are shown on the map using different colors. Here are some illustrations of various big data applications and how they relate to ITS.

6. ITS's use of big data techniques

By simultaneously examining more than two variables, multivariate analysis produces useful conclusions more quickly. Univariate is used to accommodate additional parameters for analysis. Multivariate structure uses a large number of predictor variables in contrast to linear regression, which only takes into account two variables.

Multivariate Techniques Classification

The variable's ability to be divided into dependent and interdependent versions serves as the basis for classification. The form is considered to be dependent when a variable is designated as a dependent variable and is anticipated to be predicted by independent variables. There are no independent or dependent variables in an interdependent form. A few instances of multivariate methods are displayed in the flowchart that follows.

- ***Analysis of multiple regression:***

Forecasting how a dependent variable will change in response to changes in an independent variable is the goal of multiple regression. When one dependent variable is connected to two or more independent variables, this strategy has been shown to be effective. The least squares method is used to achieve this.

With the use of this multiple regression method applied to ITS, it is feasible to predict the time (Dependent variable) at which the vehicle will arrive at its destination while also accounting for other factors like the flow of traffic along the route and the vehicle's speed.

As seen in the equation, this condenses the prediction and can be expressed in both metric and nonmetric formats.

- ***Analysis Using Multiple Discriminants***

When it is possible to divide the entire population into various groups based on a dependent variable with multiple pertinent classes, this strategy is appropriate. The major objectives are to understand the differences between the different groups and to forecast the tendency of an object to belong to one of the groups using the independent variable.

- **Multivariate method classification relevant to s-ITS**

The quickest, most efficient routes that get you to your destination faster and avoid traffic are discovered when this method is applied to ITS. This makes use of both the time factor and the location-based route map.

Analogous Regression: Multiple regression and multiple discriminant analysis are combined in the logistic regression model. When compared to multiple regression,

Combination Analysis: Both product researchers and buyers will benefit from this analysis. Customers only focus on a subset of a product's attributes and specifications throughout design;

the remainder are disregarded because they are boring to customers. Product researchers pay close attention to every aspect of a product's marketing, yet users of s-ITS in car systems are solely focused on going safely and avoiding collisions. They want to learn the procedures and tricks that will let them travel safely and without being stuck in traffic. However, it is envisaged that the framework would take into account a number of factors related to the evolution of vehicles and borders that choose continuous movement at a steady speed. the following illustration shows

Crowd Analysis: The process of grouping values into predetermined groups or clusters in order to identify differences among the data points is known as cluster analysis. The most frequent way of grouping many components is through determining the comparability of the comparable elements. The elements are then put into the appropriate clusters once the similarity has been determined. The profile of the final variable is the final step. According to how important they are in identifying the numerous components that ensure vehicle motion for efficient and accident-free transportation, the variables that affect vehicle motion in sITS are divided into different categories.

7. Intelligent Transportation System (CIoT-ITS) powered by the cloud

This study focused on an IoT and cloud-based smart city's intelligent transportation system. The intelligent transportation system (ITS), a vital component of a smart city that takes into account fuel consumption and traffic quality, is the key to the long-term evolution of intelligent smart city transportation. A smart sensor and the transportation network should be connected in order to create a sustainable IT'S. The recent success of IT'S exemplifies the growing usage of autonomous vehicles on roads to build sustainable transportation networks. The Internet of Things (IoT) and cloud computing will make transportation more efficient and use less fuel, similar to autonomous vehicles. This study suggests CIoT-ITS as a method for predicting traffic flow and reducing congestion in a smart city.

The cloud-based Intelligent Traffic Monitoring System is depicted in Figure 1. Massive real-time data collection from intelligent traffic systems is required for increased traffic. Controlling traffic infractions, preventing collisions, identifying potentially risky drivers, and simulating offline traffic conditions are the goals of a thorough traffic management system. The term "resource integrating" describes the method by which individuals, including clients, combine and use resources to produce value. In order to organize and optimize traffic on the route, find out which way the cars are moving. The traffic infrastructure manager can use this information to estimate the volume of traffic that will flow from one control point to the next and re-establish paths that will optimize traffic. Media management is a business subject that covers the description and portrayal of strategic and operational phenomena as well as management difficulties in media businesses. Through the carrier's network, wireless communication will be determined in this high-traffic location. Users of navigation systems can examine one or more charts in manual, graphical, or text format. the use of sensors and camera sources to locate a vehicle Data sharing is a defining characteristic of information communication between various businesses, individuals, and innovations. . The addition of IP addresses from different locations to different address pools and strength evaluations are encouraged by global traffic management. Address pools A and B can be used as the default IP address and address pools, respectively, in cloud access control settings. As a result, the application resources' primary and secondary instances crash. Figure 2 shows how the CIoT-ITS is supposed to work. Working with automatic driving is easier because the driver takes on the role of a passenger. As autonomous vehicles follow the same lanes in traffic flows, little space between vehicles is maintained; this cooperative driving application lowers fuel consumption and gas emissions while maintaining safe and efficient transportation. The end result is similar to a wirelessly connected car in that the following vehicle will automatically slow down, turn, and accelerate in response to the first one's action. The neighborhood is informed by the vehicle's sensors of the data they have gathered.

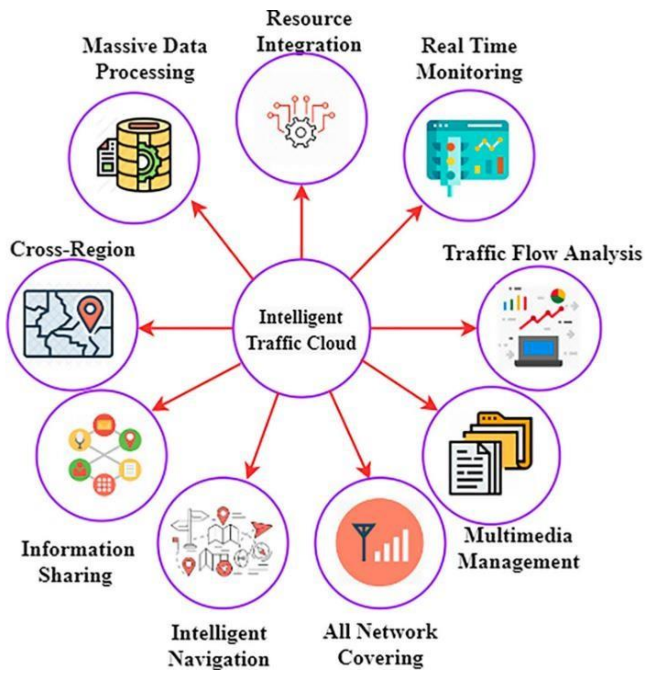

Fig.1 *Keen Traffic Checking Framework powered by the cloud*

The roadside unit (RSU) subsequently transmits a data summary to the cloud server for processing. Traffic control systems and a centralized traffic control center receive static sensing data from the road via the roadside unit (RSU). For cluster nodes that operate as agents, acquire traffic data from all node platforms, and guide it to a base station where data can be collected and processed, the cloud architecture is utilized to effectively track data movements, vehicle densities, flow times, and waiting times [21]. Smart cars can use these components as an intelligence hub to gather data on possible traffic. Technically, an RSU consists of the Base Transmitting Station (BTS) and Base Station Controller (BSC) traffic control operations. The BTS of a cell is the equipment used for signal transmission and reception. In order to operate traffic signals, traffic sensors collect data on the movement of vehicles and transmit it to the Vehicle Information and Communication System Center [22] [23]. CCTV cameras are a crucial part in maintaining the road system. Congestion and traffic jams are typical when traffic lines are created at weak points in the network to aid in transport management. Through better server management of high volume traffic, such as load balancing, accessibility issues are avoided and load times are decreased. Businesses that appropriately distribute web and network traffic across several hosts will see an improvement in application response times and throughput. The device controller examines the sensor data before determining the timing of the traffic signal by means of a traffic management algorithm. The crossroads is likely to have a lot of traffic [24]. There are two prepositional models in the suggested model. 1) A speed estimation model and a traffic forecast model.

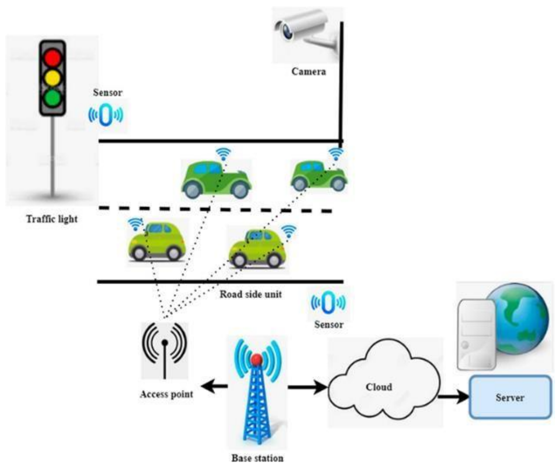

Fig.2. Conceptual CIoT-ITS

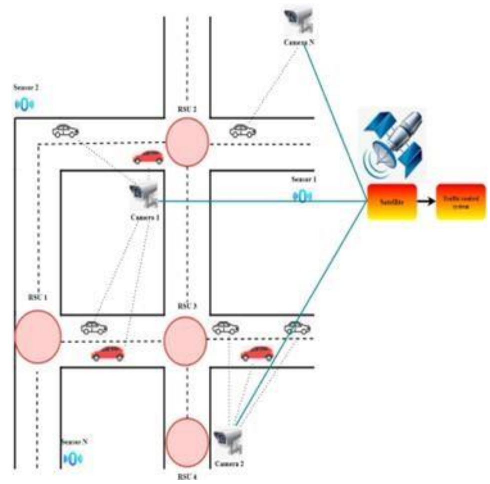

Fig 3. Intelligent Transport System.

The Intelligent Transportation System is depicted in Figure 3. Specialized on-board units (OBUs) that are connected into on-road vehicles make up an intelligent transportation system. These OBUs, which are controlled by a CPU, provide coverage for a wide range of mobility and infotainment functions. OBUs periodically send signals along the route telling the nearest RSU and other continuous vehicles of their current conditions, including speed, location, and direction. For on-road automobiles to connect, explore, and exchange messages with RSUs and other on-road vehicles that have irregular information about their connectivity restrictions, the vehicle network must be stable [25] –[27].

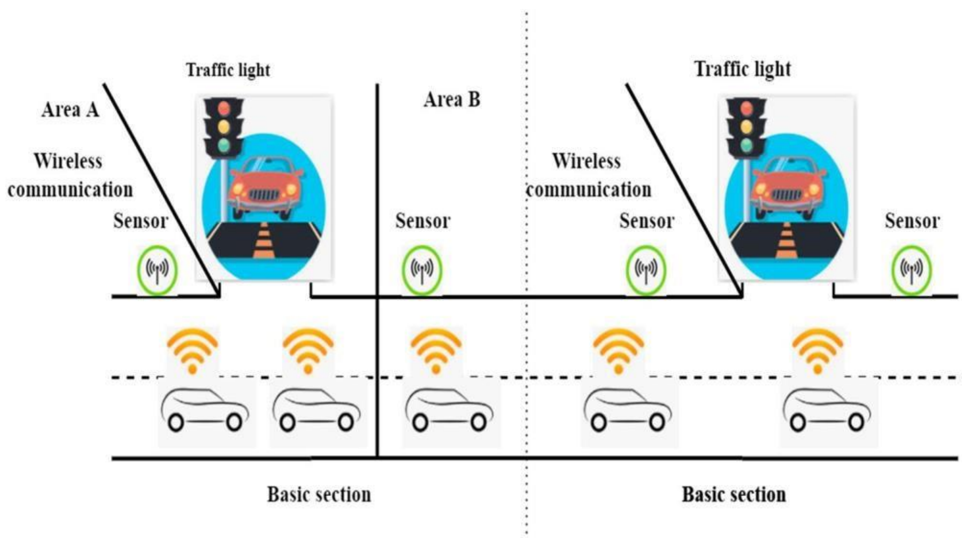

Fig 4. *A partial vehicle entry model*

8. Results of the experiment and discussion

The trial results show that the suggested framework performs better than the current ITS methods in terms of throughput and package transportation. When there is a delay or latency, it is extremely beneficial. the various elements and the weights given to them in relation to various network topologies for packet data transfer. The proposed approach shows how different network conditions affect delay. The network's most recent version, IEEE 802.11 p, has a lower latency and a higher packet delivery ratio.

The time and distance factor, along with the metrics RMSE and MAPE, are used to make the observations. To determine its effectiveness, the suggested s-ITS is compared to alternative approaches including fuzzy control rules and fuzzy rules based on genetic algorithms. To determine the most efficient path, the observation is typically conducted at peak hours and in busy areas. Because the vehicles are moved when there is traffic in a particular area, the recommended s-ITS offers both efficient traffic monitoring and simple parking.

9. Conclusion and Future Work

In the new paradigm, bigdata and IoT in particular are vital to everyday applications. Bigdata technology enables straightforward pre-processing, resulting in pre-processed data for additional processing. The s-ITS system and other big data and IoT operations are then given access to the processed traffic data. The provided framework can be used to develop effective transportation systems, intelligent parking, and vehicle position tracking. To estimate how much traffic is there in a particular area, the technology tracks the movement of the cars. The proposed s-ITS system outperforms currently in use conventional systems in terms of packet delivery and network delay. The MAPE and RMSE figures also demonstrate this. The ITS system could incorporate energy-saving features and improve system performance to better manage the current condition of the roadways. This might be the next initiative aimed at energy efficiency for a dependable and intelligent transportation system. This article explores the sensor smart road network's potential path toward intelligent speed restrictions and vehicle alert systems, in addition to actual evaluations of traffic congestion, pedestrian crossings, and free route availability for fire engines in metropolitan locations.

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