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1231: IOT-DRIVEN COMPUTER VISION TECHNOLOGY FOR SMART TRANSPORTATION APPLICATIONS

Fog robotics-based intelligence transportation system using line-of-sight intelligent transportation

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Abstract

Intelligent Transportation System (ITS) idea was developed to improve road safety, traffic management efficiency, and environmental preservation. The fog- robotics Based Intelligent Transportation Systems integrate Internet of Vehicles (IoV) devices to Fog Computing (FC) centers, which process the data. On the other hand, providing massive data from widely distant devices causes network overhead and bottlenecks in Autonomous Driving and a drain on Energy Management. To fill this research gap, fog-robotics-based intelligent transportation systems are proposed to cover the line-of-sight direction for path adopting self-directed intelligent transportation. The Intelligent Transportation Systems with FC Techniques work towards the Fog Robotics Platform for making efficient fog- robotics Transportation Systems. The Proposed System has two functionalities; firstly, the analysis of automatic Fog- robotics transportation systems is introducing decentralized wireless sensor transfer assisted flocking autonomous driving for energy management of fog- robotics transportation systems. It Shows the Sensor activities as per the "scanning of the roadside meter." It enumerates speed control. Secondly, Artificial Intelligence Enabled Intelligent speed assistance is formed based on Vehicle Infrastructure Integration (VII). This Vehicle infrastructure integration is used to show the Smart highway, which is adaptable with the fog- robotics Transportation Systems. Although the formation of "Digital modeling and fabrication framework" procedural aspect employed to connect the "Fog- robotics Transportation Systems" and "Vehicle infrastructure integration." This Artificial Intelligence configuration is used to Enabled Intelligent speed assistance for controlling the car for their atmosphere. Finally, these rely on are consolidated with the position/navigation system, and the vehicle detection ratio is analyzed with the vehicle efficiency and economic activity for intelligent speed assistance.

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Keywords Artificial intelligence · Autonomous driving · Decentralized wireless sensor · Fabrication framework · Fog- robotics transportation

1 Introduction

Recently transportation systems performed a crucial role in the intelligent transportation system with enabled IoT fog robotics. In this paper, fog robotics contains the cloud and the robotic server for data capturing and storing. Some of the issues faced by the fog robot are security and privacy, latency issues, and bandwidth limitations [46]. The fog robotics activates IoT devices and robots in warehoused and homes to contact the edge sources and cloud data centers. The fog robotics is used in the airport to communicate with other robots for information availability [16]. The main contribution of fog robotics is to issue the resources among the edge and clouds. Line-of-sight is defined as the sight between the object and the subject. Nowadays, vehicles and networks have been insisted in the transportation system in smart cities. The intelligent transport system is the communication and the information technology which make the mobility management interface with the combination of other transports [22]. The usability of a traffic control system and traffic management reflects traffic patterns. The speed camera measures the speed of vehicles at the road's sharp point. This is done using the conventional camera and radar detection. The vehicles which exceed the speeds will send a fine according to the driving license. The camera is installed on the roadside, linked with the number plate, and recognizes the average speed [27]. Also, the ISA, the intelligent speed adaption, is used to indicate the location concerning the speed limit. There are types of ISA that are active and passive ISA. This ISA system makes use of the information regarding the position and the speed. For improving road safety and the physical surrounding of the vehicles, which directly links to the applications and the technique [44]. This helps in the communication among the cars on the road. The decentralized localization in a wireless sensor network is introduced for calculating the doe making of the wireless sensor networks. The wireless sensor network makes the routing matrix in between the WSN. The volume of the vehicle is used to monitor the traffic, and the speed is calculated according to the sensor, which scans the number plates, and the fine will be sent to the respected person. The impact of the speed and the level of services make the effective measurement of the rate proposed [13]. The traffic volume is combined to form the effects of the traffic volume. The autonomous algorithm is also used in the nonlinear dynamic robot to avoid the vehicle-to-pedestrian and vehicle-to-vehicle for the safety of the urban environment. The flocking framework for the connected automatic system is used for alignment and collision avoidance. A complex driver assistance system called a collision avoidance system (CAS), sometimes known as a forward collision warning system, a pre-crash system, or a collision mitigation system, is intended to prevent collisions or minimize their severity. A forward collision warning system's most basic configuration measures a vehicle's speed, the speed of the vehicle in front of it, and the distance between the two so that it may alert the driver if the vehicles are becoming too close and possibly even prevent an accident. The deployment of collision avoidance technology may result in a 30% reduction in fatality collisions and a 40% reduction in injury crashes.The cooperative autonomous method of flocking is used for automated driving technology. The performance of driving control is done in the flocking theory. Autonomous driving depends on the sensors that observe the vehicles at Line-of-sight [20]. As it is tough to achieve the neighboring vehicles, the vehicle's decision is intense. The contribution of the paper is as follows:

- to analyze the intelligent transport system based on fog robotics using the Line-of-sight direction methods.
- Also, the speed and the traffic analysis are done using the roadside camera at the sharp point.
- The communication between the vehicle using fog robotics is done.

The section of the paper is divided as follows: In Section 1 introduction of the paper has been elaborated. In Section 2, the related work, which is the analysis of the existing paper, has been written. In Section 3, the methods and results have been proposed; in Section 4, the conclusion and the future work have been whitened.

2 Literature review

Guerrero-Ibañez et al. [10] the intelligent transportation system improves the flow of vehicles and the efficiency of the traffic. The transportation network is connected with all the digital devices, which generate a large amount of data. These data are analyzed using in-depth data analysis using deep learning techniques. This method predicts the performance of the traffic, traffic light management, capturing the objects near vehicles, lane detection, etc. this technique addresses the prediction, improving traffic flow, and intelligent environmental perception. This is proposed by Guerrero-Ibañez et al. 2021.

Azadani and Boukerche [2] In this paper, the driving behavior analysis concerning traffic safety is proposed. The drunk and drive detection and the vehicles' speed identification are analyzed. The driving model is analyzed, and then the technique of the driving model is proposed. Also, the challenges of future behavior and prediction are analyzed in this paper. This is elaborated on and suggested by Azadani et al. 2021.

Mo et al. [26] this paper provides the combination and the coordination of automated vehicles. The author has elaborated on the roadside's position and accuracy for the roadside failure. The improved and effective Kalman filter technique has been practically applied. Also, vehicle infrastructure integration is proposed to reduce autonomous vehicles and the technical bottleneck. This is said by Mo et al. 2021.

Qian et al. [30] The fast recognition of the vehicle infrastructure is sometimes called the C-V2I, which recognizes the automatic driving of the vehicles. This paper talks about the road operators as the primary stakeholders. The operation and the construction periods of the road and the vehicle coordination make the higher efficiency the increase in the safety. The path is realized quickly for autonomous self-driving. This is proposed by Qian et al. 2021.

Sahal et al. [34] The distributed consensus algorithm is used in the data analysis for applying the digital transportation system. The conceptual framework for the transportation is proposed, and the prediction of the maintenance and the intelligent logistics technology is presented. The digital autonomous and the decentralized IoT are formed using machine learning. The interoperability, efficiency, robustness, and scalability have been elaborated in the digital modeling of autonomous driving. This is said by Sahal et al. 2021.

Rana and Hossain [32] In this research, the driver-assist system's integration for the driverless option's transition has been proposed. The roadside infrastructure for path tracking is done, and the lane reduction for replacing the driver has been implemented in this novel. Also, the vehicles' automatic driving for the additional distress is done. The driving of the vehicle without any intervention of the humans is autonomous of the infrastructure of the vehicles; this is suggested by Rana et al. 2021.

3 Flocking autonomous driving for energy management

The flocks are typically considered the model with multiple agents for autonomous driving to effectively perform the autonomous driving tasks like applying the brake, taking turns, changing speed, etc., and it is inspired by the theory of the flocking method based on the distributed wireless sensor [35]. For safe and reliable driving, autonomous vehicles depends on their assessment of their surroundings. This vision system makes precise determinations of surrounding items, such as pedestrians, automobiles, traffic signs, and obstacles, using object detection algorithms. With the support of a combination of sensors, cameras, and radars, autonomous cars are able to comprehend their surroundings (obstacles and track) and proceed to their destination. In this system, autonomous driving based on the flocking method is considered for energy management by considering the following elements: roadside meters, vehicles, pedestrians, traffic signals, etc. An energy management system is a supervisory control algorithm for a vehicle power network with the main objective of distributing electricity in an energy-efficient manner. The V2X communication is implicitly assumed when flocking is added to autonomous driving, and the model determines how the V2X may be used in practice to assist the flocking algorithm adapt to non-local situations and communicate objectives with other vehicles. In this autonomous driving system, these multiple agents need to be considered for the system's effectiveness, as the drivers would like to avoid collisions with pedestrians and other vehicles; this is the importance of the flocking system. As the autonomous vehicle contains many sensors to collect data from the road environment, as the vehicle is in a continuous state of movement, the sensors connected with the wireless sensor also get altered continuously [36]. So the distributed wireless sensor is used to gather the data for autonomous driving based on a fog robotics system consisting of storage, network functioning, and control of fog computing. Then the collected data gets processed to find the distance and speed of the vehicle to avoid the collision; the sensors in the autonomous car need to work simultaneously to access the fog- robotics-based intelligent transportation systems with distributed wireless sensors. Distributed sensing is a technique that allows continuous, real-time measurements to be collected along the length of a fiber optic line. Distributed sensing uses the optical fiber rather than built devices, in comparison to typical sensors, which rely on discrete sensors measuring at fixed locations.

In Fig. 1, the robotics-based intelligent system for transportation with the help of wireless sensors has been elaborated. The autonomous car is used as assistance with the features of automatic safety to navigate roads [28]. The software that autonomous cars need to operate is executed by sensors, actuators, advanced algorithms, machine learning systems, and robust processors. Based on a number of sensors positioned throughout the vehicle, autonomous automobiles develop and update a map of their surroundings. A self-driving car could have

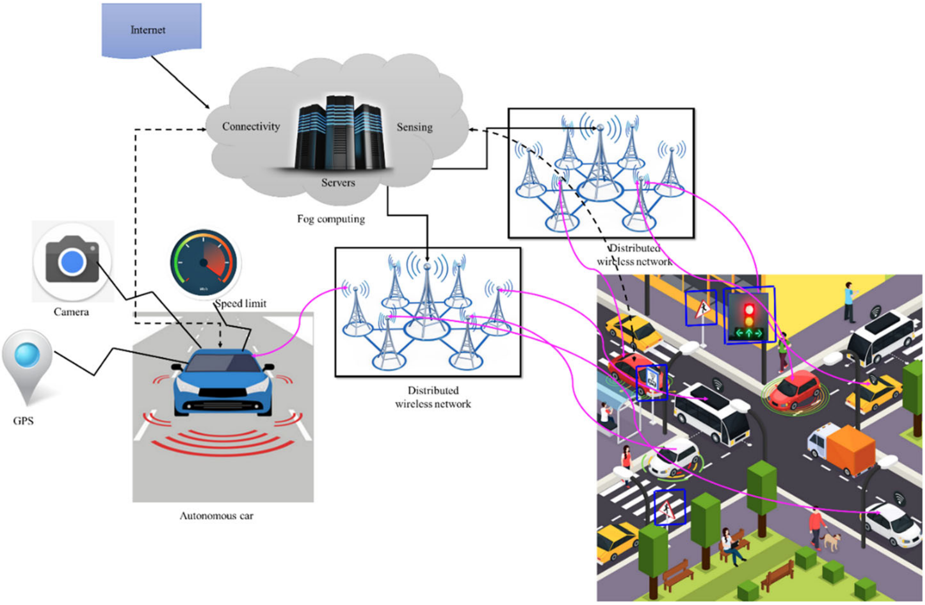

Fig. 1 Fog- robotics Based Intelligent Transportation Systems with distributed wireless sensor

both hardware and software issues. Additionally, many of the issues that exist now it may develop from operating in hazardous weather situations. In this fog computing system, the standard positioning service (SPS) is used to find the location of the car, for identifying the limitation of the speed identification, the speed sensor has been induced in the infrastructure in the speed meter of the car. All GPS users have access to the Standard Positioning Service (SPS), a positioning and timing service that operates on GPS L1, L2, and L5 frequencies. A coarse acquisition (C/A) code and a navigation data message may be found on the L1 frequency. The objective of fog computing is to improve the processing, intelligence, and data gathering closer to the Edge devices. When data is generated, transferred to the cloud, and retrieved from the cloud, a fog node device is situated between the cloud and the edge device. By allowing data to be processed where it is utilized, sending data to the cloud for processing more efficiently, and situating the cloud closer to the data access point. And the camera for capturing the vehicles which are moving aside [11]. Then, the data from the speed sensor, GPs, and the camera are sent to the server with the help of the internet is done and the data is processed in fog computing. Fog computing is proposed for sending and receiving data from the distributed wireless network [9]. Fog computing is the decentralized computing structure between the sensor devices providing the data and the cloud. This receives the data from both the autonomous car and the signal, and this gets processed in cloud computing [43]. In decentralized communication networks, all members of the same group have direct communication access to each other, which means that information does not need to travel through an assistant, an HR representative, or any intermediary before attaining high managers and executives. It is a networked system where no one entity has total control. It is the design in which the hardware and software workloads are divided among a number of workstations. Every vehicle data is collected and then processed by the fog-based intelligent computing system for the transportation system analysis. Real-time environmental data is collected by sensors, processed, and analyzed to enhance and protect transportation networks. To develop a sustainable intelligent transportation system that solves problems like high CO2 emissions, high levels of traffic congestion, and increased road safety, sensor technology may be linked with the transportation infrastructure. This makes the formation of the data traffic from one network to another network, so many distributed wirelesses are made to analyze the data from each vehicle [44].

3.1 Scanning of roadside meters

The autonomous vehicle is the one that can drive itself from the start point to the destination in the mode of autopilot by adapting various technologies and sensors, including speed control based on the vehicles, traffic, and the traffic signal; it is considered as the most important for safe driving. AI is a key area of attention for the testing and development of autonomous cars, and these vehicles are using AI in innovative and different techniques. Cameras, radar, ultrasonic, and LiDAR sensors are the most crucial vehicle sensors for observing the surroundings. The time-of-flight theory underlies all of them, with the exception of cameras. In this paper, the Lidar Light Detection and Range scanner is used to collect the environmental information in front of the vehicle, and then the object detection process takes place [38]. LiDAR (Light Detection and Ranging) is one of the most discussed sensor technologies in self-driving cars, and it has been employed from the early days of self-driving car technology. It is a very adaptable technology that is being employed more often in a variety of applications. Laser beams produced by LiDAR systems are at eye-safe levels. In LiDAR, laser light is emitted from a transmitter and reflected by the scene's objects. The system receiver collects the reflected light, and the time of flight (TOF) is used to produce a distance map of the scene's objects. The objects might be roadside meters, the distance of the car in front, and the traffic on the road is estimated based on the number of car objects in the 3d format [29]. Continuous processing must occur as the lidar collects a large amount of data. Measuring the device range is essential for detecting the objects in the path of the autonomous transportation system. Doppler-type sensors detect moving objects by changing frequency in accordance with the speed of the object utilizing the ultrasonic Doppler effect. They are positioned on low-traffic side roads and are used for recall control, changing the traffic signal on the side road to green only when a vehicle is detected. The combinations of sensors like radar, lidar, laser, and so on can also be used to capture the data in the roadside path [25]. This method detects data in the range of fewer than 5 m. Then the captured data are inputted to the unit for evaluation based on the estimation method like Kalman's filter. The evaluation team found any roadside meter or car before or traffic signal, and this data are provided to the driver in visual format or the form of a warning signal. The data is collected during sunny time with the laser scanner, which is mounted in front of the autonomous car, phasing forward with an angle of 25degrees; hence this laser scanner model is used to scan the view of the field up to degrees field of view with the maximum range of scanning 300 m. Laser Scanners are non-contact devices that use laser infrared technology to generate accurate 3D scans in a matter of minutes while collecting millions of discrete data points to measure an object or location. The images are made up of a point cloud, or millions of 3D data points. While 3D laser scanning uses lasers to measure the geometry of an item and generate a digital 3D representation. As 3D laser scanning can capture three-dimensional data on things, independent of their surface characteristics or size, it is employed in a variety of settings and businesses. Rapid measurement, lower HSE risk, non-contact data collection, cost reduction, and time savings are the main advantages of laser scanning. The Lidar data consist of higher accuracy and resolution when compared to the data collected using RADAR which helps build the 3D model of objects [42]. The light from pulsed laser beams of near-infrared wavelengths is used by LiDAR systems. Microwaves are used by RADAR systems, which operate at considerably longer wavelengths. LiDAR doesn't track how long it takes for the pulse to return, in comparison to RADAR, instead, it calculates the distance to an object depending on how long it takes for the light to reflect back to the sensor.

Lidar is the most discussed technique for 3D imaging for the autonomy of things, including autonomous vehicles. The YOLO v3 is the model is the primary structure that is used to identify the objects like vehicles, roadside meters, and so on. It is a deep convolution network with a higher speed for process and with higher accuracy. When comparing the convolution network, it uses only the convolution layer without connecting the pooling layers. YOLO is a fully convolutional network (FCN) that uses only convolutional layers, without the usage of pooling layers. Instead, the feature maps are down sampled using a convolutional layer with a stride of two. Low-level features related to pooling layers are less likely to be removed as a result. Thus the convolution layer with the feature map is used for the down-sampling process, which helps to reduce the size of the feature map and the loss of features as the pooling layer [18]. The layer of convolution with 1x one never changes the feature map size. However, it might change the number of available feature maps, thus where the attributes of maps in each cell are $E(5+A)$, where Estates the total number of bounding boxes that can be predicted for single-cell, and A determines the total number of classes, thus in the model of YOLO v3 E is equal to 3 and the prediction of objects based on the cells through any one of the bounding boxes when the center of the object is presented in the particular field of the cell. The dimensions of the bounding box can be predicted by providing output with the log space, then the score of objects is considered as the probability of the object presented in the bounding box. If the classifier predicts that an object is present in a specific cell, a box is drawn around that cell. In order to identify every object in an image and construct a box around each one, object identification algorithms frequently employ bounding boxes. In video data, they may also be used to monitor objects over time. Thus, for object detection in small objects, the detection uses a feature map with YOLO based on the three various sizes; in the scenario of object detection on the roadside environment, there might be various perspectives that might influence the accuracy of the object detection [37].

After the recognition of an object, the text or numerical data in the object, i.e., the roadside meter, is conducted to find the amount of speed that must be adopted while traveling on the particular road to avoid the risk of an accident. Thus, again YOLO v3 model is incorporated to recognize the text or numerical data in the object by feature extraction and recognition methods which helps to find the speed limit mentioned in the roadside meter [7]. So speed and distance estimation are essential to monitoring autonomous vehicles [21]. It is based on the equation of mirror. The speed is determined as the differential distance between the frames of adjacent, and the size of the object is used to recognize the real-world objects with the ratio of magnification; thus, the equation for estimating the distance and speed is given as follows,

$$\frac{1}{A} = \frac{1}{d_O} + \frac{1}{d_I} \tag{1}$$

$$N = \left|\frac{d_O}{d_I}\right| = \left|\frac{h_O}{h_I}\right| \tag{2}$$

Where A is considered as the focal length, then d_O and d_I are the distance from the camera to the object and image and h_O and h_I Are the height of the image and objects. The distance of the image and focal length are considered fixed based on the particular camera, which can be obtained from the information found in the camera [22]; if the object which needs to be detected is in focus, then it is determined as the focal length is equal to the distance of the image.

The speed is estimated to find whether a car is moving at the rate mentioned in the meter placed on the roadside. Ultrasonic sensor technology is used by the most common type of vehicle active motion detectors; these motion sensors produce sound waves to detect the presence of objects. Using image and video processing techniques, vehicle speed detection is utilized to calculate the speed of the moving vehicle. Real-time speed analysis of video is performed without the need of camera calibration. If not, the speed should be limited to find the vehicle's speed. The speed estimation plays an important role, and when the car in front is found, a particular amount of distance needs to be maintained; hence, for this process, the speed needs to be estimated and limited if it is high or when the distance is shorter [28]. They are split based on car, truck, and bus to find the vehicle's distance. Their width are respectively determined as 2.0, 3.1, and 3.1 m; the width of the vehicle in the image is W_i Which is determined based on the vehicle's width based on the pixel units by multiplying the pixel's pitch based on the unit of meters [19]. The distance of the object can be found using the equation as follows,

$$d_O = \frac{|d_I|.W_O}{W_I} = \frac{|d_I|.W_O}{W_{IP}l_P} = \frac{A.W_O}{W_{IP}l_P} \tag{3}$$

By considering that in the image, the vehicles were unfound in the center and it is vital to transform the vehicle before the process of computing with the width of the image is much important, the determination of transformation is estimated based on the location of vehicles in the image as the views of lens angles and the width of the road are found to be fixed. Hence, calculating the speed and distance can estimate the speed limit [41].

In this Fig. 2, the roadside meter's scanning and the sensor's activity have been analyzed. The autonomous care has been fixed with the 3d camera sensor Lidar or radar. The lidar is the remote sensing method that uses the light in a pulsed laser to measure the ranges. Radar is the radio wave that emits electromagnetic waves like mobile phones and wireless networks. This camera sensor analyses the environments with an object related to the speed limit or a speed symbol. In a camera system, incident light (photons) that has been focussed by a lens or other optics is received by the image sensor. The sensor will provide data to the following sequence as either a voltage or a digital signal depending on whether it is CCD or CMOS. If it founds the speed limit board on the roadside, it checks whether it is a speed limit board. If the object is a speed limit board or has a sign of the speed limit that is equal to the speed limit, it saves the

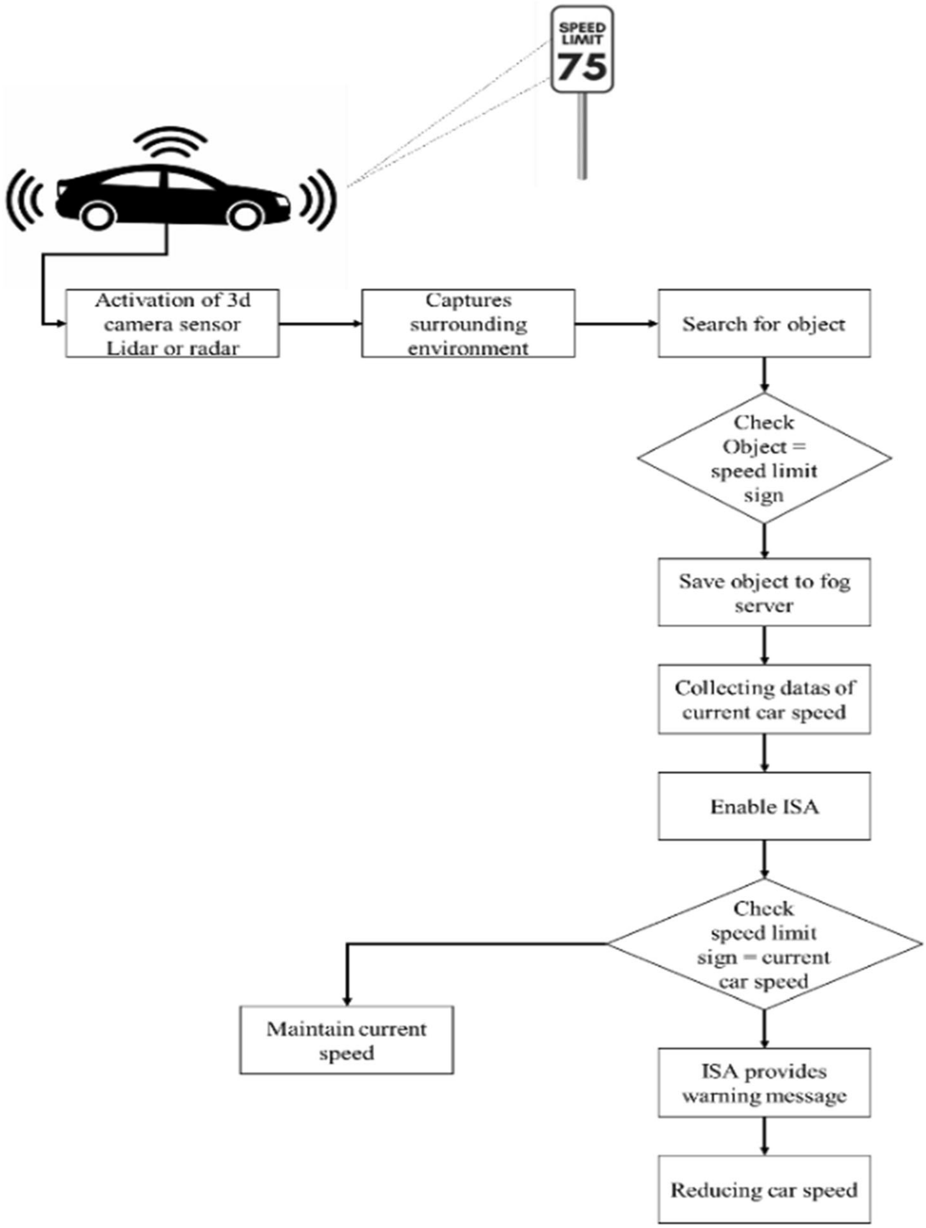

Fig. 2 Sensor activities for scanning the roadside meter

object to the fog server then [31]. At once, the fog server collects the car's current speed; therefore, the ISA intelligent speed assistance is enabled and used as the speed limiter. It automatically reduces the vehicle's speed and the engine's power. Then the sign of the speed limit and the current car speed are checked while checking if the condition is genuinely equal, that is the current speed, and the sign limit are equal, it maintains the same speed; otherwise, the ISA will provide the warning of "reduce the car speed" This process of scanning of the roadside speed meter using the camera sensor has been derived.

This flow of the camera sensor in the autonomous car has been analyzed by the ISA enabled, which calculates the car's speed. And also, the speed can be limited using this system, or a warning sign of reducing the car speed is intimated to the autonomous car. Then the car speed is reduced according to the speed sign by the roadside. This is one of the smart highway adaptable fog- robotics transportation systems.

4 Smart highway adaptable fog- robotics transportation systems

The Vehicle Infrastructure Integration (VII) program is used to restructure the transportation system by providing the infrastructure for communication which provides a massive range of safety applications; in this method, VII technology is used to prevent collisions during car driving based on different conditions with the fog robotic system [5]. The Vehicle Infrastructure Integration (VII) strategy stimulates research and application development for a number of technologies that directly connect road vehicles to their physical environment, primarily to increase road safety. The technology is influenced by a number of fields, including computer science, electrical engineering, automotive engineering, and transport engineering. Although comparable technologies are already use or are being developed for other types of transportation, VII primarily addresses road transportation. For automatic guidance, planes, for instance, employ ground-based beacons. This enables the autopilot to operate the jet without human input. In highway engineering, increasing a roadway's safety may increase overall effectiveness. VII intends to improve both efficiency and safety. It combines the edge popular technologies as it consists of a wireless communication system, computer processing on-board, sensors for a vehicle, GPS for the navigation system, and so on, which produces the communication in two ways that is between the controller and vehicles, thus with the capacity of autonomous communication vehicles are found to have the ability to recognize the threats in the roads like traffic, the distance between the vehicles, roadside meters and so on these information's are communicated over the wireless network for safe driving in an autonomous vehicle [47]. GPS serves as a tool for data collecting and provides details on the predicted arrival times of certain cars at specific locations. This makes sure that public transportation employees are informed of the precise location of the car and further enables them to understand how delays result in traffic congestion. The Dedicated Short Range Communication (DSRC) system provides the data transmission between control units of vehicles and also the roadside units to provide reliable communication between the infrastructure and vehicles; and short-range communication is through fog computing by placing the server in the distributed locations near highways [17].

The objective of vehicle infrastructure integration is to create a communication link between the vehicle and road infrastructure, to increase the efficiency and road safety of the transportation system. Each vehicle has a dedicated short-range communication link between the vehicle and roadside meter, On-Board Equipment (OBE), and a Global Positioning System (GPS). It can manage the traffic flow, information about the traveler, weather sensing, and collision avoidance system. The fully autonomous car assures increased safety while traveling on the road, decreases the infrastructure cost, improves an individual's mobility, and prevents accidents by using various types of sensors. The sensors are camera sensor, lidar sensor, and radar sensor.

pseudocode For Working Principles for Vehicle Infrastructure Integration

```
input: traffic information
vehicle to roadside communication
DSRC→ 75Mhz at 5.9 GHz
enable→RSE
for moving car
    RSE sends messages asking about location and speed
    OBE responds to location and speed
    if (speed> speed limit)
        voice alert message
        else if (speed ≤ speed limit sign)
            maintain car speed
    end if
end for
result; alert message sent
```

Roadside hotspots enable the Vehicle Infrastructure Integration (VII) system by dedicated short-range communication within 75 MHz for free and near bandwidth 5.9 GHz. The Road Side Equipment (RSE) is connected with each vehicle via DSRC; by using this method, we can send or receive a message from the nearby vehicle [40]. The back-office team continuously monitoring and controlling the roadside equipment also endured. The RSE device may be operated at a fixed position or portable device that is temporarily placed in the locality of a traffic incident, road construction, and so on. This system also has a processor, a secure place for data, and secure communication between the vehicles and centers.

When a moving car is on the intelligent way, the RSE can get location information and the car's speed. The RSE simultaneously observes the traffic signals, traffic signs, and so on. RSE sends the request message to get the car's speed and location. The On-Board Equipment with the computer system responds to the measurements of car speed and information about the location [12]. The system compares the speed of the car and the speed limit sign; if the car's speed is greater than the speed limit, the RSE system produces an alert message to the car. If the car speed is lesser than or equal to the speed limit sign, then the RSE maintains the car speed.

The traffic and distance between vehicles data are recorded from the radio link, and then the data are stored and processed in the fog system, where the system utilizes the frequency range from 5.9 GHz as the rate of the data transmission is higher with the wireless channel than the lower frequency is 915 MHz, For communication, the servers are located based on two cases,

Case 1:- Placing the server on each roadside meter on highways because of the short-range communication process.
Case 2:- Accessing the server in an autonomous car as head for communication.

The cases mentioned above are used for faster and more secure communication between the vehicle and infrastructure for the autonomous driving process by providing decentralized servers for short-range communications. Case 1 is one of the ways to place the server in the roadside meter. It can be accessed by cars for communication. Usually, the roadside meters are placed at a distance of 7 m; thus, servers are also placed at a distance of 7 m and can access the range around the 7-meter radius. When the autonomous car joins in the middle of the smart highway, it checks for the nearest server access. If the server is founded within a radius of 7 m, then the car accesses the particular server for communication, as shown in Fig. 3.

Case 2 is another way for accessing the server in the car as ahead for the communication process, the number of cars using the same road might not apply to the same destination [39].

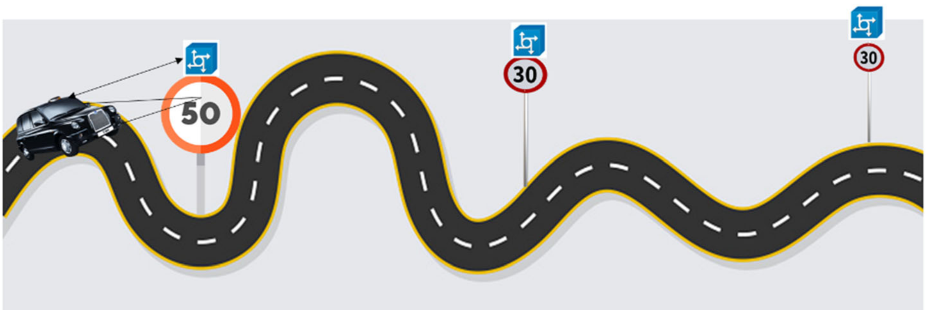

Fig. 3 The server on each roadside meter

Thus, in this case, the cars in the path form the network by considering a server of a car as the head, which is connected to the number of the car as an enslaved person for communication, and if a single slave moves to the other direction they it may connect to the head in the particular direction which is nearer to the server for data transmission process is shown in Fig. 3.

There are various sensors for the data collection from roadside meters on the road to avoid risks. The decentralization model fixes the processing of the data in the tiny range of communication, and the transportation system is found in the car's communication in the server for access (Fig. 4).

4.1 Vehicle infrastructure integration process

Fog computing includes the network functions that assure fog computing is closer to the robots. Fog Robotics primarily worked based on the cloud and the fog robot server. The "Fog Robotics" technique, is utilized in deep robot learning which federates the distribution of computation, storage, and networking resources between the Cloud and the Edge. It is primarily utilized for wireless network-based robot learning and inference of deep neural networks for tasks including object identification, grasp planning, and localization. Fog Robotics also provides computational resources near to mobile robots, allowing access to more data through various sensors on a single robot or across numerous robots. With the help of a local server, fog computing shoves the data to an adjacent user. To establish fog robotics in the transportation system using a cloud and fog robotic server [45]. The fog transportation system includes the interaction of elements that satisfies the travel demand. The cloud technology automatically controls the robot's motion, relying on a real-time sensor. Fog robotics implies the data sharing process instead of cloud resources [14].

Fig. 4 Accessing the server in the car for communication

4.2 The general algorithm for fog- robotics transportation systems

```
input; fog robotics- fog server & cloud, sensor
for each car in a smart way
        enable GPS
        enable sensor
        observe continuously
        capture→3D image of a road
        if (detect = traffic signal) yes
                show→ shorten roadway
                else if(detect = traffic sign)
                        adjust→ car speed
                        else
                                maintain car speed and current roadway
        end if
        if( autonomous driving ) yes
                spend time and energy requirement is less
                else
                        spend time and energy requirement is more
        end if
        end for
```

The data security and privacy access within a secured infrastructure. Robotics computes the offloading tasks of the fog server. When replicating the image, a robot gets the data from the local server with sensor output storage [1]. The fog-robotic enabled autonomous car mainly increases road safety and optimizes the traffic flow. Still, we want to translocate ourselves physically, so we need to spend more time and energy on transportation. But the safe robotic transportation system offers a luxurious life. Sometimes, humans cannot drive vehicles and are not good at driving. But the robotic transportation system has a speed limit, and it will never go above the speed limit. The autonomous system has already estimated the route, communicates with neighborhood cars, increases safety, and optimizes the throughput [33].

The GPS navigation software helps shorten current roadway transportation. The autonomous car is integrated with vehicle infrastructure to improve transportation route maps. The GPS, lidar, radar, and camera sensors are used to analyze the location, capture the 3D image around the vehicle, and detect the object to avoid a collision. Using a fog robotics transportation system, we can spend less time and energy on transport [24].

Edge devices and the raw data accessed by the sensor data, which needs to analyze the data processing, analysis, computing, and storage function, reduce the intelligent devices' cloud system and the amount of data sent to the cloud. The fogging is the concept of pre-processing the data deployed before the cloud. The main property of fogging is to reduce the cloud system's load. The component of the fog node controls the node of the fog. The F Nj receives the flow like TCCF, TCVF, VIF, and the traffic cloud. This manages the delivery traffic, the control flow for the specific vehicles, and the planned traffic condition.

The vehicle infrastructure integration initiates the application development and the research forecasting, which is directed connected to the roads. This improves road safety and makes the surroundings foremost. This allows flying the plane with the help of human intervention by using efficiency and safety. The various discipline includes electrical engineering, automotive engineering, transport engineering, and computer science engineering, which covers the transport on the roads that manages transport development.

In the past years, vehicle-infrastructure integration used the U.S dot attention focused on the DSRC technology. This wireless technology is designed for the mobile environment and mobile communication needs. It has the3 wide range of technology with a wireless network. This makes the weakness and the strength that supports the application of short-range communication to the WIFI technology. The bad critical situation is transportation system produces environmental factors. This manages the cellular and critical communications from the different wireless sensors from the signals and distributed systems. The WIFI can be used for connectivity latency, packet losses, and inadequate information. For cellular communication, the category such as the WiMAX and the 4G LTE are from the future generations, which cause the cellular services, the local transparency, and the elements in the infrastructure. Satellite communication is also used in remote access for the local transportation agency to implement the alternatives [8]. This causes the safety applications and the system management. The low bandwidth and the short-range service to support the application are done using the issues of the local agency of transportation. The elements of the infrastructure make the application support wireless technology.

4.3 Digital modeling and fabrication

Digital modeling and fabrication is the production process integrating 3D modeling and the CAD system manufactured by refining matching. The purpose of digital modeling is the successful design's physical model [40]. And the variety of the industries. Several methods for the digital models and solid objects are to make 3-D printing and laser culture options for the fabrications. This involves holding the autonomous car that does not break while the speed limit is low. This is done by fabricating the metal in the car mold. The coverage of the car is done by heating the melding at the temperature of the 50s. Various CAD software is used for 3D modeling and modeming, including the wireframe surface and the solid. Some of the machines popular for fabrication are Laser cutters, 3D printers, and CNC routers [6].

The data from all the traveler information systems and traffic management systems is collected and shore in the different servers for analysis and traffic control. In this Fig. 5, the vehicle sends the data to the satellite, and the distance of the vehicle-to-vehicle makes the formation of the system for the formation of the system functions and the vehicle cellular that manages the cellular service provider of the system for functions of storing the data that manages the data from one server to another server [15]. This communication process through the vehicles and the satellite vehicles connects the data in the roadside equipment communication. This communication manages all the data from the signal management system, the traveler information system, the telematics service provider, etc. Also, the data from the telematics is received by the traveler information system. That information is sent to the private sector to handle the car's details, speed, and capacity. This is then sent to the control room to identify any risk in the road traffic, such as the accident, over-speed, etc. Also, the distance between the front and the back car is calculated, and, in this process, the autonomous car has been worked [23].

4.4 Working principle of the digital modelling and fabrication framework

Design of Fog- robotics Transportation Systems connect to the Vehicle infrastructure integration in an autonomous driving car starts with the design of simple and most effective. The 3D cameras are used to take a 360º view of a surrounding. It gives the border image of a traffic condition around the vehicle, traffic signboards, signals, the distance between the vehicles, and so on. The 3D-radar sensors (radio detection and ranging) are used to detect the objection on the road by using a radio wave. In the car, the short-range radio wave is used for analyzing spot monitoring [29].

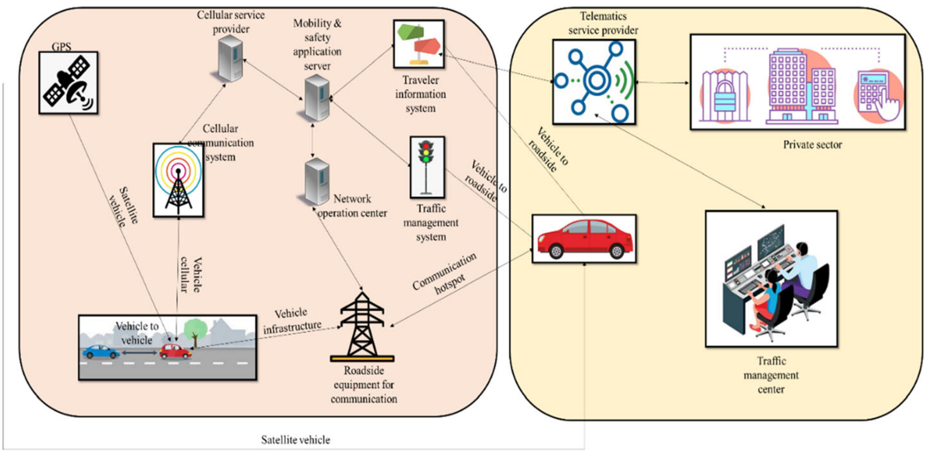

Fig. 5 Vehicle infrastructure integration

Similarly, the long-range radio wave is used to identify the objects. The 3D-lidar sensors (light detection and ranging) are also used to identify the objects and the distance between the vehicle and object by using a laser. These sensors are used to get real-time data of a surrounding, which is stored on the fog robot server using a wireless network. Vehicle Infrastructure Integration also provides the (V2I) vehicle-to-vehicle communication, and we can also share and get the data from other vehicles. If the robot wants any data, first it requests from the Fog Robot Server (FRS), then the server will give the surrounding real-time data. The fog robotics enhanced the data security and worked as a bridge between the cloud and robots. It is hard to hack and more secure. The complete process includes observing, recognizing, sharing, and responding based on the condition of the fog robot [14].

pseudocode for Working Principles of Digital Modeling and Fabrication Framework

// connect the "Fog- robotics Transportation Systems" and "Vehicle infrastructure integration."

```
enable sensors

calculate →speed of the car

V2road side communication

link→DSRC

collect→real-time data

store→ real-time data in FRS

enable for robot server

if robot requests data

        check query the FRS upon availability

        processing locally

        else

                cloud utilized

end if
```

4.5 Intelligent speed assistance and its functions

ISA intelligent speed assistance is a vehicle safety technique already available in several model cars in the EU. ISA uses sign recognition with a video camera and a GPS link to identify and analyze the current speed limit. To prevent exceeding the current speed limit, the overridden temporary switch is there to off the car. This system limits the power of the engine, which helps the driver from the current speed exceeding and improves road safety. Some benefits of the current technology's safety are managing the European Commission and other main positive impacts. Which tackles the emission of Co2; the total efficiency of the total death rate in a road accident is reduced in the USA and Europe. Some results show that 30% of severe cases and the death is by 20% reduced [17].

This autonomous vehicle did not break when the vehicle detected the speed limit was low. The ISA system will not apply the brake for the speed reduction. If the vehicle encounters a low-speed limit, it should display a warning for the driver. The driver has the responsibility to reduce the speed then. If the driver has not applied the brake, the case slows down for the new speed limit is reduced. This is equivalent to off the accelerator. If the vehicle's speed is incorrect, the speed sign recognition technique is rapidly improved [21]. Also, it should currently detect the speed limit and the information stored in the built-in communications. This type of car industry manages the driving functions in the carmaker and thus makes the ISA's rapid adoption for the development of the robust approach [42]. The ISA is not expensive; most technology is required for the standards of care anyway. This makes the mandatory of an emergency system for calling. The cost of the components in autonomous care is 186–249 European dollars [44] (Fig. 6)

In the diagram mentioned above, the car's speed limit is monitored by the autonomous care, which sends the signal to the satellite using cloud computing; the satellite controls the autonomous care to control the speed using the help of the GPs. This speed is controlled, and then the speed is checked if the speed limit equal to the speed in the speedometer is equal, it ends the process or reduces the speed of the car to the speed limit. This is the autonomous car speed controlling system [14].

The Intelligent Speed Assistance (ISA) system continuously monitors the speed of the car and the local speed limit on the highway. This ISA system is preprogrammed to alert the driver when the car's speed exceeds the speed limit. The ISA system uses a camera sensor to capture the 3D image of speed limit signs on the road. If it detects any speed limit sign, it compares with a car's speed. The intelligent speed assistance will warn the driver if the car's speed exceeds the speed limit [15]. Or it may automatically reduce the car speed. Otherwise, it repeats the process. It also keeps an eye on the car behind to avoid a collision. The intelligent speed assistance priorly has the lane info regarding each place. If the system detects any obstacle/object on the highway, so sends a warning to a driver; otherwise, it goes unnoticed [3].

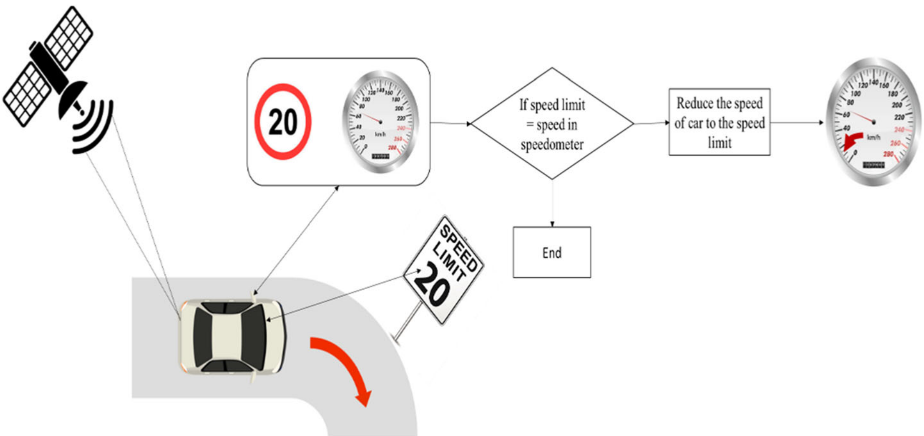

Fig. 6 Artificial Intelligence Enabled Intelligent speed assistance

pseudocode For Artificial Intelligence Enabled Intelligent Speed Assistance (ISA)

```
input; camera and speed sensor data
output; controlling the car based on the atmosphere.
for each vehicle
enable Intelligent Speed Assistance
observe ← car speed and speed limit
if (detects← speed-limit)
        compare (car speed= speed-limit sign)
        else if (car speed > speed-limit sign)
                ISA issue alert message→driver
                ISA reduces speed automatically
                else
                        observe the car's speed
end if
// detection of object
ISA has lane info
while the stop criterion is not met, do
        if (detect= objects)
                identify → object type
                track→ object
                estimate→object distance
                if (object= close to car)
                        ISA issue alert message→driver
                        else
                                continuously observe the 3D-image
                end if
                else
                        continuously observe the 3D-image
        end if
end while
end for
```

In the car or other vehicle, intelligent speed assistance is enabled as inbuilt. The system continuously observes the car speed and speed limit sign on the roadside meter. The system automatically takes an image of the speed limit if any roadside meter is founded. Then, it compares the taken image and car speed [7]. If the car speed exceeds the speed limit, the system automatically sends the warning as a voice message to the concerned driver. Otherwise, the system automatically reduces the speed of the car. Based on the atmosphere of a car, the system will automatically change the car's speed [4]. In the moving car, the system identifies and tracks the object type if the camera sensor takes an image of an obstacle or object. And then estimates the distance of an object from the vehicle. If the object is very close to the vehicle, the system will give the warning as a voice message to the concerned driver. Otherwise, it is unnoticed [17].

5 Result and analysis

An intelligent transportation system is an advanced application that aims to provide innovative services relating to different modes of transport and traffic management and enable users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks. An intelligent transport system is used to integrate communications and data processing technologies to improve people and goods' mobility. The proposed system focuses on fog- robotics Based Intelligent Transportation Systems, Line-of-Sight Direction for Path Adopting Self-directed Intelligent Transportation uses. Fog robotics can be defined as an architecture comprising storage, networking functions, and control with Fog computing closer to robots. The researcher can provide time, distance, speed, and proportion factors. The search result is approximately 65.43% efficient (Table 1).

$$L = \frac{(E_{BKR} - E_{ARR})v}{2S} - lead\ length \tag{4}$$

Table 1 Analysis of fog-robotics-based intelligent transportation system

E_{BKR}	E_{ARR}	Wave speed (v)	Rate of risk (s)	Lead length	Separation distance (m)	Time (sec)
0.45	1	3	2	3.5	5.15	0.78
0.89	4	7	5	8	62.42	1.23
1.33	7	11	8	12.5	26.98	1.68
1.77	10	15	11	17	65.97	2.13
2.21	13	19	14	21.5	56.57	2.58
2.65	16	23	17	26	35.93	3.03
3.09	19	27	20	30.5	43.2	3.48
3.53	22	31	23	35	19.56	3.93
3.97	25	35	26	39.5	56.15	4.38
4.41	28	39	29	44	84.1	4.83
4.85	31	43	32	48.5	39.7	5.28
5.29	34	47	35	53	67	5.73
5.73	37	51	38	57.5	58.1	6.18
6.17	40	55	41	62	35.3	6.63
6.61	43	59	44	66.5	47.7	7.08

The fog-robotics-based intelligent transportation system explanation is showing important. FR can make a better impact on robust human-robot interaction. For better understanding and calculation of results, we chose The fog-robotics-based intelligent transportation system. Based on the results, we can say that the Fog-Robotic system maintained a time of intelligent transportation even though the number of robots and FRS are increasing (Fig. 7).

This graph presents a review of state of the art in intelligent transport intelligent systems. This graph focuses on a wide field named Intelligent Transport Systems and discusses its wide applications, technologies, and usage in different areas. This graph comparison result is compared to traffic detection and road/lane detection. This approximate comparison result is 50% efficient (Table 2).

$$Speed = \frac{Distance}{Time} \tag{5}$$

Speed is equal to distance divided by time.

$$Energy\ cost = Power\ consumed * Energy\ price \tag{6}$$

Energy cost is equal to the power consumed multiplied by energy price.

Due to the fast growth of technology and communication systems, energy management intelligent transportation systems must be met with the highest quality and reliability. We aim to bring industrial researchers to explore new opportunities and speed up the transition into smart energy management techniques for the intelligent transportation system (Fig. 8).

Energy Management Intelligent Transportation Systems' result is compared to capacity, economic activity, and vehicle efficiency. This analysis's efficient result is 65%. A smart energy management system is a computer-based system designed to monitor, control, measure, and optimize energy consumption in a building, factory, or facility. Energy Management

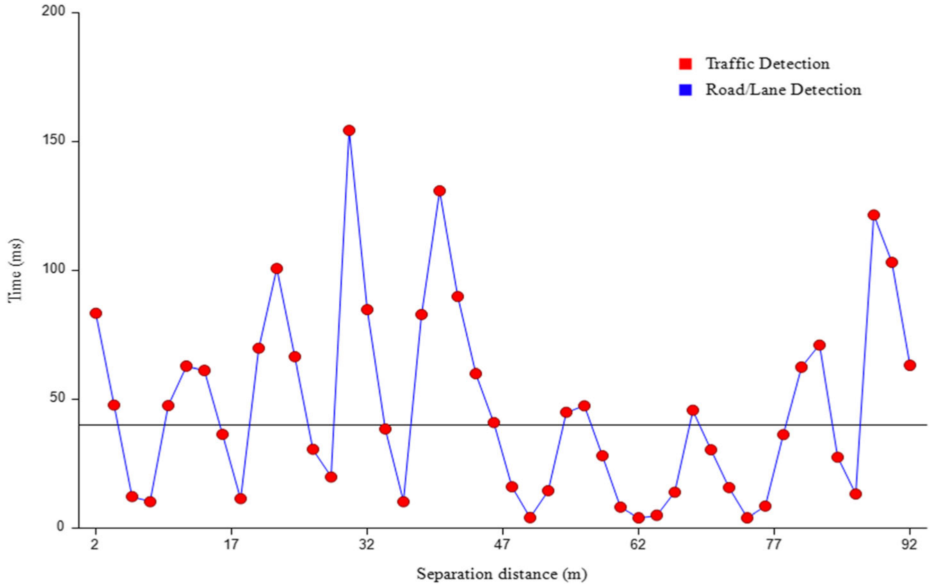

Fig. 7 Result analysis of robust human-robot interaction of Intelligent Transportation Systems

Table 2 Analysis of energy management intelligent transportation system based on speed and energy

Distance	Time (s)	Speed (m/sec)	Power consumed	Energy price	Energy cost (J/kg)
0.89	0.23	3.869565	1	0.2	0.2
1.56	0.78	2	3.67	0.45	1.65
2.23	1.33	1.676692	6.34	0.7	4.43
2.9	1.88	1.542553	9.01	0.95	8.55
3.57	2.43	1.469136	11.68	1.2	14.0
4.24	2.98	1.422819	14.35	1.45	20.80
4.91	3.53	1.390935	17.02	1.7	28.9
5.58	4.08	1.367647	19.69	1.95	38.39
6.25	4.63	1.349892	22.36	2.2	49.192
6.92	5.18	1.335907	25.03	2.45	61.3235
7.59	5.73	1.324607	27.7	2.7	74.79
8.26	6.28	1.315287	30.37	2.95	89.59
8.93	6.83	1.307467	33.04	3.2	65.7
9.6	7.38	1.300813	35.71	3.45	23.19
10.27	7.93	1.295082	38.38	3.7	65

Systems (EMS) are automation systems that collect energy measurement data from the field and make it available to users through graphics, online monitoring tools, and energy quality analyzers, thus enabling the management of energy resources (Table 3).

$$Speed = \frac{Distance}{Time} \tag{7}$$

Speed is equal to distance divided by time.

The measured or measurable period during which an action, process, or condition exists or continues. Speed is a scalar quantity that refers to how fast an object moves. Speed can be considered the rate at which an object covers distance (Fig. 9).

Speed over time of the two measurement vehicles, the approximate result is 56% efficient. Those observed on the vehicles' speedometers (90 km/h) during the measurement run (see

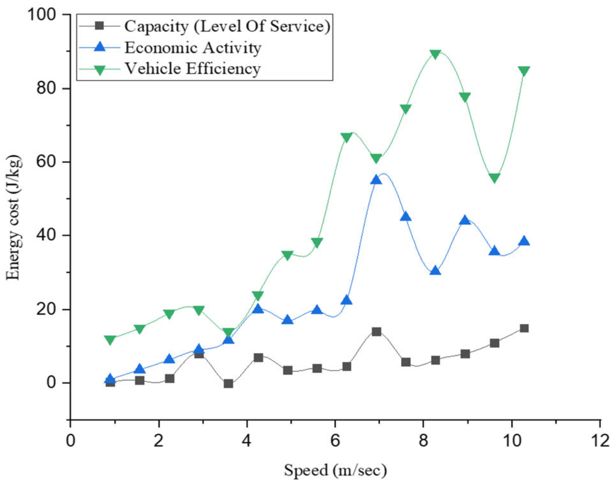

Fig. 8 Result analysis of energy management intelligent transportation systems

Table 3 Analysis of speed over time of the two measurement vehicles based on time and speed

Distance (KM)	Time (Sec)	Speed (t)
0.89	0.56	1.58
2.78	0.78	3.56
4.67	1	4.67
6.56	1.22	5.37
8.45	1.44	5.89
10.34	1.66	6.22
12.23	1.88	6.50
14.12	2.1	6.72
16.01	2.32	6.90
17.9	2.54	7.04
19.79	2.76	7.17
21.68	2.98	7.27
23.57	3.2	7.36
25.46	3.42	8.44
27.35	3.64	8.51

Fig. 3). The relative speed between the two vehicles, which is, in this case, the sum of the speeds of the individual vehicles, is approximately 180 km/h (Table 4).

Link-based travel time is the sum of the vehicle's travel time in the consecutive individual links that constitute the whole plan. Departure time is when a public conveyance is scheduled to depart from a given point of origin. Both types of travel time data are prepared as the input of the proposed predictive models (Fig. 10).

This graphical representation comparison result is predicted travel time and actual travel time. These times are based on typical conditions and during the incident. This analysis result is 46.2% efficient. Two types of link-based models are developed in the experiment. The travel time predicted by Link-based model I is calculated by adding the travel times predicted in all the successive links used to estimate the path travel times in different time intervals based on normal traffic conditions and during the incident (Table 5).

This table representation is based on departure time and travel time. Travel-time can be generally defined as the time to reach a destination or cross a link. Travel-time prediction refers to the prediction of current or future travel time. There are two ways to predict travel time, namely direct prediction methods and indirect prediction methods (Fig. 11).

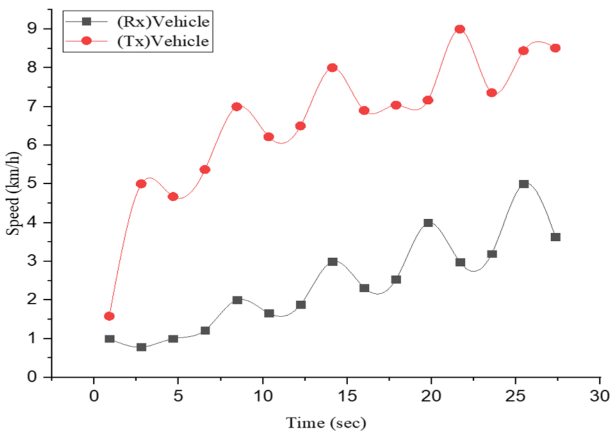

Fig. 9 Result analysis of speed over time of the two measurement vehicle

Table 4 Analysis of travel time prediction in both normal traffic conditions and during the incident

Departure time (mins)	Travel time (mins)	Departure time (mins)	Travel time (mins)
5.34	2.75	56.7	13.95
8.55	3.45	59.91	14.65
11.76	4.15	63.12	15.35
14.97	4.85	66.33	16.05
18.18	5.55	69.54	16.75
21.39	6.25	72.75	17.45
24.6	6.95	75.96	18.15
27.81	7.65	79.17	18.85
31.02	8.35	82.38	19.55
34.23	9.05	85.59	20.25
37.44	9.75	88.8	20.95
40.65	10.45	92.01	21.65
43.86	11.15	95.22	22.35
47.07	11.85	98.43	23.05
50.28	12.55	56.7	27.95

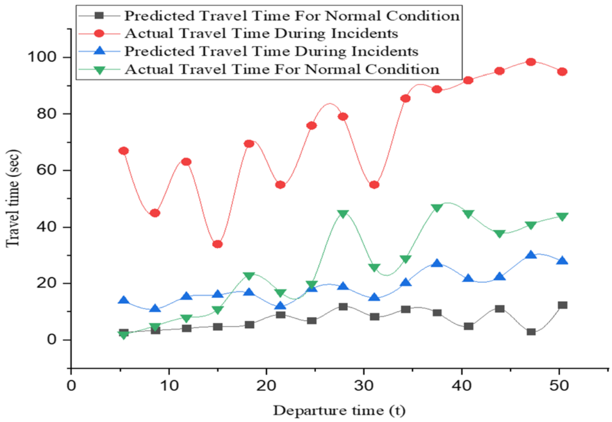

Fig. 10 Result analysis of travel time prediction in both normal traffic conditions and during the incident

Table 5 Analysis of the travel time prediction using an instantaneous prediction model

Departure time (mins)	Travel time (mins)	Departure time (mins)	Travel time (mins)
4.56	1.34	44.16	48.74
7.2	4.5	46.8	51.9
9.84	7.66	49.44	55.06
12.48	10.82	52.08	58.22
15.12	13.98	54.72	61.38
17.76	17.14	57.36	64.54
20.4	20.3	60	67.7
23.04	23.46	62.64	70.86
25.68	26.62	65.28	74.02
28.32	29.78	67.92	77.18
30.96	32.94	70.56	80.34
33.6	36.1	73.2	83.5
36.24	39.26	75.84	86.66
38.88	42.42	78.48	89.82
41.52	45.58	81.12	92.98

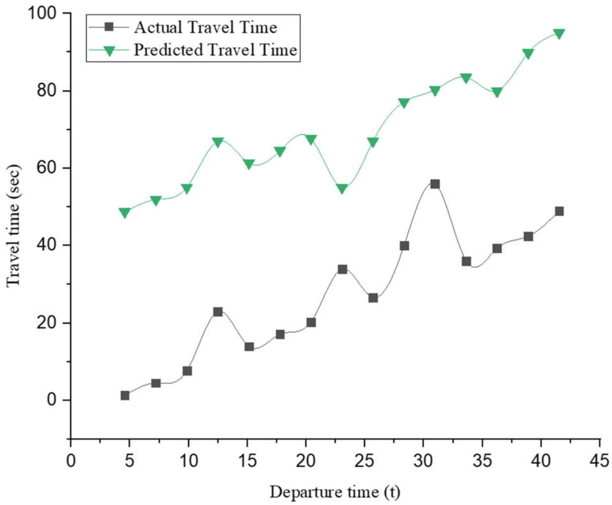

Fig. 11 Result analysis of travel time prediction using an instantaneous prediction model

The travel time prediction uses the instantaneous prediction model, and road users use different sources of information on the current state of the road network in their decision process. The efficiency of these decisions strongly depends on how accurate, reliable, and timely the available information is. The comparison result of the actual travel time approximate result is 50% efficient, and the predicted travel time approximate result is 85% efficient (Table 6).

Two ratios are said to be proportionate when the two ratios are equal. For example, the time taken by train to cover 25 km per half an hour is equal to the time taken to cover the distance of 250 km for 5 h. Such as 25 km/half an hr = 250 km/5hrs. distance is the extent or amount of space between two things, points, lines, etc (Fig. 12).

Intelligent Speed Assistance (ISA) systems can actively prevent drivers from exceeding the speed limit using road-sign recognition cameras and GPS-linked speed-limit databases. Intelligent Speed Assist is designed to aid your speed control, enabling you to concentrate on the

Table 6 Analysis of speed assistance artificial intelligence-enabled intelligent fog robotics system

Distance (M)	Time (mins)	Speed (t)	Proportion (%)
4.56	0.45	10.13	3.45
6.7	1.45	4.62	5.8
8.84	2.45	7.60	8.15
10.98	3.45	9.18	10.5
13.12	4.45	12.94	12.85
15.26	5.45	15.8	15.2
17.4	6.45	18.69	17.55
19.54	7.45	20.62	19.9
21.68	8.45	27.56	22.25
23.82	9.45	29.52	24.6
25.96	10.45	32.48	26.95
28.1	11.45	37.45	29.3
30.24	12.45	45.42	31.65
32.38	13.45	47.40	34
34.52	14.45	5.38	36.35

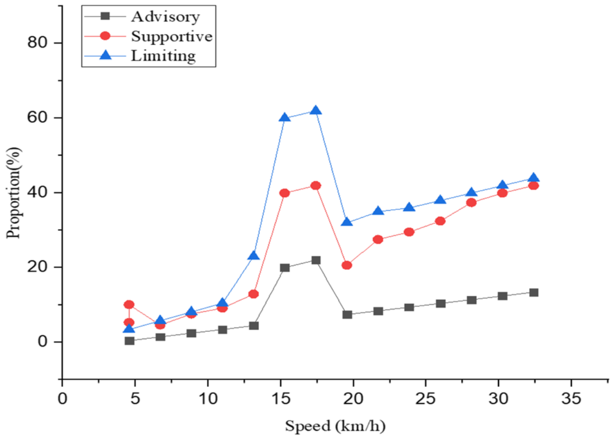

Fig. 12 Result analysis of intelligent speed assistance

road. The intelligent speed assistance graphical representation is based on speed and proportion. This graph representation comparison result is 19.9% efficient.

6 Conclusion

For considering the Intelligent Transportation System (ITS), the improvement of road safety, traffic management efficiency, and environmental preservation are generally handled by the Internet of Vehicles (IoV). To fuse on this, constrain the fog- robotics Based Intelligent Transportation Systems that integrate the Internet of Vehicles (IoV) are explained for Providing massive data from widely distant devices and controlling the network overhead against the Autonomous Driving and reduction of drain Energy Management. In addition, the general algorithm for Fog-robotics Transportation Systems gives the Fog-based Vehicle infrastructure integration. Research result helps with digital modeling, fabrication framework, and artificial intelligence-enabled intelligent speed assistance. Finally, the sensor activities as per the scanning of roadside meters for speed analysis are analyzed concerning traffic detection, road/lane detection, position/navigation system, vehicle detection, vehicle efficiency, economic activity, and capacity. The specified information's discussed in the fog- robotics-based intelligent transportation analysis contribution. This research uses a fog-robotics-based intelligent transportation system based on separation distance and time to deduce the underlying probability distribution features. This outcome is potentially 45% effective. By comparing speed and energy estimations, inferential statistical analysis may deduce characteristics of an energy management intelligent transportation system. The approximate efficiency of this analysis is 65%. These studies compare speed and time by evaluating some notion of speed over time of the two measurement vehicles using a sample and predicting the value or potential range of values of some characteristic of the speed and time based on a sample. The comparison's effectiveness is 56%. The researcher combines the text's predictions of travel times under normal traffic circumstances and during the incident with their background estimates to arrive at the 78% search analysis efficiency number. As part of the continuing data processing, the inference is based on The departure time level for the instantaneous prediction model is 4.56–81%, and the efficiency of enhanced accuracy trip time is 74%. They were estimating sophisticated speed aid powered by artificial intelligence. A 65% efficient association exists between the speed level of 10 to 45 km/h and the enhanced accuracy range.

Authors' contributions All author is contributed to the design and methodology of this study, the assessment of the outcomes and the writing of the manuscript.

Data availability No datasets were generated or analyzed during the current study.

Code availability Not applicable.

Declarations

Conflict of interest Authors do not have any conflicts.

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