International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

An Elaborative Study on Vehicle Speed Detection and Tracking

Apoorva Shah*[1], Dr. Betty P[2], Dr. Avani Vasant[3]

Submitted: 10/09/2022 **Accepted:** 20/12/2022

Abstract: Vehicle detection, speed tracking, and controlling are emerging fields where a lot of studies were carried out in the past decade. This paper presents a detailed survey of the various methodologies presented in the state of the art for vehicle tracking and speed controlling. The autonomous car has progressed in the advancement of the Internet of Things and Artificial Intelligence. Many times it happens that, though we have a good quality of cameras due to weather, the camera cannot detect the vehicle properly. The camera may face some problems like in day and night vision, sometimes in the rainy season, the vision cannot be clear. At this time the technology moves from Image Processing to Computer Vision. At the same time, IoT devices are useful to track the speed of the vehicle as well as control the speed of the vehicle. The comparative analysis of the various methods found in the literature using the image and video processing was discussed.

Keywords: *Computer Vision, IoT, Safety, Speed tracking*

1. Introduction

Safety is very important to reduce the occurrence of accidents at high speed. According to a recent survey, most accidents happen near school and hospital zones, and at sharp turns. This number has increased in the past few years. Therefore controlling the vehicle speed is a most essential issue. Several methods are discussed in this paper related to vehicle detection through image processing, digital image processing and computer vision. After detection of a vehicle, the next step is to measure its speed and further discussion is going on controlling vehicle speed using IoT devices. Traffic video and image analysis will be utilised for traffic observation, investigation and checking for traffic conditions in numerous urban areas and metropolitan territories[30].Object tracking aims to segment a Region of Interest (ROI) from a video scene sequence and keep tracking its motion and position[35]. Image processing system is good in free-flow traffic, but they face difficulties with congestion, shadows and lighting transformation [27]. To remove these, a new feature-based method and technology are developed known as Computer Vision. Many computer vision algorithms are using Morphological operations that apply a structuring element to an input image and create an output image of the same size [4].

2. Literature Survey

The authors [1] proposed a technique through which the vehicles are detected and classified based on their sizes. Firstly video camera recording is given to the preprocessing to detect the vehicle and classification of vehicle. The author used the Sobel edge detection algorithm to detect vehicle edges. Then the first level of binary dilation is done on horizontal, vertical and 45-degree vehicles. Then based on this, an algorithm will fill the binary holes. After that second level of binary dilation and Morphological binary operation is performed to classify the vehicles. An algorithm also uses threshold values, filtering algorithms and edge detection algorithms for vehicle detection; vehicles are classified by their length.

[2] The authors have proposed an algorithm for vehicle counter classification. Here in the proposed algorithm, video frames are given as input to the algorithm. These video frames will be broken into frames as images, firstly the images are converted into grayscale images and then it passes for the image enhancement. For edge detection, an author used the Canny operator. Motion analysis is fetched by a combination of backward image and forward image differencing method. And then it passes to the Sobel edge detector. Detection zone definition generates a pane of ⅓ of height and ⅔ of width. The Kalman filter can optimally estimate the current position of each vehicle and also predict the location of the vehicle in future video frames by minimizing noise. After this, an algorithm counts the number of vehicles coming and leaving the region. This can be useful for traffic flow counting for moving vehicles.

With the help of CCTV cameras, it is possible to detect the speed of a vehicle. In [9] the authors presented an algorithm that counts the number of vehicles along with the speed of the vehicle. At the very first step, the input video is converted into various small frames, and then applied threshold and morphological operations. Detection of objects is done using the connected component method. Temporal differencing optical flow algorithms and

[1]*Assistant Professor, CSE Department, KPGU, Vadodara, Gujarat - 391240, INDIA*
[2] *Assistant Professor, CSE Department, KPGU, Vadodara, Gujarat - 391240, INDIA*
[3] *Professor and Head, CSE Department, KPGU, Vadodara, Gujarat - 391240, INDIA*
* *Corresponding Author Email: apoorva1227@email.com*

background subtraction methods are used for the detection of moving vehicles. Feature extraction based on background subtraction is done with various techniques like extracted images, region of interest, threshold on converting grayscale images into binary images and morphological operations to remove noise. Mahalanobis distance algorithm is used for object matching. Finally, a speed teaching algorithm is applied.

Satellite images are having small sizes of vehicles, due to this detection of vehicles sometimes gives ambiguous results. In [11] the authors presented a new technique to detect the vehicle from satellite images. With the help of the Geographical Information System (GIS), accurate road information is available. In the proposed model, firstly using satellite images and GIS information ROI (Region of interest) can be detected. I.e. length and bounded width, repetitive patterns and sometimes replica is also detected to correspond to vehicle dimensions. Based on these parameters, a filtering algorithm is applied and a vehicle queue is detected. After that, a line extraction algorithm is applied for the extraction and filtering of an image. Using the combined least square adjustment method a car can be determined.

Vehicle detection using high-resolution satellite images is a challenging task. Here [3] authors proposed an algorithm to detect a vehicle from satellite images. For this, firstly the satellite image is read in Matlab to detect a vehicle. Then RGB to Grayscale and Grayscale to Binary conversion is done, to apply necessary operations on binary images. The Canny edge detection algorithm is used for image segmentation based on their edges. Finally, image enhancement is done with the help of filtration and cropping in some areas. Also, Clob analysis is used to detect the vehicles.

In[32], authors have proposed a tracking algorithm for adaptive background subtraction from window deleting tracking moving objects. The authors used a median filter to achieve a background image from the video, also compared the median filter with the mean filter and proved the median filter has a better effect since it reduces impulse noise. In the last step, they use an adaptive background subtraction algorithm to detect and track moving objects.

In [28], the authors proposed a new technique for vehicle speed estimation. In the proposed technique, a stationary camera will collect the traffic videos. The cameras are marked based on geographical equations in this technique, the image sequence is 12 frames/second. First, is the mean filter method for background generation for background extraction. Then, an algorithm which takes advantage of two-color-based characteristics and combines them for object extraction is used.

By using only color features or by using only texture features of an image, a suitable background model cannot be achieved. To remove this disadvantage [34] authors proposed a new algorithm named Gaussian pyramid layered algorithm. The Gaussian pyramid layered algorithm is a combination of the codebook algorithm and local binary patterns algorithm (LBP). In the first step, noise generated by camera shaking is eliminated by an image pyramid. After this, the codebook model is constructed on the low-level and LBP model is constructed on the high level of the Gaussian pyramid. At last, a set of operations are performed according to the spatial relations of pixels. The main purpose of developing this algorithm is to detect the moving vehicle on camera shaking.

Object detection is one of the primary tasks in computer vision which consists of determining the location of the image where certain objects are present, as well as classifying those objects. In 2015, the YOLO (You Only Look Once) algorithm was born with a new approach, reframing object detection as a regression problem and performing in a single neural network. That made the object detection field explode and obtained much more remarkable achievements than just a decade ago. So far, combining with many of the most innovative ideas coming out of the computer vision research community, YOLO has been upgraded to five versions and assessed as one of the outstanding object detection algorithms.

An author presents a new approach as "You Only Look Once". Here authors frame object detection as a regression problem to spatially separated bounding boxes and associated class probabilities. In one evaluation a single neural network predicts bounding boxes and class probabilities directly from full images. This model can be directly trained on full images [5].

Authors detected YOLOv2 as "YOLO9000", which detects 9000 different objects [6]

The Authors presented an incremental approach to YOLO named "YOLOv3". Here authors trained a new network. This network is a little bigger than its previous version, but this gives more accurate detection [7].

To improve a Convolution Neural Network accuracy, [8] authors added new improvements as a new method for data augmentation Mosaic and self–adversarial training, selected optimal hyper-parameters while applying genetic algorithms and cross mini-batch normalization. Authors give a name as YOLOv4.

In [10], an author proposed a new technique for vehicle detection and tracking vehicles. Here, the image resizing is done based on the input frame. An improved YOLO detection algorithm is used for vehicle detection (iYOLO-proposed in this paper). Multi-object Spatial Association rule is applied for priority ordered output. Based on this tracking information is fetched. iYOLO algorithm is designed on parameters reduction, combined vehicle class and concentrating two level features. The next algorithm is known as Double layer long short term memory refiner (dLSTM) as proposed in this paper. In this, the multi-object association rule is applied and an adaptive missed detection counting threshold method is applied to improve its performance.

To detect any moving vehicle, starting reference point and ending reference point are required. In [12], the authors presented a new method for vehicle speed detection. An algorithm starts with detecting a moving object as a vehicle where a video image sequence is applied as input, from this an image is fetched. These images are converted into binary images, and then background subtraction and foreground modelling methods are applied to get the clear image in binary format. Speed is estimated using the difference between the previous image frame and the new image frame based on their location. The authors give the name the Shrinking algorithm.

In [33], here authors present a system that achieves vehicle detection by using a background image subtraction algorithm based on blocks followed by a deep learning data validation algorithm. The purpose is to segment the image into equal size blocks and to model the static reference background image by calculating the variance between each block pixel and each part block pixel in the adjacent frame. The proposed system has four background modelling based on the blocks method. The first method is an absolute difference, the second method on image entropy, the third method on XOR function and the fourth on discrete cosine transform (DCT). Among these four, based on experiment results, authors proved that the DCT method has the highest vehicle detection accuracy.

In [13], the authors used monocular cameras used for vehicle speed detection. These cameras have wider coverage compared to two-camera systems. In the proposed model, from the video sequences, RBG images and optical flow images are found. Due to the symmetry between time and space domains, a new spatial-temporal convolutional block is created as (2+1)D Convolution. The author is claiming that by using this technique, this model is not requiring manual intervention.

In [14], the author introduces the processing of automatic vehicle detection and recognition using a static image dataset. Here, the model uses a surveillance CCTV camera system that includes detection of moving vehicles, counting the number of vehicles and verification of their permit with the organization. The video is given as input, from which a license plate is detected through frame extraction, edge detection, corner detection, rectangle detection and range of rectangle. Preprocessing step includes, applying sharpness, histogram equalization technique, smoothing the rectangle of plate number and applying a threshold value. Text is recognized with the help of the division of the number plate into horizontal segments and recognition of the number plate from the segments of the number plate. Authentication can be done with the comparison of number plate data and database entries along with some basic database operations.

In[23], the authors have proposed a moving vehicle congestion detection in OpenCV. Here they used the adaptive threshold method, Gaussian-based background subtraction with tracking methods such as block tracking and virtual detector. The proposed system can identify, track the congestion and count the object. They used Otsu's algorithm in which adaptive threshold will be done for background modelling. Also given a feature as a false alarm due to shadow, so that shadow elimination was done, to get the clear object.

In [16], the authors proposed a prototype for a vehicle speed monitoring system using accelerometer-based wireless sensors. The speeding sensors detect the vehicle details like vehicle number, speed detail, time and send data to the analysis station. Based on the data received, warning messages are sent to their vehicles. On the other hand vehicle Ad-hoc network (VANET) systems like nearby vehicles through wireless networks. The proposed model is also capable of generating e-reports for simulated speed vehicles. The main aim of the proposed system is to avoid accidents and to alert the drivers about the speed limits for safe travelling.

In [25], the author proposed a new technique as a fast mean shift-based target tracking system for partial conclusion and changes in object appearance.

In[35], the authors have proposed an algorithm for tracking a single moving object. In the first phase, the moving object is detected using simple background subtraction. In the next phase, the system will track the detected object using a modified mean shift method (proposed) and Kalman filter. The author compared both the object tracking algorithms: the modified mean shift method and the Kalman filter and proved that the Kalman filter generates a good output with respect to time.

In [22], the authors proposed a new technique for face tracking. The Continuous Adaptive mean SHIFT also called CamShift, this algorithm shows unstable tracking when there exist objects with a similar color to that of a face in the background. The improved CamShift algorithm uses Kinect's pixel-by-pixel depth information and the sin detection method to extract candidate skin regions in HSV color space. Also, the authors are saying that the proposed improved Camshift is better than the Tracking learning detection algorithm in terms of processing speed.

Sometimes, the camera is shaking due to the vibration of the running vehicle, due to rough roads and tracking a vehicle is a little tough. So [24] have proposed a new algorithm to improve this. They proposed an improved particle filter-based vehicle tracking algorithm via a histogram of oriented gradient features. To match the corresponding, fast retina keypoint algorithm and to remove outliers M-estimator sample consensus algorithm is used. Finally, the image is extracted by affine transformation matrix calculated from the retained inliner. After this, a proposed algorithm is applied for vehicle tracking.

We often find complex scenes on the road consisting of trees, buildings and others, so conventional optical flow methods can not accurately detect the boundary of a moving vehicle. Here in[26], the authors proposed a new technique for these challenges. In the newly proposed technique, firstly a moving vehicle is detected by the optical flow method and then uses a shadow detection algorithm based on the HSV color space algorithm to make the shadow position. After this, threshold segmentation and then later combines the region-labelling algorithm to realize the shadow removal and accurately detect the moving vehicle. The author also introduces improved affinity calculation and mutation function of antibodies to make particle algorithms.

In [29], the authors proposed an algorithm as "the Kalman filter " which aims to predict the speed of a vehicle with respect to the data from a recorded video. An input video is given firstly to the OpenCV, which converts in grayscale and applies the Canny algorithm for preprocessing phase. Object detection is done based on the adaptive foundation subtraction procedure. A DBSCAN: Density-based spatial social affair of organization and with tumult, is used for clustering and noise. This DBSCAN is used to recognize each article in a gathering of the vehicles and also uses flexible heaps of pixels for perceiving the speed from vertical adjustment.

In [30], the authors aim to build an automatic alert system that can accurately localize and track the speed of any vehicle that appears in aerial video frames, using an automated speed detection camera system (SDCD) that alerts the concerned when a vehicle crosses the speed limit. These cameras also recognize the number plate of a vehicle, checking the database of the owner of that vehicle the message is sent to them.

In [31], the authors proposed an algorithm for moving car detection and recognition techniques based on artificial intelligence. To enhance the high-frequency information of the image, the point operation is adopted.

In [15], the author presented a model, using Arduino programming speed control is proposed. Arduino is programmed in such a way that the prescribed speed limit is incorporated in the transmitter unit, which transmits the signals. These signals are received by receivers in the vehicle using Zigbee wireless communication technology. The speed of the vehicle was automatically controlled by the input signals by the receiver, with the help of an encoder sensor.

Here [17], the authors proposed a technique for accident prevention in hilly areas. In their proposed system, they use a transmitter antenna that is placed on a critical region. When any vehicle passes through this speed-limited region, that time the vehicle receives this frequency: the frequency of speed and the speed of the vehicle is automatically fixed to a particular speed in that region. The objective of this model is to save fuel energy and provide control of vehicles to drivers. This model uses interfaces such as the Radio Frequency (RF) with the help of an encoder, decoder and the Integrated Circuit (IC) that sense hazard field and distance. According to the distance, it generates the PWM pulse that controls the speed of the vehicle and displays it on the LCD screen. The model can also sense the obstacles and gives intimation to the driver.

In [18], the authors proposed a technique, where an automatic speed controlling framework is fabricated utilizing the microcontroller-based foundation of the Arduino Uno board. The signals are transmitted by the transmission unit and it was received by the collector in the vehicle utilizing Zigbee remote correspondence and the speed of the vehicle is consequently constrained by the beat width balance or DC engine controlling fuel handle. In the proposed model, the first system will send a message to the driver to slow down the speed, if the speed is higher than that prescribed speed in the particular area and the driver doesn't reduce speed then, in a few seconds the system will take over control automatically and reduce the speed of the vehicle.

Here [19], the authors proposed a model that controls a vehicle's speed using an IoT device. RFID tags are kept at the beginning and end of a restricted region. When a vehicle passes through a restricted area like a school or college, the RF receiver in the vehicle will send a signal to the microcontroller. Through the transmitter, the RF receiver will receive the speed of the vehicle and compare the speed with available data. If the speed is above the specified speed, it controls the vehicle's speed automatically. In this model, using slotted couplers the speed of the vehicle is monitored and using the PWM technique the speed of the vehicle can be maintained.

In [20], the authors have proposed a new technique for the speed control system. Often sign boards are available on the roadside for speed control. Using image processing concepts, these sign boards are scanned and using a microcontroller speed is checked. If the speed is above the signboard, an alert message is passed to the driver. If the driver still does not control the vehicle, then the vehicle automatically controls and speed is reduced to the threshold speed limit on the speed label. Also, one notification is passed to the traffic authority about over-speed driving with vehicle information.

In [21], authors have proposed a new approach for automatic speed controlling of cars. In this approach, the authors used the traffic signal automated system by using light-sensitive sensors. Here, the authors developed a system, where the traffic signal lights (red, green, yellow) are embedded on the streets and cars would have light detecting sensors. These sensors are kept at the bottom of the car, which will differentially detect the colors of lights omitted and accordingly signal the car is the-accelerated. For any emergency purpose, manual speed control is also provided.

In [37], the authors present a new stereo vision-based model for multi-object detection and tracking in surveillance systems. Monocular camera-based systems have some drawbacks like illumination variation, shadow interference, and object occlusion. Here, a sparse set of feature points are identified in the camera coordinate system and then projected to the 2D ground plane in each frame. According to their height values and locations on the plane, a kernel-based clustering algorithm is proposed to group the projected points. By producing clusters, the orientation of objects, the number of objects and the position of an object through the surveillance scene can be determined for online multi-object detection and tracking. Experiments have been done on both indoor and outdoor applications with complex scenes to show the advantages of the proposed system.

In[36], the authors present a vehicle detection and counting technique as a Haar feature. The Haar feature was previously developed for face detection. This feature is a machine learning technique that uses positive and negative datasets as a training phase, and this extracts features from these images

3. Conclusion

As per the literature, various methods were used for vehicle detection, speed tracking and controlling near schools, hospital zones and sharp turns to prevent accidents. The traffic video and image analysis were used for resolving the various traffic and accident related issues.

Recent studies says that, the image processing system is modified to computer vision to overcome the problem of congestion of traffic, shadows and lighting transformations. Researchers have presented various techniques for resolving the above problem.

Hence, it is utmost mandatory to detect vehicle, its number plate, speed, driver's license number, so that over speeding person can be penalised. Few studies were also reported recently towards the hidden cameras on toll road and crucial points to find out over speeding drivers. In over populated country like India, It is very important to take suitable measure to regulate the traffic and prevent the chance of creating the accidents.

4. References and Footnotes

4.1. References

[1] Priya k. And Jayanthi rajee R.B. "Length based vehicle classification using digital image processing", international journal of advanced information science and technology, Vol:4, Nov 4, April 2015.

[2] Raha Justin, Dr. Ravindra kumar "vehicle detection and counting based on digital image processing in Python" International journal of electrical electronics and computer science engineering, 2018.

[3] Noor Preet Kaur Gill, Anand Sharma "Vehicle detection from satellite images in digital image processing" International journal of computational intelligence research, Volume 13, November 5, 2017

[4] K.Sreedhar and B.Panlal "ENHANCEMENT OF IMAGES USING MORPHOLOGICAL TRANSFORMATIONS" International Journal of Computer Science & Information Technology (IJCSIT) Vol 4, No 1, Feb 2012

[5] Joseph Redmon , Santosh Divvala, Ross Girshick , Ali Farhadi ``You Only Look Once: Unified, Real-Time Object Detection" ' in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR), June. 2016, pp. 779–788.

[6] J. Redmon and A. Farhadi, ''YOLO9000: Better, faster, stronger,'' 2017, arXiv:1612.08242. [Online]. Available: https://arxiv.org/abs/1612.08242

[7] J. Redmon and A. Farhadi, ''YOLOV3: An incremental improvement,'' 2018, in Proceedings of Computer vision and pattern recognition arXiv:1804.02767.

[8] Alexey Bochkovskiy, Chien-Yao Wang, Hong-Yuan Mark Liao, "YOLOv4: Optimal Speed and Accuracy of Object Detection", arXiv:2004.10934, 23rd April, 2020.

[9] Tume-Bruce, B. A. A. ., A. . Delgado, and E. L. . Huamaní. "Implementation of a Web System for the Improvement in Sales and in the Application of Digital Marketing in the Company Selcom". International Journal on Recent and Innovation Trends in Computing and Communication, vol. 10, no. 5, May 2022, pp. 48-59, doi:10.17762/ijritcc.v10i5.5553.

[10] Mohit Chandorkar, Shivam Pednekar, Dr. Schin Bojewar "Vehicle detection and speed tracking", International journal of engineering and technology, volume 10, issue 5, May - 2021.

[11] Wei - Jong Uang, Wan 0 Ju Lioe, Shao Fu Chen, Jar Ferr Yang, Pau Choo Chung, Songan Mao "Improved vehicle detection systems with double layer LSTM modules", EURASIP journal on advances in Signal Processing, 2022.

[12] Jens Leitolff, Uwe Stilla "Automatic vehicle detection in satellite images", Research gate Article 2006.

[13] Bhagyashri Makwana, Prof. Praveshkumar Goel "Moving vehicle detection and speed measurement in video sequence", International journal of engineering research and technology, volume 2, issue 10, 2013.

[14] Huanan Dong, Ming Wen and Zhouwang Yang, "Vehicle speed estimation based on 3D ConvNets and non - local blocks", an article on future internet, May 2019.

[15] Sriashika Addala, "research paper on vehicle detection and recognition", Article on Research gate, may 2020.

[16] Satishkumar Saminathan, Navean G V , Hari Prakash R , Vishnu Praveen "Automatic vehicle speed control system in a restricted area ", International journal of scientific and technology research, February 2020.

[17] P. Sai Chaitanya, V. Vikram, B. Kalesh. "Automatic vehicle speed control system using wireless fidelity", International journal of advanced electrical and electronics engineering, volume 3, issue 4, 2014.

[18] Dr. Pikesh Bansal, Abhinav Srivastava, Aadil Zaya, Bhuvnesh Sharma, Anuj Upadhyay, "Design and Fabrication of Automatic Speed Controller for Automobile", International Journal of Trend in Scientific Research and Development, Volume: 3 Issue: 4, May-Jun 2019.

[19] Spoorthi Rakesh , Raju. D , Suresh. K. S , AdarshAngadi , RonitMalaja, "Automatic Speed Control of Vehicle ", a research article on IJESC, volume 10, issue 5, may 2020.

[20] Prof. Narendra Babu, Varshitha K, Ranjitha S R, Thejaswini M, Vani R, "Vehicle speed control using IoT in restricted areas", International research journal of engineering and technology, volume 7, issue 8, Aug 2020.

[21] Ashok Reddy K, Bharath K P, Sakshi Patel, Rajesh Kumar M, "Embedded vehicle speed control and over-speed violation alert using IoT", Innovations in power and advanced computing technology, 2019.

[22] Gupta, D. J. . (2022). A Study on Various Cloud Computing Technologies, Implementation Process, Categories and Application Use in Organisation. International Journal on Future Revolution in Computer Science &Amp; Communication Engineering, 8(1), 09–12. https://doi.org/10.17762/ijfrcsce.v8i1.2064

[23] Surinder Singh Arora, Pritha Roy, "Automated Speed Control of Vehicles Integrated with Traffic Control System", International Journal of Recent Technology and Engineering, Volume-8, Issue-1S4, June 2019.

[24] JH. Lee, HJ. Jung, and J. Yoo, "A real-time face tracking algorithm using improved CamShift with depth information," Journal of Electrical Engineering & Technology, vol. 12, no. 5, pp. 2067–2078, 2017.

[25] Sowmya Kini M, Rekha Bhandarkar and Praveen Shenoy, "Real time moving vehicle congestion detection and tracking using open CV", Turkish journal of computer and mathematics education, volume 12, no10, 2021

[26] XF. Kong, Q. Chen, GH. Gu, K. Ren, WX. Qian, and ZW. Liu, "Particle filter-based vehicle tracking via HOG features after image stabilisation in intelligent drive system," IET Intelligent Transport Systems, vol. 13, no. 6, pp. 942–949, 2018

[27] Sehirli, E., & Alesmaeil, A. (2022). Detecting Face-Touch Hand Moves Using Smartwatch Inertial Sensors and Convolutional Neural Networks. International Journal of Intelligent Systems and Applications in Engineering, 10(1), 122–128. https://doi.org/10.18201/ijisae.2022.275

[28] J. Sun, "A fast MEANSHIFT algorithm-based target tracking system," Sensors, vol. 12, no. 6, pp. 8218–8235, 2012

[29] Wei Sun, Min Sun, Xiaorui Zhang and Mian Li, "Moving Vehicle Detection and Tracking Based on Optical Flow Method and Immune Particle Filter under Complex Transportation Environments", Research Article on WILEY, Hindawi ,2020.

[30] Benjamin Coifmana, David Beymer, Philip McLauchlan , Jitendra Malik, "A real-time computer vision system for vehicle tracking and traffic surveillance", transportation research part C6 , 1998, page no 271-288.

[31] Ararsh Gholami Rad, Abbas Dehghani and Mohamed Rehan Karim, "Vehicle speed detection in video image sequences using CVS method", international journal of the physical science, volume 5, December 2010, page no: 2555-2563.

[32] Md Mubeen Khan, K Sarinivas, Kavitha J, " Vehicle speed detection using Python", international research journal of engineering and technology, volume 7, issue 5, May 2020.

[33] Aditya Singh, Bhavya Pandey, Devanshish Dana, Harsh Vikram Singh, Sandhya N, "Implementing real time vehicle speed estimation technique", International Journal of Advance Research and Innovative Ideas in Education, volume 7, issue 4, 2021, Page no: 247-250.

[34] Zengfang Shi, Meizhou Liu, "Moving vehicle detection and recognition technology on artificial intelligence", International journal of circuits, systems and signal processing, volume 16,2022, page no: 399-405

[35] Ruolin Zhang, Jian Ding "Object Tracking and Detecting Based on Adaptive Background Subtraction", Procedia Engineering 29(2012), page no 1351-1355.
[36] Mohamed Shehata, Reda Abo-Al-Ez, Farid Zaghlool, and Mohamed Taha, "Vehicles Detection Based on Background Modelling" International Journal of Engineering Trends and Technology (IJETT) - Volume 66 Number 2 - December 2018, page no 92 - 95.
[37] Xu, Xm., Zhou, Lc., Mo, Q. et al. "Vehicle detection algorithm based on codebook and local binary patterns algorithms". Springer Article, Journal of Central South University 22, 593–600 (2015).
[38] N. A. Libre. (2021). A Discussion Platform for Enhancing Students Interaction in the Online Education. Journal of Online Engineering Education, 12(2), 07–12. Retrieved from http://onlineengineeringeducation.com/index.php/joee/article/view/49
[39] Nikita Rawat, Rohit Raja "Moving Vehicle Detection and Tracking Using Modified Mean Shift Method and Kalman Filter and Research",International Journal of New Technology and Research (IJNTR), Volume-2, Issue-5, May 2016 Pages 96-100.
[40] S. Choudhury, S. P. Chattopadhyay and T. K. Hazra, "Vehicle detection and counting using haar feature-based classifier," 2017 8th Annual Industrial Automation and Electromechanical Engineering Conference (IEMECON), 2017, pp. 106-109.
[41] L. Cai, L. He, Y. Xu, Y. Zhao, and X. Yang. Multi-object detection and tracking by stereo vision. Pattern Recogn., 43(12):4028–4041, Dec. 2010.

Conflicts of interest

We are declaring there is no conflicts of interest.