IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 11, November 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.542

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911038 |

A Comprehensive Review on Automatic Vehicle Detection and Tracking Systems

Shiva Thakur[1], Vivek Kumar Sinha[2]

M.Tech Student, Dept. of CSE, Raipur Institute of Technology, Raipur, Chhattisgarh, India[1]

Assistant Professor, Dept. of CSE, Raipur Institute of Technology, Raipur, Chhattisgarh, India[2]

ABSTRACT: Digital webcam has lately been widely deployed throughout transportation monitoring operations that efficiently give vital road traffic monitoring datasets. Incorporating sophisticated technologies, such as computerized images, advanced webcams, higher-end processing capability, including automated image assessment, complements the use of webcams for vehicle monitoring. The recognition of automobile makers as well as models seems to have become important for automobile recognition on metropolitan roadways to ensure traffic protection as well as reliability. Automobile identification plays an important role across a variety of monitoring cameras uses; however, object recognition entails some well-proven methodologies that this article delves into in-depth. This paper provides a comprehensive review of automatic vehicle detection and tracking systems. Visible as well as infrared webcams, which have been widely utilized when detecting settings, occurrences, movements, including individuals, have some of the very common kinds of equipment for vehicle monitoring equipment. Attempts to autonomously evaluate picture or video footage via security cams were also made across several research involving background-foreground separation as well as objects identification categorization. There has already been done a multifarious investigation on automatic vehicle detection and tracking systems as well as methods but still, there are vital opportunities for future work in this arena to explore more novel methods and systems that automatically detect the vehicle's movement over the roads in the desired manner.

KEYWORDS: Automobile Identification, Camera, Highway, Tracking Systems, Vehicle Detection.

I. INTRODUCTION

Automobile identification is indeed the initial stage during video-rooted ITS (Intelligent Transportation System) assessment, because it's crucial for detecting vehicles, monitoring, as well as better analytics. Motion-rooted, as well as appearance-rooted approaches, are two diverse subcategories of investigation in this domain. Motion-rooted approaches use enhances performance to distinguish between passing automobiles and the surroundings. Appearance-rooted approaches separate automobiles from the adjacent environment scene by using visual characteristics like coloring, geometry, as well as smoothness. Automobile identification, as well as acceleration monitoring, is critical aspects of infrastructure development [1], [2]. Vision-rooted traffic surveillance systems have gotten a lot of interest throughout recent years. Automobile identification, as well as velocity surveillance, may be used to accomplish this. The surveillance device provides data such as transportation volume, road congestion, as well as automobile velocity. Velocity has become the primary cause of traffic fatalities. It's indeed possible to establish if the automobile is traveling beyond the prescribed limits by selecting images via the camera as well as measuring the velocity among two spots. Automobile identification again from a backdrop may be accomplished using a variety of methods. Initially, radar systems have been utilized for similar purposes, even though they had several drawbacks. As a result, new ways for determining the speed of automobiles utilizing picture analysis have indeed been introduced to alleviate existing approaches [3], [4].

Overcrowding mostly on roads seems to be a serious issue all around the globe. The method incorporates cameras footage as some of the most cost-effective methods of vehicle tracking. Scholars had already experimented with several images preprocessing approaches. Occlusions, as well as changeable lighting situations, are issues with previous approaches. The latest researches about Indian highways also show that existing picture recognition technologies had a median inaccuracy of 55.00 percent when counting vehicles. To accurately detect traffic on the roads, the new system considers combined day as well as night circumstances. Automobile categorization, traffic volume, automobile counting, number plate identification, as well as occurrence identification, are also available. It integrates several current techniques such as backdrop removal, Kalman filter, including, traffic headlights identification, as well as number plate identification. The suggested approach uses 2-line algorithms as well as automotive categorization

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911038 |

utilizing one Kalman filter during the day as well as headlight rooted identification during night time to aid for automobiles recognition [5], [6]. Figure 1 illustrates the block diagram that shows the three main stages of the ITS.

Figure 1: Illustrates the Block diagram that shows the three main stages of the ITS.

A. *Motion Segmentation:*

The goal behind motion categorization, a fundamental stage within computer vision applications, seems to be to break down footage into a succession of rolling entities including backgrounds. Decomposition is the most critical stage in image processing techniques. It has been used through a variety of areas, including spectroscopy, surveillance footage, examination, as well as automation. Various research has brought attention to the issue of segments, however, the results are not noticeable sufficient for humans. Background removal, as well as optical flow, is two types of motion separation [7].

Background removal has been used to identify floating objects throughout films requiring previous information until the early 1990s. It's mostly used during camera monitoring since it's necessary to identify individuals, pets, including automobiles before additional advanced operations like incursion recognition, monitoring, including individual counts can be carried out. Approaches for backdrop removal may be classified into three further categories i.e. parametric as well as non-parametric including predictive [8].

The pixels evolution of pictures is often used throughout non-parametric backdrop simulation approaches to construct stochastic interpretations of experiences. KDE (Kernel density estimation), as well as the codebook prototypical, include the background extractor among instances of such a method. Background modeling becomes critical during surveillance footage, even though it is generally hard to implement across complex circumstances. Lighting variations, as well as shifting backdrops, provide challenges [9].

The KDE is indeed a nonparametric approach for approximation density approximation wherein the defined density function is being used as an average among observed pieces of information, resulting in liquid estimates. Now a day, the AKDE (Adaptive non-parametric kernel density estimation) is offered as a new approach towards backdrop simulation. The difficulty of finding subject areas in movies containing semi-stationary backgrounds gets solved using this approach, which identifies a unique base-line model [10].

By replacing variables of probability algorithms utilizing component patterns, pixels brightness, as well as area experiences, the Colebrook approach discusses a set of constantly managed code names to depict backdrop images. Segmentation of texture data is being used to determine the background area. The coding scheme additionally models color indications again from the backdrop, which can be used to enhance texture-based identification outcomes generated via color as well as texture attributes [11]. Figure 2 illustrates the classifications of the motion segmentation techniques.

Visual backdrop extractor (VBE) seems to be another reliable approach for extracting backdrops having minimal computing investment as well as higher accuracy. The new use of randomized strategy throughout this technique would be to pick parameters on how to construct sample-rooted backdrop estimate. Research offered a technique that uses a global specimen background removal set of rules to save a range of the amounts for all the pixels that were obtained prior [12].

The intensity of the pixels (that is pixels colors) has been described using the probability distribution function along with the defined vector form using parametric approaches. Whenever one singular Gaussian distribution has been employed for backdrop modeling, this Gaussian distribution seems to be a common approach to identifying mean as well as variance as variables that predicts variables using periodic average or periodic nonlinear filtration. Most approaches, on the other hand, were inapplicable to complicated vibrant scenarios not in which the coloring dispersion of backdrop pixels varies substantially [13].

Every collection containing N frames is totaled as well as subdivided with the number of frames using classic average approaches. The modeling can then be removed across the following frames, which seems to be a common procedure employed in previous investigations. Yet another research demonstrated the reliability of 95.00% but couldn't even function using shadow impacts, whereas further research demonstrated the reliability of 97.00 percent but seemed to have a similar issue [14].

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911038 |

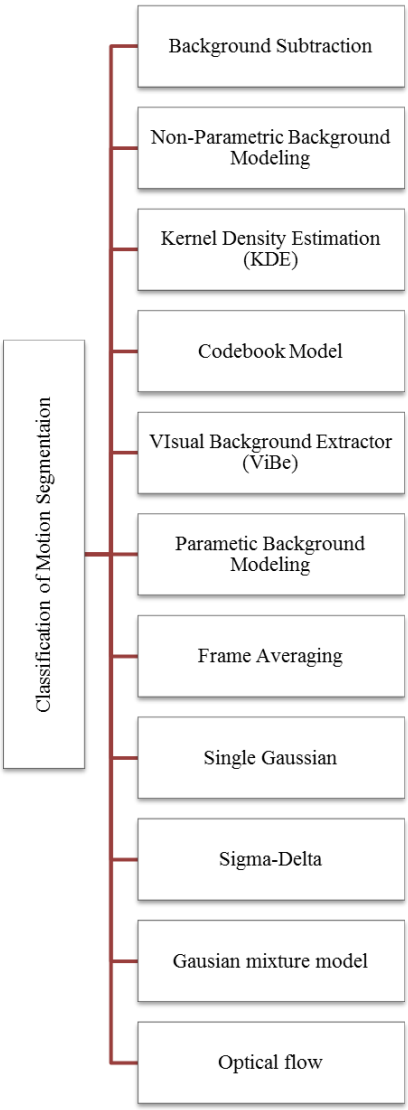

Figure 2: Illustrates the classifications of the motion segmentation techniques.

In several iterations, a temporally singular Gaussian was employed to represent the backdrop, improving efficiency while minimizing memory usage. Foreground separation was done using one Gaussian backdrop simulation, with each separated foreground profile being accompanied by something like an input vector depending on the estimated profile values. Another adaptable noise removal approach, wherein every backdrop image is treated as just an independent Gaussian process having median, may easily locate the number of pixels that are parts of a dynamical item [15].

Sigma-delta backdrop estimate, originally demonstrated through the A. Manzanera, compares simple increases as well as declines. Accuracy of up to 95.00 percent has indeed been attained utilizing the suggested strategy, with just 45.00 percent of erroneous alerts. Additional research through S. Toral found that the upgraded approach improved stability via preferentially recalibrating speckle noise to identify large slow automobiles [16].

GMM (Gaussian mixture model) is another temporal modeling that uses online updating to simulate two or maybe higher Gaussians. GMM has been used for backdrop removal inside one investigation, although erroneous categorization resulted from excessively noisy pictures. This approach further improved using HF (hole filling) set of rules, which resulted within 97.90%. This approach further improved using HF (hole filling) set of rules, which resulted within 97.90%. Utilizing a similar strategy, further investigations comprised an accuracy of 94.0 percent as well as 98.24 percent (72.22 percent under rush hour traffic situations) [17].

Optical flow analyzes pixels movement to identify movement, whether it be in a cluster or separately. The notion called optical flow was inspired because of how humans detect item movement through recording as well as evaluating gradients, intensity, reflectivity, as well as other factors. To recognize dynamically areas in the footage, the approach

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911038 |

has been developed by, who had used flow vectors properties for moving objects throughout the duration. The immediate particle velocity on an imaging area refers to specific 3D objects [18].

B. *Appearance Based Techniques:*

Unlike motion segments approaches, which can only identify movement, appearance-rooted techniques use characteristics to recognize static items in the pictures. Pre-requisite datasets have still been required when using visual data which includes colors, patterns, as well as geometry for automobile recognition. As a result, extracted features are being utilized to analyze 2-D as well as real-time 3-D pictures [19].

For the evaluation of the visual look of cars, feature-rooted methodologies use coded explanations for the elements. Vehicle tracking has made use of a variety of characteristics, particularly regional symmetries boundary processors. Because this approach is susceptible to changes throughout size as well as light, it necessitates the use of more spatially similar edge-rooted scatter plots than previously required. Subsequently, characteristics have grown into more complex traits that allow for automobile orientation as well as categorization [20].

Haar-like characteristics describe the overall grey-level diversity of nearby areas by forming a summation as well as differences of squares for an enhanced picture. Several filters are employed to gather the characteristics, and they may be placed and resized appropriately. Filter outcome is calculated by summing the intensities of the pixels for something like the black as well as whitening regions individually, then averaging the gap among the pair [21].

The SIFT method was devised by David G. Lowe to turn pictures within the large numbers of locally extracted features. Picture motion, magnification, as well as rotations, were all identical, except for small changes in lighting as well as 3D representation. The authors of this investigation's primary constraint were indeed the requirement for different perspectives of something like the 3D framework for portrayal; however, a little real research has been accomplished utilizing the simplified SIFT characteristic in [22].

The SURF seems to be scaling as well as control scheme keypoints detection as well as a classifier with a drastically lower computing cost than SIFT owing to the use of boxes of filtration rather than one Gaussian filter, which has a little influence on productivity. To localize all locations of concern, this approach uses simple Hessian matrix estimation on just an integrated picture, including the partial derivatives characterizing native deformations [23].

The HOG method has been originally designed to identify people, even though it was subsequently modified to include cars by utilizing a 3-D modeling interface rather than a 2-D matrix of cells to construct 3-D binary images gradients. It generates a picture intensity directed distribution, which is a combined display of gradients as well as boundary characteristics. This approach must watch the detector's keyframes, especially for partly obscured items, as evidenced by investigations showing levels of accuracy of 93.10 percent, 94.50 percent, 94.44 percent, and 97.24 percent [24], [25]. Figure 3 illustrates the classification of the appearance-based techniques.

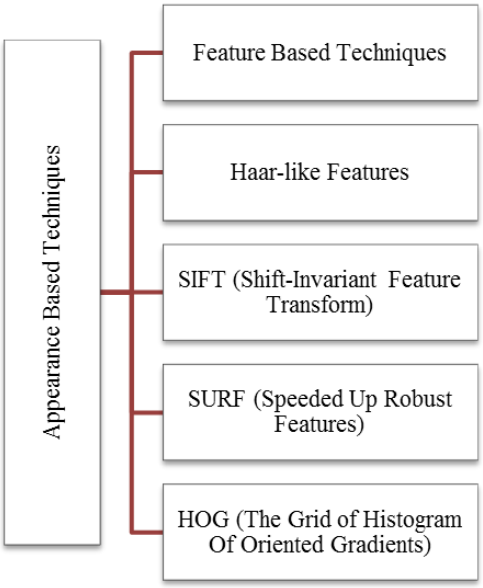

Figure 3: Illustrates the classification of the appearance-based techniques.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911038 |

II. RELATED WORK

J. Han et al carried research on automatic vehicle identification methods in their study. The invention of strategies enabling numerous object recognition as well as surveillance inside the context of sensors technology, as well as their implementation to automated navigating as well as obstacle detection technologies for the USV, seems to be the focus of current research. Several vision instruments including sonar, lidar, as well as multifarious cameras including the microphones have indeed been placed somewhat on USV architecture to enable adaptive cruise control capabilities, among automated ship identification methods were implemented towards the different detectors. In some kind of detector monitoring filtering, the comparative positions among both the USV as well as surrounding elements are used to calculate the movement of the targeted items. To provide continuous as well as dependable object monitoring capability, the projected movement data via the different monitoring filtration systems are pooled in some kind of a fundamental composite sensor. The aggregated tracking output is utilized as impediment datasets for autonomous vessel collision mitigation because suitable conflict-avoidant coping actions are devised as well as conducted in compliance with worldwide laws enabling avoiding fatalities at marine. The developing methods of something like automobile architecture as well as automated navigation techniques have been documented throughout this article, as well as the outcomes of experimental studies [26].

V. Mandal et al. carried another research on automatic vehicles surveillance systems for road safety during higher moving traffic. A coverage of videos-rooted automobile counting systems has been greatly expanded because of fast advances with deep learning as well as higher-execution computers. The researchers present whole research use several cutting-edge entity identifications as well as surveillance methods to identify as well as monitor various types of cars in specific study areas. The purpose of properly recognizing as well as monitoring automobiles throughout particular ROI would be to get precise automobile information. To identify the optimum automobile identification architecture, many configurations of objects recognition methods and various surveillance methods are being used. Throughout its computation-intensive development as well as reinforcement loops, the system effectively solves issues related to diverse meteorological scenarios, diffraction, including lower-light environments, as well as effectively extracting automobile data including paths [27].

H. J. Kim et al. carried another research on automatic vehicle detection in the nighttime in their work. Considering a midnight context, the research paper presents an automobile identification as well as an acceleration measuring system that estimates a car's movement through recognizing its headlamp attributes. Researchers describe a highway monitoring technology with something like a backdrop separation as well as an automated disappearing moment in time identification technique for automobile identification as well as surveillance at midnight. Researchers demonstrate that somehow a separate webcam successfully computes as well as identifies a boundary over the daylight in some kind of an adequate as well as efficient manner. This has been utilized in the midnight pretreatment of an unmanned vehicle monitoring platform. The findings of the investigation indicate robust automobile surveillance is achievable especially at midnight. Initial testing findings show that the suggested technologies for all of this nocturnal automobile monitoring technology are feasible and successful. Researchers show that a solitary video with either an integrated picture computing device would detect, identify, as well as identify many cars across several directions at midnight just as well as throughout the morning [28].

A. Crouzil et al. carried a study for automatic vehicle counting in their research in a pragmatic manner. The purpose of this paper would provide another vision-based method for tracking as well as classifying highway vehicles. Sometimes in tough conditions including complex backgrounds and/or constant existence of shadowing, the technology is capable to start counting extremely high reliability. The system's premise would be to utilize webcams that have previously been put in roadway infrastructures without its need for further new certification. Researchers present a strong classification technique for detecting running automobile images in the surroundings. To begin, the method uses the adapted Gaussian distribution to describe individual pixels of the backdrop. Such paradigm is combined with something like a movement detecting approach that enables traveling automobiles to be accurately located in space-time. Due to the overall obvious structure of something like the experiments, which include maximum hours as well as a variety of automobile categories, there are more occlusions amongst vehicles especially among autos as well as tractors. A technique for detecting strong occlusions focused on the concept of stability has been developed as well as validated. Additionally, the approach presented in the current paper seems competent in handling elevated shadowing. The technique in concern has been evaluated as well as contrasted to a traditional technique. Experiments using 4 major samples indicate that our system really can identify as well as categorize cars instantaneously with something like a remarkable degree of accuracy (>98.00%) in a variety of ambient circumstances, outperforming traditional capacitive looped sensors [29].

M. S. Srikanth et al. carried a research on the automatic vehicle surveillance system to solve the traffic congestion problem on the roads. Currently, automobile surveillance has become a time-consuming task that necessitates the preservation of records or its remembering of dates needed servicing on some kind of regular basis. Another issue is

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911038 |

tracking the car's position to provide greater protection as well as safeguard precautions when traveling. It necessitates additional individual work including both circumstances. Our suggested approach makes utilization of cutting-edge technology such as the Internet of Things, cloud technology, as well as advanced analytics. IoT enables numerous components to interact as well as gather information such as miles traveled, lubricating levels, tire problems, smoking generation, as well as other machinery requirements, as well as tracking automobile movement using the GPS (Global Positioning System). An ultrasonic detector, as well as LDR detector datasets, would be captured as well as saved within the cloud storing system. This suggested prototypical has been trained utilizing machine learning method as well as sampling datasets received in real-time car services platforms for service assessment utilizes GPS information for automobile surveillance. Furthermore, using this developed algorithm predicts the car's performance and recommends the following servicing schedule. It'll also assist one in reducing the amount of administrative labor necessary to forecast the automobile servicing schedule. This system is competent in delivering an optimal output through using already supplied facts as well as analysis techniques. Furthermore, the acquired information has been kept somewhere on the internet as well as utilized to anticipate forthcoming maintenance dates, while many essential operations, such as vehicle maintenance dates including GPS position information, have always been delivered to the client as well as service operator via an Android mobile app enabling simplicity of usage [30].

III. DISCUSSION

The majority of research mainly focused on highways as well as metropolitan routes, including backdrop removal as well as feature-rooted algorithms, particularly SIFTS as well as SURF, including the HOG, being the highly prevalent methods throughout contemporary times. Notwithstanding all of the various strategies, several problems have had a detrimental influence on modern platforms. Webcam viewpoint, as well as operational conditions, is two instances of similar issues, both of that impose extra constraints. ITSs encounter a variety of challenges, particularly in metropolitan congestion scenarios including junctions, where high congestion, automobile occlusion, as well as sensor location all, impact the equipment's effectiveness. Such difficult difficulties, particularly the situation of metropolitan highways, still demand further study as well as improvement. In recent decades, research has concentrated on methods to recognize automobiles in complicated settings, as well as whether to identify cars in the presence of occlusion items or even in dim illumination. To attain high reliability, investigators attempted to employ large automobile databases.

IV. CONCLUSION

Automobile identification, as well as monitoring apps, is useful in commercial as well as armed forces situations including road traffic monitoring, administration, especially metropolitan transportation management. Traffic surveillance processes on the highway are being utilized for automobile monitoring, counting, mean speeds of specific vehicles, transportation analytics, including automobile categorization, and could be employed in some kind of a variety of situations. Multiple automobile identification algorithms on video-rooted road observation as well as tracking devices were given throughout this article. Automobile identification algorithms are divided into 2 categories: motion-rooted as well as appearance-rooted. With different computing difficulties as well as detecting reliability, various strategies may be used to extract automobiles from the camera image. This paper provides a comprehensive review of automatic vehicle detection and tracking systems and respective existing technologies in a pragmatic manner. Considering the explanations of several current approaches, it is clear that the majority of them reached great degrees of precision. Nevertheless, the majority of detecting technologies have always had certain flaws that seem to have a detrimental influence on reliability. Bad visibility, climate fluctuations, shadowing, as well as reflections are all examples of such constraints. Several investigators should concentrate on identifying automobiles underneath occlusion including recognizing the forward as well as the back perspective of the automobile amid bad lighting circumstances whilst eliminating the shadows again from images as a potential avenue for additional study towards this issue of object tracking. There have also done several studies on automatic vehicle detection and tracking during recent years, but still, there is a pragmatic need for further research to resolve the existing traffic congestion issues over the roads to avoid the chances of any causality more pragmatically as demanded in the modern world.

REFERENCES

[1] X. Luo *et al.*, “Fast automatic vehicle detection in UAV images using convolutional neural networks,” *Remote Sens.*, 2020, doi: 10.3390/rs12121994.

[2] X. Gao, J. Szep, P. Satam, S. Hariri, S. Ram, and J. J. Rodriguez, “Spatiooral Processing for Automatic Vehicle Detection in Wide-Area Aerial Video,” *IEEE Access*, 2020, doi: 10.1109/ACCESS.2020.3033466.

[3] M. Najm and Y. H. Ali, “Automatic vehicles detection, classification and counting techniques / survey,” *Iraqi*

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911038 |

J. Sci., 2020, doi: 10.24996/ijs.2020.61.7.30.

[4] S. I. T. Joseph, S. Velliangiri, and C. S. C. Devadass, "Investigation of deep learning methodologies in intelligent green transportation system," *J. Green Eng.*, 2020.

[5] J. Wu, H. Xu, J. Zheng, and J. Zhao, "Automatic vehicle detection with roadside LiDAR data under rainy and snowy conditions," *IEEE Intell. Transp. Syst. Mag.*, 2021, doi: 10.1109/MITS.2019.2926362.

[6] R. Radhakrishnan, L. A. Nellisserry, O. Muralikrishnan, R. Thambi, and M. Parvathy, "Automatic vehicle accident detection and rescue system," *Mater. Today Proc.*, 2021, doi: 10.1016/j.matpr.2020.12.1141.

[7] P. C. Gosal, A. C. P, A. B. R, M. K. K M, and M. T M, "Intelligent Automatic Vehicle Accident Detection and Prevention System," *Int. J. Eng. Res. Appl.*, 2017, doi: 10.9790/9622-0707023741.

[8] J. Xu, J. Zhang, K. Zhang, T. Liu, D. Wang, and X. Wang, "An APF-ACO algorithm for automatic defect detection on vehicle paint," *Multimed. Tools Appl.*, 2020, doi: 10.1007/s11042-020-09245-2.

[9] L. Kodwani, "Automatic Vehicle Detection, Tracking and Recognition of License Plate in Real Time Videos," *Master Thesis*, 2013.

[10] S. Hamsa, A. Panthakkan, S. Al Mansoori, and H. Alahamed, "Automatic Vehicle Detection from Aerial Images using Cascaded Support Vector Machine and Gaussian Mixture Model," 2019, doi: 10.1109/CSPIS.2018.8642716.

[11] P. M. Ferreira, G. Marques, P. M. Jorge, A. J. Abrantes, and A. Amador, "Automatic vehicle detection and classification," 2008, doi: 10.1109/ITSC.2008.4732682.

[12] H. Tao and X. Lu, "Automatic smoky vehicle detection from traffic surveillance video based on vehicle rear detection and multi-feature fusion," *IET Intell. Transp. Syst.*, 2019, doi: 10.1049/iet-its.2018.5039.

[13] H. Jang, I. Won, and D. Jeong, "Automatic Vehicle Detection and Counting Algorithm," *Int. J. Comput. Sci. Netw. Secur.*, 2014.

[14] G. L. Corneto *et al.*, "A New Method for Automatic Vehicle License Plate Detection," *IEEE Lat. Am. Trans.*, 2017, doi: 10.1109/TLA.2017.7827890.

[15] J. Zhang *et al.*, "An improved MobileNet-SSD algorithm for automatic defect detection on vehicle body paint," *Multimed. Tools Appl.*, 2020, doi: 10.1007/s11042-020-09152-6.

[16] D. Tian, C. Zhang, X. Duan, and X. Wang, "An Automatic Car Accident Detection Method Based on Cooperative Vehicle Infrastructure Systems," *IEEE Access*, 2019, doi: 10.1109/ACCESS.2019.2939532.

[17] B. Peng, X. Cai, J. Tang, J. Xie, and Y. Zhang, "Automatic vehicle detection with UAV videos based on modified Faster R-CNN," *Dongnan Daxue Xuebao (Ziran Kexue Ban)/Journal Southeast Univ. (Natural Sci. Ed.*, 2019, doi: 10.3969/j.issn.1001-0505.2019.06.025.

[18] A. Gomaa, M. M. Abdelwahab, M. Abo-Zahhad, T. Minematsu, and R. I. Taniguchi, "Robust vehicle detection and counting algorithm employing a convolution neural network and optical flow," *Sensors (Switzerland)*, 2019, doi: 10.3390/s19204588.

[19] N. Sulaiman, S. N. H. M. Jalani, M. Mustafa, and K. Hawari, "Development of automatic vehicle plate detection system," 2013, doi: 10.1109/ICSEngT.2013.6650157.

[20] C. PRABHA, R. SUNITHA, and R. ANITHA, "Automatic Vehicle Accident Detection and Messaging System Using GSM and GPS Modem," *Int. J. Adv. Res. Electr. Electron. Instrum. Eng.*, 2014, doi: 10.15662/ijareeie.2014.0307062.

[21] K. M. A. Yousef, B. J. Mohd, Y. A. A. H. Al-Khalaileh, A. H. Al-Hmeadat, and B. I. El-Ziq, "Automatic license plate detection and recognition for jordanian vehicles," *Adv. Sci. Technol. Eng. Syst.*, 2020, doi: 10.25046/aj050684.

[22] S. Stephen Raj and P. Sripriya, "Automatic vehicle detection using GPS and challenges in image processing," *Int. J. Civ. Eng. Technol.*, 2017.

[23] M. S. Sheikh, J. Liang, and W. Wang, "An Improved Automatic Traffic Incident Detection Technique Using a Vehicle to Infrastructure Communication," *J. Adv. Transp.*, 2020, doi: 10.1155/2020/9139074.

[24] A. Tourani, A. Shahbahrami, S. Soroori, S. Khazaee, and C. Y. Suen, "A robust deep learning approach for automatic Iranian vehicle license plate detection and recognition for surveillance systems," *IEEE Access*, 2020, doi: 10.1109/ACCESS.2020.3035992.

[25] Y. Zhang, D. Zhu, P. Wang, G. Zhang, and H. Leung, "Vision-Based Vehicle Detection for VideoSAR Surveillance Using Low-Rank plus Sparse Three-Term Decomposition," *IEEE Trans. Veh. Technol.*, 2020, doi: 10.1109/TVT.2020.2978263.

[26] J. Han, Y. Cho, J. Kim, J. Kim, N. sun Son, and S. Y. Kim, "Autonomous collision detection and avoidance for ARAGON USV: Development and field tests," *J. F. Robot.*, 2020, doi: 10.1002/rob.21935.

[27] V. Mandal and Y. Adu-Gyamfi, "Object Detection and Tracking Algorithms for Vehicle Counting: A Comparative Analysis," *J. Big Data Anal. Transp.*, 2020, doi: 10.1007/s42421-020-00025-w.

[28] H. J. Kim, "Vehicle detection and speed estimation for automated traffic surveillance systems at nighttime,"

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911038 |

Teh. Vjesn., 2019, doi: 10.17559/TV-20170827091448.

[29] A. Crouzil, L. Khoudour, P. Valiere, and D. N. Truong Cong, "Automatic vehicle counting system for traffic monitoring," *J. Electron. Imaging*, 2016, doi: 10.1117/1.jei.25.5.051207.

[30] M. S. Srikanth, T. G. K. Kumar, and V. Sharma, "Automatic vehicle service monitoring and tracking system using iot and machine learning," *Lect. Notes Data Eng. Commun. Technol.*, 2021, doi: 10.1007/978-981-16-0965-7_72.

BIOGRAPHY

Shiva Thakur is currently pursuing her M.Tech degree in Computer Science and Engineering from Raipur Institute Of Technology affiliated to Chhattisgarh Swami Vivekanand Technical University, Bhilai, Chhattisgarh, India. She has completed Bachelor Of Engineering (B.E.) in Computer Science and Engineering from M.M.College Of Technology affiliated to Chhattisgarh Swami Vivekanand Technical University, Bhilai, Chhattisgarh,India in 2016. Her research interest fields are Networking, Image Processing, Deep Learning and Data Mining.

Vivek Kumar Sinhais currently working as an Assistant Professor in the Computer Science and Engineering Department at Raipur Institute of Technology, affiliated to Chhattisgarh Swami Vivekanand Technical University, Bhilai, Chhattisgarh, India. He is having 14 years of experience in teaching. He is currently Research Scholar at Lovely Professional University Phagwara, Jalandhar, Punjab, India.

INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 7.542

doi cross ref

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

9940 572 462 6381 907 438 ijircce@gmail.com

www.ijircce.com

Scan to save the contact details