A Semi-automated Method for Monitoring of Roads With Traffic From High Resolution Satellite Image

*** Srishti Jaiswal**
**** Aparna S. Bhaskar**

Abstract

Efficient traffic management is critical in today's overcrowded urban environments. Thanks to modern satellite imagery, high resolution images of current traffic conditions at regular intervals are easily available. In order to be able to respond to changes in traffic conditions quickly, it is critical to have an efficient and accurate system for traffic analysis of the static imagery available from these high resolution satellites. Two sub-problems are involved : detection of roads and detection of vehicles. A variety of algorithms are already available for solving these problems individually. For road tracking, we have median filers, color box segmentation, morphological processing, etc. There are algorithms like Bayesian background transformation, Blob extraction, and other vision based algorithms for vehicle detection. The goal of this paper is to automate tracking of roads and vehicles together from high resolution satellite images at any time statically, that is, without motion detection and leaving areas which are not roads like parking lot, settlements etc. Doing so, key points can be formalized in urban planning like finding other routes, human health factors, construction in endangered areas etc. By achieving the targeted objective and comparison with different algorithms, many problem statements can be defined and can be worked upon towards developing a solution.

Keywords : **Detection, high resolution satellite images, roads, traffic management, vehicles, tracking**

I. INTRODUCTION

To automate traffic monitoring from high resolution satellite image and aerial photograph, an algorithm can be developed for efficient traffic monitoring and analysis. This will reduce time consumed in monitoring of vehicles which are on roads. By monitoring traffic, many long-term objectives in urbanization can be achieved. The focus of this paper is traffic on roads in high resolution satellite image to determine the traffic condition or pattern by leaving parking lots and other areas which are not roads [1]. Here, in this paper tracking of roads was done through pattern recognition or pattern matching algorithm which gave the flexibility to recognize roads using vision based algorithm [2], that is, if vehicles are in some regular pattern which forms a rectangular pattern, then those areas are parking lots. Irregular pattern of vehicles that don't form a rectangular pattern and are not positioned together are part of roads. To monitor traffic and leave areas which are not part of roads like parking lot and which have similarity with roads like grey coloured rooftop of settlements are left or removed by sub-setting or masking data using GIS software. While performing detection of vehicles on roads, there is a possibility that some vehicles are not in motion and stand still but those are on roads and this makes them part of the traffic. The main goal is to develop an algorithm for offline traffic marking analysis which is going to be based on remote sensing techniques and there are mainly three algorithms which are Median filter algorithm, Blob extraction algorithm, and Vision based algorithm. Counting blobs or vehicles on roads can be used for traffic marking analysis by identifying choked points. It can be used for road-network continuation and security in

Manuscript Received : October 11, 2020 ; Revised : March 12, 2021 ; Accepted : March 14, 2021. Date of Publication : June 5, 2021.
* *S. Jaiswal* was Student at Department of Civil Engineering, SRM Institute of Science and Technology, Kattankulathur, Kanchipuram, Tamil Nadu - 603 203.
Email : jsrishti395@gmail.com ; ORCID iD : https://orcid.org/0000-0002-1623-3736
** *A. S. Bhaskar* is Associate Professor with Department of Civil Engineering, SRM Institute of Science and Technology, Kanchipuram, Tamil Nadu - 603 203.
Email: aparnavettu@gmail.com ; ORCD iD : https://orcid.org/0000-0001-9959-9970

DOI : https://doi.org/10.17010/ijce/2021/v4i1/160806

urbanization. These three algorithms are described as follows :

➩ **Median Filter Algorithm :** The algorithm removes salt & pepper noise from the image. It gives a filtered image and preserves edges in the image. This enhances the image and removes unwanted pixels from the image.

➩ **Blob Extraction Algorithm :** Blob extraction algorithm extracts the blob from images like vehicles from the image. This works on the principle of connected component analysis. The goal is to extract blobs or vehicles from the images or de-noising images for target detection.

➩ **Vision Based Algorithm :** Vision based algorithm detects vehicles from images and helps in forming bounding regions around vehicles which count the number of vehicles or blobs.

II. BACKGROUND

Transportation and goods play a vital role in everyday life. Traffic monitoring with an automation method in satellite image helps us to identify important information about day to day traffic planning in urbanization. Many researchers have proposed vehicle detection using different methods, traffic density measurement in aerial video, and lane detection system using filters. Here we are going to describe methods through which many objectives have been achieved by researchers in roads monitoring, traffic monitoring, and vehicle detection in videos and images. Algorithms for roads and traffic analysis are available like roads monitoring by applying median filter in an image for lane detection system to minimize frequency of road accidents [3]. Noise reduction was done in roads by using median filter, wiener filter, and hybrid median filter in different light conditions [4]. Edge detection too has contributed a part in lane detection system and finding road backgrounds in different scenes. A system was presented to detect cars in low resolution aerial images along road directions by posing cars as 3D object recognition problem and deciding boundaries for its recognition by psychological tests. The information is represented in Bayesian network which is used to integrate all features [5]. Blobs are dark colored objects on light colored background or the opposite, i.e. light colored objects on dark colored background [6]. Color thresholder app allows us to segment color images by thresholding the color channels based on different color spaces [7]. The gradient of a function is a vector function which represents changes in the steepest ascent [8]. High resolution satellite imagery is processed into accurate traffic parameters by conducting field tests to determine flow rates from aerial photos and various image processing approaches like background subtraction using reflectance values were used on scanned aerial imagery to simulate satellite imagery [9]. Some road detection was done for detection and tracking of vehicles by segmentation of blobs in a neural network classifier and it produced real time operations [10]. Blobs detection was done for identification of signs in roads through support vector machines, color segmentation and classification of shapes for identifying different shapes to work nicely in tough situations [11]. Traffic parameters were extracted for different behaviors under implicit and explicit occlusions of vehicles like wrong way, slow, normal travelling etc. [12].

Few researches were applied on high resolution satellite images like vehicles detection by blob detection algorithm for annual average day traffic with limitations in counting vehicles [13]. Vision based algorithm was applied on vehicle attribute with background scene and unknown attributes for real time vehicles detection [14]. Vision based algorithm was applied for counting vehicles in traffic density measurements by gradient vectors processing from aerial images [15]. Vehicles were identified by image subtraction and transformations in reflectance in aerial images [16]. Vision based driver support and assistance system was implemented by vehicle detection for nearby vehicles through acquisition of road scenes in daytime processing algorithm [17]. Vehicle detection and tracking for traffic surveillance control and management was done by motion detection using Bayesian background subtraction, feature based tracking, and differencing methods in frame [18]. Survey on road detection by lane detection, tracking and driving support systems by texture supported road detection, matching criteria, brightness variance etc. were done using vision based algorithm [19].

Morphological operations are operations done on images to enhance images for producing a desired output. Morphological operations were used for text character recognition on Indian vehicles number plates using morphological processing like edge detection, connected component retrieval by filtering operations [20]. Image segmentation was done using morphological operations in medical roles like finding shape as well as structure of human MRI by edge detection and using K-means clustering and noise filtering for accurate results [21].

When talking about pattern matching, it reminds us of first searching some content on the web. Pattern matching is like searching some content on web and finding results with same characters containing contents related with same words. Here the searched content can be some text, audio or video which is processed through speech recognition, parsing texts or image recognition for video. Here, all results came through some kind of pattern recognition or matching of texts, image, voice etc. [22]. Pattern matching is also described as a qualitative analysis where it might occur as a result or conclusion of thought processes where some kind of pattern matching happens in the data, whether it is made explicitly known or not, result occurs due to presence of it [23]. Pattern recognition is also known as a feature classification system where selection of some variables leads to pattern recognition results using filters, wrappers, and embedded mechanism solutions [24]. Some have used pattern matching for finding the large sequence of characters in finding DNA pattern matching algorithms like Knuth-Morris-Pratt and Boyer Moore algorithms [25].

III. MATERIALS AND METHODS USED

➭ **Materials Required :** ENVI, ArcGIS, and MATLAB softwares are required to subset, geo-reference, and apply coding to the high resolution satellite images.

➭ **STUDY AREA :** Fig. 1 displays very high resolution satellite image of Phoenix city, Arizona which was taken as study area in which roads with vehicles, that is, large data of traffic are present.

➭ **ArcGIS :** ArcGIS is a Geographic Information System (GIS) software for working with maps and geographic information In this project, ArcGIS was used to convert the image downloaded from Google Earth to tif format from jpeg format for further remote sensing processes like geo-reference or subset the image where road structure is complex in the available photographs to extract road regions only [27].

➭ **ENVI :** ENVI (an acronym for "Environment for Visualizing Images") is a software application used to process and analyze geospatial imagery. It is commonly used by remote sensing professionals and image analysts. In this project, ENVI was being used to subset the data using region of interest (ROI) where other features like parking lot, settlements, vegetation etc. are present in the images which has to be removed [28].

➭ **MATLAB :** MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. In this paper, MATLAB was being used for reading RGB images, conversion into binary images, filtering images, making bounding regions around blobs or vehicles detected, counting number of blobs and writing the output images [29].

Here is the step-wise explanation of development of algorithm in ArcGIS, ENVI, and Matlab for traffic monitoring and pattern analysis from the data downloaded from Google Earth.

➭ **Step 1 :** Searched the high resolution satellite image

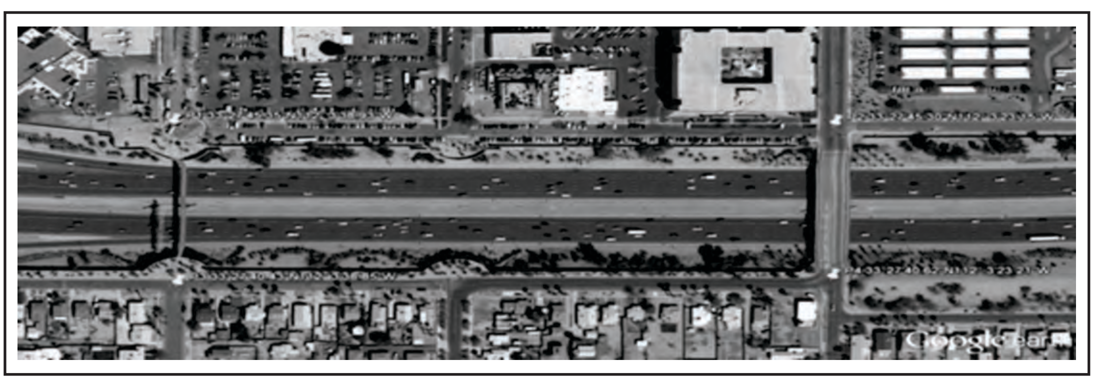

Fig. 1. Very High Resolution Satellite Image, Phoenix City (Arizona)
Source : Google Earth. earth.google.com/web **[26]**

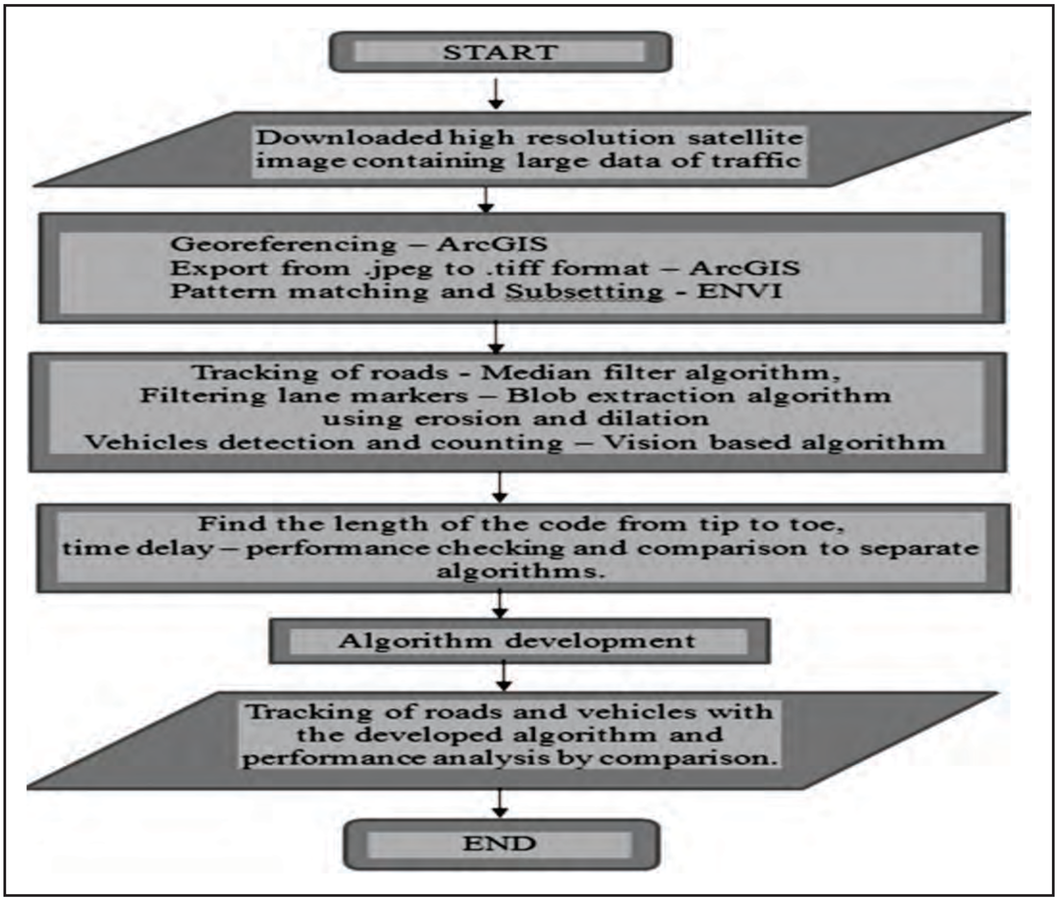

Fig. 2. Methodology for Algorithm Development

from Google Earth which contains large data of traffic in a famous city.

- **Step 2 :** Marked lat-long points in the image for geo-referencing like P1, P2, P3, and P4.
- **Step 3 :** Downloaded the Google earth data containing traffic after marking four points in jpeg format.
- **Step 4 :** Opened the data in ArcGIS, geo-referenced it for ortho-rectification
- **Step 5 :** Exported the image from jpeg format to tiff format in ArcGIS
- **Step 6 :** Opened the image in Envi and subsetted the data containing roads and traffic with pattern matching or vision based algorithm using rectangle ROI and saved it.
- **Step 7 :** Read RGB image in tiff format in Matlab and wrote images in further processing.
- **Step 8 :** Converted RGB image to grayscale image for next level implementation and processing.
- **Step 9 :** Applied median filter for smoothing or de- noising the image.
- **Step 10 :** Converted image to binary image by thresholding grayscale values to detect blobs/vehicles both light and dark colored.
- **Step 11 :** Complemented the image and filled holes in the image for blobs/vehicles detection.
- **Step 12 :** Applied erosion and dilation for removing lane markers and de-noised the image for blob/vehicles extraction.
- **Step 13 :** Plotted boundary around extracted blobs/vehicles using vision based algorithm.
- **Step 14 :** Counted blobs on roads for monitoring traffic.
- **Step 15 :** Algorithm development was done in Matlab.
- **Step 16 :** Time delay calculation in developed algorithm and comparison with separate algorithms was done using Matlab software.
- **Step 17 :** Tracking of roads and vehicles and performance analysis were done with developed algorithm for traffic monitoring.

Fig. 2. displays the methodology flowchart for algorithm development with proper steps.

IV. RESULTS AND DISCUSSION

Fig. 3 consists of road regions, light and dark colored vehicles, and one over-bridge. Shapes of the vehicles are mostly rectangular with a bit curvilinear shape.

Fig. 4 displays the converted gray-scale image from Fig. 3.

Fig. 5 displays the median filtered image for de-noising. It smoothens the image and removes the salt & pepper noise.

Fig. 6 displays the image on which blob detection was being done using binary conversion with thresholding to detect both light and dark colored vehicles.

Fig. 7 displays the complement image of Fig. 6 for further operations to be done.

Fig. 8 displays the image in which holes inside all detected blobs were being filled for connected component analysis.

Fig. 9 displays the output of erosion and dilation

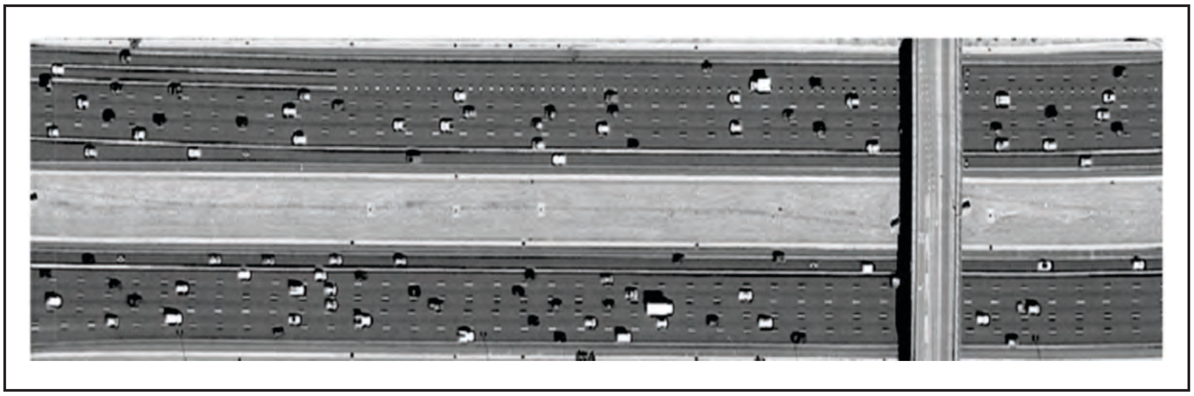

Fig. 3. Sub-Setting of Satellite Image to Extract Road Regions

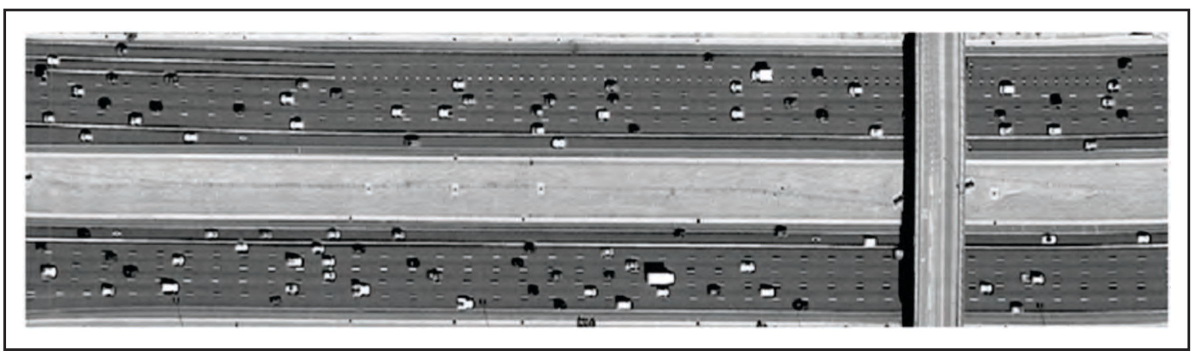

Fig. 4. Gray-Scale Conversion

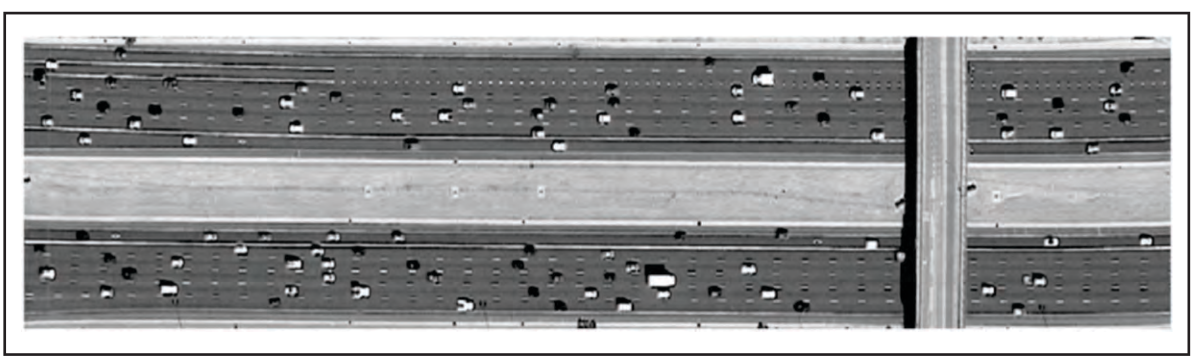

Fig. 5. Median Filter Applied on Gray-Scale Image

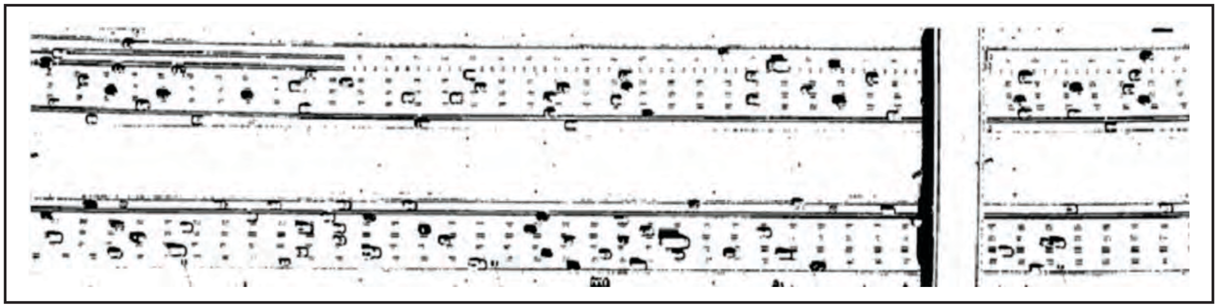

Fig. 6. Blob Detection in Binary Image

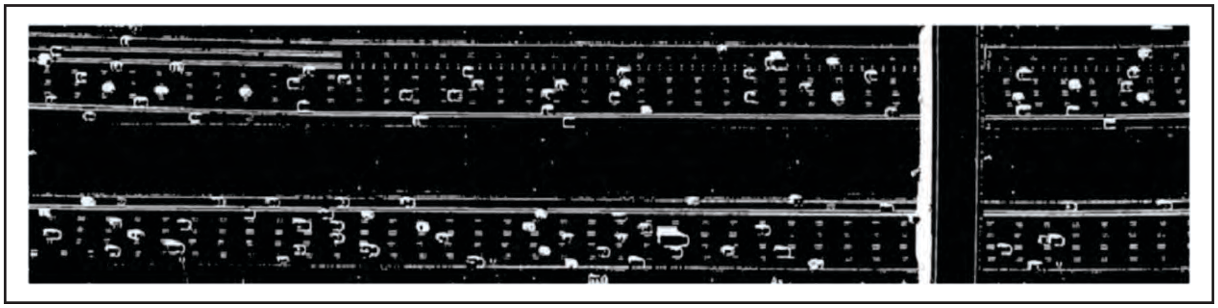

Fig. 7. Complement of Fig. 6

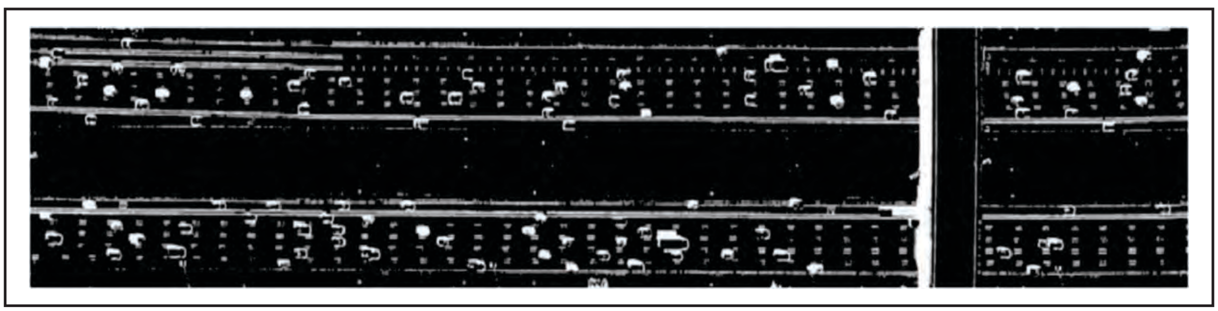

Fig. 8. Filled Holes in the Blobs

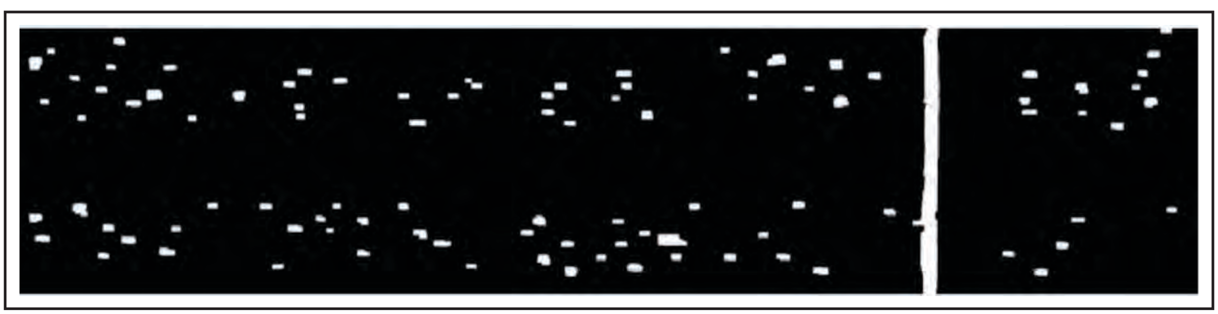

Fig. 9. Blobs Identification After Applying Erosion and Dilation to Filter Lane Markers

operation done for vehicles detection after filtering the lane markers.

Fig. 10 displays the output of vision based algorithm, that is, boundaries around the detected blobs for counting vehicles. After applying Matlab coding in Fig. 10, total number of blobs were found to be 96.

➭ **Validation of Vehicles Detection :** After deducing one blob from counting which is shadow of the over-bridge and clearly visible in the final image, total count for vehicles was validated with the original image by manual counting. It was found to be correct with very slight difference which is while filtering the lane markers, one

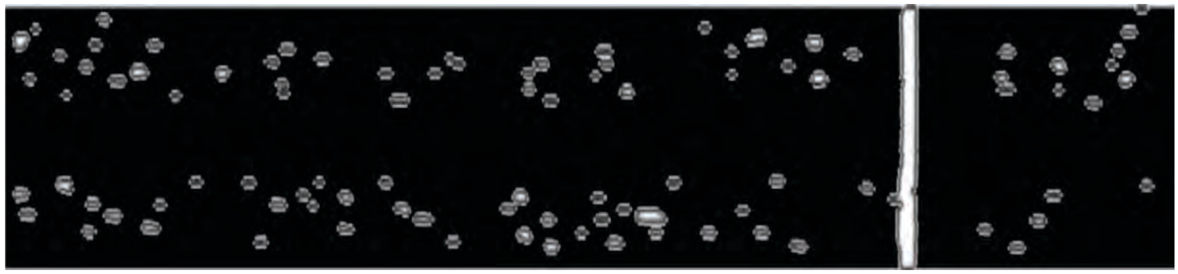

Fig. 10. Boundary Around the Vehicles

vehicle nearby lane markers got split into two and vehicles under shadow of over-bridge were not being detected in blob detection. Total number of vehicles in the original RGB image was found to be 97 leaving vehicles under shadow of over-bridge while total number of vehicles found in the image of the final algorithm development was found to be 95 after deducing the over-bridge blob from total counting.

Fig. 11(a) and Fig. 11(b) display the cross-checking and validation of vehicles counting with the original image and final image after the application of the algorithm respectively.

➪ **Comparison of Developed Algorithm with Earlier Algorithms :** The target to make a single algorithm by mixing three algorithms defined earlier and remote sensing techniques to track traffic was achieved. However, comparison of the mixed algorithm with separate algorithms will reveal performance analysis of the developed algorithm. Here, if we apply Median filter algorithm separately on satellite image which removes salt and pepper noise from image, then the output will preserve edges in the image which will detect roads only by detecting lane markers. It takes time delay of almost 5 seconds. The second algorithm which is Blob extraction algorithm when applied separately to detect vehicles will detect either light colored vehicles or only dark colored vehicles and without applying Median filter algorithm it will detect lane markers as blobs too. We won't be able to count by automation and time delay will be 20–30 sec. Vision based algorithm when applied separately to plot bounding regions will plot too many bounding regions

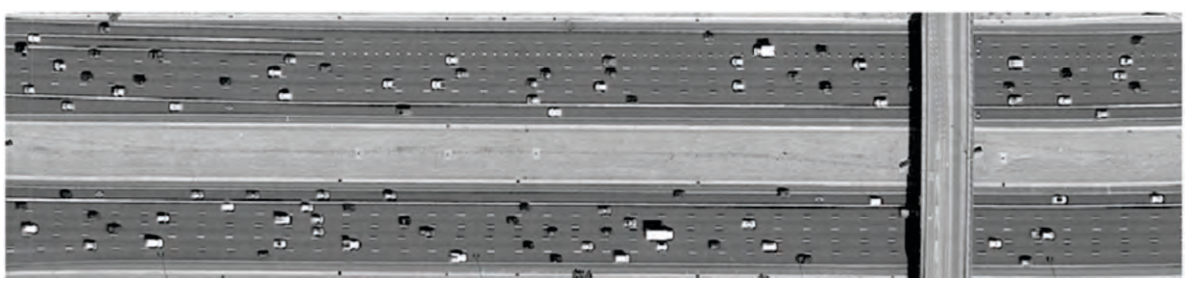

Fig. 11(a). Original Image

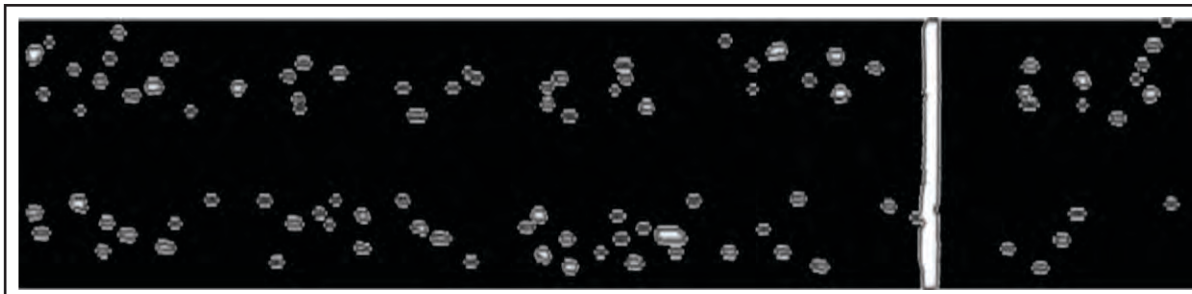

Fig. 11(b). Validation of Vehicles Counting of Final Image with the Original Image without applying blob extraction algorithm .This will raise the counting of traffic to hundreds which is not true. The time delay will be 10–15 sec. Here other mentioned algorithms which are Color box segmentation, Gradient vector, Bayesian background transformation, morphological operations etc. when applied didn't reach the stated goal. Color box segmentation was able to detect roads only. Bayesian background transformation and Gradient vector were able to detect vehicles in motion, that is, in videos only by image registration in extracted frames of videos. Thus, by mixing above mentioned three algorithms in targeted objective and applying morphological operations on satellite image, we saved time in execution of the program which is 10 – 20 seconds and the goal was achieved to monitor traffic efficiently.

V. CONCLUSION

Tracking of roads and vehicles together was being done with the developed algorithm and counting of vehicles was cross-checked and validated with original image by manual counting. There was a minor difference in number of vehicles which was found to be around 3 – 4 vehicles of the algorithm that is leaving those vehicles which were under the shadow of over-bridge and under shadows of trees.

Limitations were found in the algorithm development was while filtering the lane markers using erosion and dilation, there is possibility that vehicles which are nearby bigger lane markers may split into two blobs. Shadows of bigger obstacles like over-bridge or trees coming above roads were also getting detected as blobs while converting to binary image. Vehicles which are under shadows of over-bridge or trees were not getting detected. On an average, total time delay found while running the developed algorithm in Matlab code for satellite image was found to be 10 – 20 sec. Code efficiency was quite good for high resolution satellite image.

For traffic monitoring, counting of vehicles made the algorithm efficient at a given time and at a given point. This makes the algorithm useful for traffic pattern analysis if averaged over a day, over a month or over a year for traffic monitoring programs. Limitations found in the developed algorithm can be removed by image registration in 3 – 4 consecutive images of vehicles on roads, that is, by motion detection. Image registration will validate the road alignment and one-to-one vehicle detection for identifying unique vehicles.

ACKNOWLEDGEMENT

The authors are grateful to SRM IST, Kattankulathur for providing necessary facilities and constant support to conduct the research.

REFERENCES

[1] S. Jaiswal and A. S. Bhaskar, "Developing an algorithm for tracking vehicles in high resolution satellite image and aerial photographs," *Int. J. of Eng. Res. & Technol. Geospatial,* vol. *4,* no. 20, 2016.

[2] Comput. vision. In *Wikipedia.* [Online]. Available: en.wikipedia.org/wiki/Computer_vision

[3] Homepage. [Online]. Available: inf.ed.ac.uk/rbf/HIPR2/median.htm

[4] S. Srivastava, R. Singal, and M. Lumb, "Efficient lane detection algorithm using different filtering," *Int. J. of Comput. Appl. (0975 – 8887),* vol. *88,* no. 3, pp. 6 – 11, February 2014. [Online]. Available: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.428.6669&rep=rep1&type=pdf

[5] T. Zhao, and R. Nevatia, "Car detection in low resolution aerial images," *Image and Vision Computing,* vol. *21,* no. 8, pp. 693–703, 2003. doi: https://doi.org/10.1016/S0262-8856(03)00064-7

[6] "Blob Detection". *Scikit-image. Image Proc.* in Python.[Online]. Available: Scikit-image.org/docs/dev/auto_examples/features_detection/plot_blob.html

[7] "Color Thresholder." MathWorks. .[Online]. Available: https://in.mathworks.com/help/images/ref/colorthresholder-app.html?s_tid=srchtitleIn.mathworks.com/help/matlab/ref/gradient.html

[8] "The gradient and directional derivative," Web Study Guide for Vector Calculus. [Online]. Available: http://sites.science.oregonstate.edu/math/home/programs/undergrad/CalculusQuestStudyGuides/vcalc/grad/grad.html

[9] M. R. McCord, C. J. Merry, and P. Goel, "Incorporating satellite imagery in traffic monitoring programs," *North Americ. Travel Monitoring Exhibition and Conf. Charlotte, 1998.*

[10] X. Li, X. Yao, Y. L. Murphey, R. Karlsen, and G. Gerhart, "A real-time vehicle detection and tracking system in outdoor traffic scenes," *Proc. of the 17th Int. Conf. on Pattern Recognition,* pp. 761–764, ICPR 2004, Cambridge, 2004. doi: https://10.1109/ICPR.2004.1334370

[11] S. Maldonado-Bascon, S. Lafuente-Arroyo, P. Gil-Jimenez, H. Gomez-Moreno, and F. Lopez-Ferreras, "Road-sign detection and recognition based on support vector machines," in *IEEE Trans. on Intelligent Transportation Syst.,* vol. *8,* no. 2, pp. 264–278, June 2007. doi: https://doi.org/ 10.1109/TITS.2007.895311.

[12] Y. Jung, and Y. Ho, "Multiple-object tracking under occlusion conditions," In Proc. SPIE 4067, Visual Commun. and Image Proc., May 30, 2000, Perth, Australia. *The Int. Soc. for Opt. Eng.,* 2000. doi: https://doi.org/10.1117/12.386706.

[13] S. Larsen, H. Koren, and R. Solberg, "Traffic monitoring using very high resolution satellite imagery, photogrammetric engineering and remote sensing," *Photogrammetric Enginering & Remote Sensing,* vol. *75,* no. 7, pp. 859–869, 2009.

[14] B. Placzek, "A real time vehicle detection algorithm for vision-based sensors". In: Bolc L., Tadeusiewicz R., Chmielewski L.J., Wojciechowski K. (eds.) *Comput. Vision and Graph.* ICCVG 2010. Lecture Notes in Comput. Sci., vol. *6375.* Springer, Berlin, Heidelberg. doi: https://doi.org/10.1007/978-3-642-15907-7_26

[15] S. Ghaffarian, and I. Gokasar, "Traffic density measurement by automatic detection of vehicles using gradient vectors from aerial images," *Int. J. of Civil and Environmental Eng.,* vol. *9,* no. 8, 2015. doi: https://doi.org/10.5281/zenodo.1107513

[16] P. Jaikumar, A. Singh, and S. K. Mitra, "Background subtraction in videos using Bayesian learning with motion information," *Proceeding of the Brit. Mach. Vision Conf.,* 2008. doi: https://doi.org/10.5244/C.22.61

[17] Y. Kuo, N. Pai, and Y. Li, "Vision-based vehicle detection for a driver assistance system," *Comput. and Mathematics with Appl.,* vol. *61,* no. 8, pp. 2096–2100, 2011. doi: https://doi.org/10.1016/j.camwa.2010.08.081

[18] R. A. Hadi, G. Sulong, and L. E. George, "Vehicle detection and tracking techniques: A concise rev.", *Signal & Image Proc.: An Int. J.,* vol. *5,* no. 1, 2014. doi: https://doi.org/10.5121/sipij.2013.5101

[19] V. H. Mistry, and R. Makwana, "Survey: Vision based road detection techniques," *Int. J. of Comput. Sci. and Inform. Technologies,* vol. *5,* no. 3, pp. 4741–4747, 2014.

[20] R. Radha and C. P. Sumathi, "A novel approach to extract text from license plate of vehicles," *Signal & Image Proc. An Int. J.,* vol. *3,* no. 4, pp. 181–192, 2012.

[21] K. Somasundaram and T. Genish, "Binarization of MRI with intensity inhomogeneity using K-Means clustering for segmenting Hippocampus". *The Int. J. of Multimedia & Its Appl.,* vol. *5,* no. 1, 11–19, 2013. doi: https://doi.org/10.5121/ijma.2013.5102

[22] R. Diwate, "Study of different algorithms for pattern matching," *Int. J. of Advanced Res. in Comput. Sci. and Software Eng.,* vol. *3,* no. 3, 2013.

[23] N. Sinkovics, "Pattern matching in qualitative analysis," In C. Cassell, A. L. Cunliffe, and G. Grandy, *The Sage Handbook of Qualitative Bus. and Manage. Res. Methods,* pp. 468–484. London: SAGE Publications Ltd. doi: https://doi.org/10.4135/9781526430236

[24] U. Stanczyk, "Feature evaluation by filter, wrapper, and embedded approaches," *Stud. in Computational Intell.,* vol. *584,* pp. 29–44, 2015. [Online]. Available: https://link.springer.com/chapter/10.1007%2F978-3-662-45620-0_3

[25] S. Banerjee, T. Chakrabarti, and D. Sinha, "A genetic algorithm based pattern matcher," *Int. J. of Scientific & Eng. Res.,* vol. *3,* no. 11, 2012. [Online]. Available: https://www.ijser.org/paper/A-Genetic-Algorithm-Based-Pattern-Matcher.html

[26] Google Earth. [Online]. Available: earth.google.com/web. Accessed on: March 2, 2016.

[27]ArcGIS Online. [Online]. Available: https://www.arcgis.com/index.html

[28] "ENVI." L3Harris Geospatial. [Online]. Available: https://www.harrisgeospatial.com/Software-Technology/ENVI

[29] "MATLAB." MathWorks. [Online]. Available: https://www.mathworks.com/products/matlab.html

About the Authors

Srishti Jaiswal received B.Tech. degree in Computer Science from Rajasthan Technical University in 2011 and M.Tech. from SRM Institute of Science and Technology in 2016. She worked with Council of Scientific and Industrial Research-Institute of Himalayan Bioresource Technology (CSIR-IHBT) from December 2016 to December 2018. Her research interests are in the arena of satellite image processing. Currently she is working as Senior Software Engineer with Palacio Inc.

Dr. Aparna S. Bhaskar received M. Phil. degree in Geology and Ph. D. in Geological Remote sensing in 2006 and 2010 respectively from Anna University, Chennai India. She has been working with SRM Institute of Science and Technology since 2012. Her research interests are in the application of remote sensing in natural resource exploration and image processing.

AMC INDIAN JOURNAL OF CIVIL ENGINEERING

Statement about ownership and other particulars about the newspaper "AMC Indian Journal of Civil Engineering" to be published in the 1st issue every year after the last day of February.

FORM 1V
(see Rule 18)

1.	Place of Publication	:	NEW DELHI
2.	Periodicity of Publication	:	BI - ANNUAL
3.	4,5 Printer, Publisher and Editor's Name	:	S. GILANI
4.	Nationality	:	INDIAN
5.	Address	:	Y-21,HAUZ KHAS, NEW DELHI - 16
6.	Newspaper and Address of individual	:	ASSOCIATED MANAGEMENT
	Who owns the newspaper and partner of	:	CONSULTANTS PRIVATE LIMITED
	Shareholder holding more than one percent.	:	Y-21, HAUZ KHAS, NEW DELHI-16

I, S.Gilani, hereby declare that the particulars given above are true to the best of my knowledge and belief.

DATED : March 1, 2021

Sd/-
S. Gilani
Signature of Publisher