

# Vehicle Detection from Video using Morphological Operations

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**Abstract**— We had presented a proposed filter based on morphological operation which is used for detection of vehicle from CCTV surveillance video camera. Our motive was to develop a filter that can reduce the noise in background subtracted binary image. We had evaluated the performance of filter by employing PSNR(Peak Signal to Noise Ratio) and compared our proposed method performance with morphological open, close, erosion, dilation, and median filters. We had achieved higher value of PSNR which is 66.15 than other method. Furthermore, we used our filter for the Vehicle detection to identify the vehicles. Thus, we conclude the new proposed filter is sufficient for de-noising binary image, and suitable for vehicle detection. This research paper introduces Morphological approach based morphological techniques for vehicle detection from video.

**Index Terms**— Proposed Algorithm; image processing; vehicle detection; Morphological operations

## 1) INTRODUCTION

Computer vision has always been widely accepted in application to extract information from video source. However, removing noises in a frame of the video was a difficult task, and a lot of filtering algorithms were developed in last decades. Mathematical morphology has been used as a powerful tool for filtering noises, while preserving the important geometrical features. Furthermore, morphological methods use structuring elements (SE) such as rectangle, ellipse and cross [1, 2], and size of the SE can be adjusted to get better results.

The SE of the morphological filter is similar to the window or mask function. In actual applications, there is quite a difference of morphological features among the vibration signals because of operating environment and processing parameters of the mechanical equipment [3]. At present, morphological opening, morphological closing and their combinations (open and close) are widely used in image processing. Also omnidirectional methods of morphology were introduced. Moreover it is said that close-opening and open-closing filter [4]-[7].

Median filters and order-statistic filters are a class of nonlinear and translation-invariant discrete filters that have become popular in digital speech and image processing, and also in statistical or economic time series analysis. These filters are easy to implement and can suppress impulse noises, which blur edges [8]-[10]. Furthermore median blur method blurs the frame according to the kernel size which is deficient for proper usage.

We found out that aforementioned filters could not remove noise from binary image as we desired. Thus, we intended to develop a better filter that could remove more noise while keeping the geometrical structure of the moving vehicles.

## 2) LITERATURE SURVEY

Researches and developments had done in image processing techniques which is applied to traffic data collection and analysis. In this paper, it explains computer vision based approach to road monitoring and traffic analysis problem. Approved methods and algorithms are implemented in the intelligent video monitoring system with data transferring over computer networks and archiving in local and central databases. The image-processing and pattern recognition methods designed and modified to the requirement and constrains of road traffic study. These methods combined together gives purposeful capabilities of the system to supervise the road, to initiate automated vehicle tracking, to compute the speed [14]. Image detection is a lot dependent on the background updating and threshold selection methods. Edge detection techniques which is used in image processing. An edge detector used to extracts the edges of the objects of a scene irrespective to which it belongs to the background details or the objects [15]. Image processing techniques are applied for the recognition of environmental and road conditions from real-time camera images. The system determines the directional components of a camera's position using the current camera image [16]. Simulink environment is an efficient simulation model through which we can count the vehicles from the colored and gray-scale images using image processing techniques. used for the. The rapid design, prototyping, graphical simulation, and efficient code of video and image processing algorithms generated through Video and Image Processing Blockset tool. For this, we can use morphological operation (Opening) which works very efficiently for images captured. The developed method includes object feature identification, detection, and counting of the objects [17].

Toufiq P. et al., in [18] describes background subtraction as the widely used paradigm for detection of moving objects in videos taken from static camera. By using this, we can automatically generate and maintain a representation of the background, which could be used to classify any new observation as background or foreground. In [19] background subtraction also includes calculation of a reference image and subtracting each new frame from this image and thresholding the result. This method is a better version of adaptive background mixture model which is faster and adapts efficiently to varying environments. A new method for detection of moving vehicles have introduced by [20] based on histogram. In this method, two procedures involved to segmentation and detection of the vehicles in video sequence. The novel background changing method makes the bright changing in video scene in the first step. In

the second step, adaptable movement histogram-based vehicles detection is used.

Luo-wei tsai, Jun-wei hsieh et al [21] proposed a novel method for vehicle detection using color transform model and edge map. Different phases has been introduced by this method for detection. In the first phase a color transform model identifies vehicle pixels from the image backgrounds. This technique reduced number of random samples unlike previous methods it takes only less number of images for training. In the second phase a classification is carried out using Bayesian classifier which detects pixels corresponding to the vehicle or not and also generates different vehicle premise. The coefficient of wavelet transform, edges and corners of images hypothesized the validation process in the final phase. This method is efficient results in accurate vehicle detection.

### 3) PROPOSED METHOD

In binary morphology, the dilation (1) and erosion (2) are respectively defined as below [22]:

$$(G \oplus B)(x, y) = \max\{G(x - i, y - i) + B(i, j) \mid (i, j) \in D_B\} \quad (1)$$

$$(G \ominus B)(x, y) = \min\{G(x - i, y - j) - B(i, j) \mid (i, j) \in D_B\} \quad (2)$$

where  $\oplus$ , and  $\ominus$  denotes, respectively, dilation operator and erosion operator,  $G(x, y)$  is binary image, and  $B(x, y)$  is structure element.

Opening (3) and closing (4) operation of binary image are defined as [22]:

where  $\circ$  and  $\bullet$  denotes, respectively, opening operator and

$$G \circ B = (G \ominus B) \oplus B \quad (3)$$

$$G \bullet B = (G \oplus B) \ominus B \quad (4)$$

closing operator.

The filter window can be 2D square, rectangle, cross, and ellipse in default morphological filters, but in our case, we used a square window. Window size can be resizable to improve the result of the filter. Following is flowchart of our Proposed method.

### (A) IMPLEMENTATION OF PROPOSED METHOD

The fig.12 shows the complete flow chart for detection of vehicles from video feed from surveillance camera

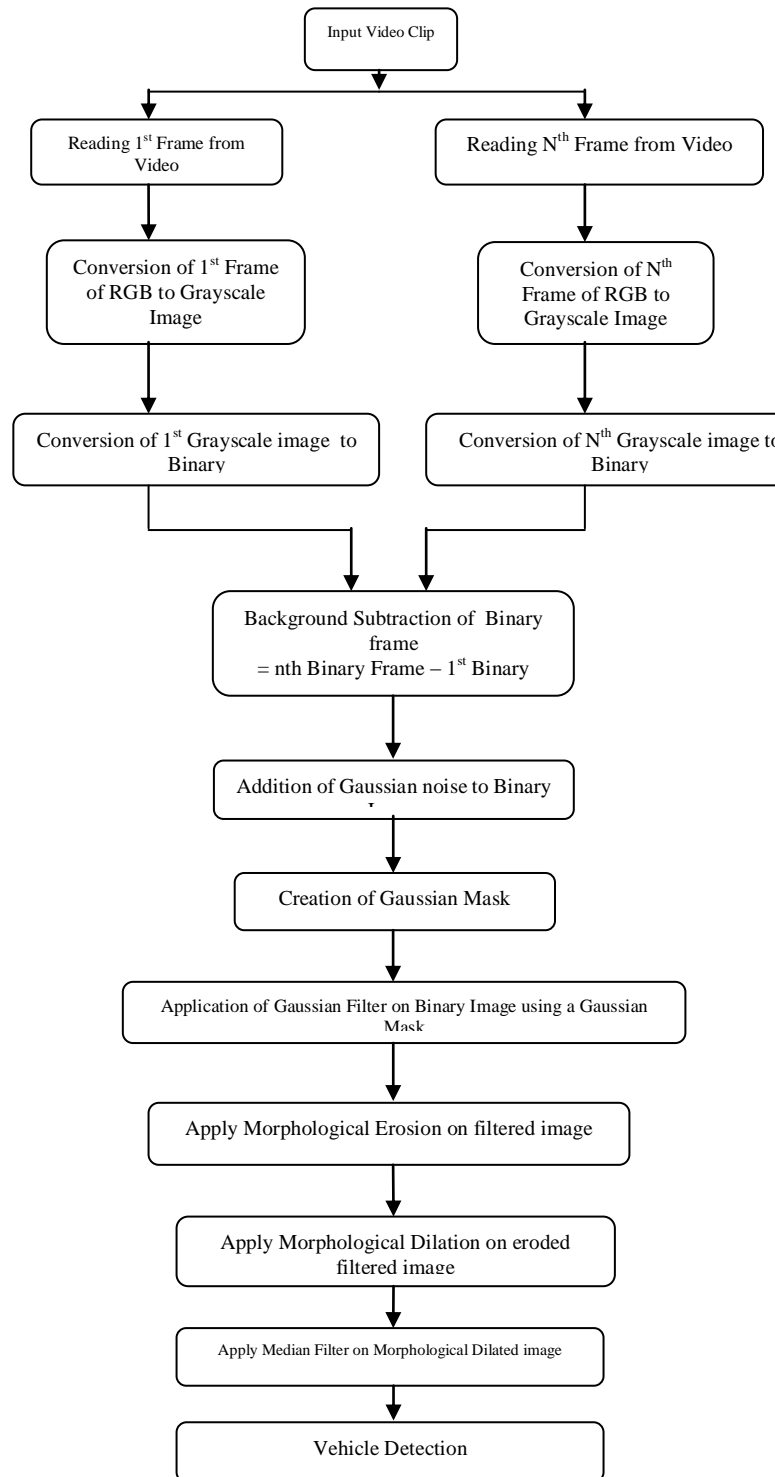


Fig.12 .Flow chart of Proposed Method for vehicle detection

## (B) DESCRIPTION OF ALGORITHM FOR VEHICLE DETECTION

This section, describes how to detect the moving vehicles by reading the video using Matlab software.

- Step 1) Acquire the video feed from surveillance camera.

In this step, we will access video using Matlab predefined function 'VideoReader'. Vid=VideoReader(X); By using The VideoReader function constructs a multimedia reader object that can read video data from Multimedia file 'X'. This function is very useful as it can read the video file with different formats. VideoReader supports the following formats: AVI, MPG, MPEG, WMV, ASF, and ASX.

- Step 2) Reading of the frames from the video

In this step, we have to extract Nth sample RGB frame from the video which is having some moving objects and 1st sample RGB frame from the video as a stationary frame having stationary background. So, to extract frames from the video file, we will use 'read' function. It reads in all video frames from the video file by using Im=read(Vid,1); This function, we can read 1st frame from the video file. Similarly, we can read Nth frame (where we got some moving vehicles) from video file also.

- Step 3) Conversion of 1st and Nth RGB frame to gray & then to Binary

(a) Conversion of RGB image into a Gray-scale Intensity image:

The image that is acquired from the camera is a RGB color image. The algorithm convert RGB color image into a Grayscale image. Grayscale is selected because its two dimensional matrix nature & simplicity nature. This conversion is done by using the MATLAB function rgb2gray. This function, converts 1st and Nth RGB frame to gray frame.

(b) Conversion of Intensity image into a Binary image :

This transformation is called as Image Quantization. The intensity image can be converted into binary Image by comparing pixel intensities with a threshold value. The threshold value is taken as a 150 (in gray scale of 0-255). This value reasonably quantizes those pixels which has a pixel-value greater than the selected threshold value. The remaining portions, which have a pixel-value less than the threshold value, are darkened. So, to convert Gray image to binary image, we will use 'im2bw' Matlab function. This function Converts gray image to binary image, based on threshold value.

- Step 4) Perform Background subtraction

In this step, we will perform background subtraction in which we are subtracting 1st Binary frame from Nth Binary frame to separate the moving objects from stationary background to detect the foreground objects.

- Step 5) Addition of Gaussian Noise to the background subtracted binary image

In this step, we are adding Gaussian Noise to the background subtracted binary image to make that image as a 'noisy background subtracted image.' So for that we will use Matlab function 'gn=imnoise(BS1,'gaussian',0,0.01)'. This function adds Gaussian white noise to the intensity image BS1 having mean m is zero mean noise and variance v is 0.01.

- Step 6) Creation of Gaussian mask having size of mask as a 5x5

In this step, we will create Gaussian mask which is used for the filtration process. So, for this, we are using Matlab define function 'm=fspecial('gaussian',[5 5], 0.9)'. This function returns a rotationally symmetric Gaussian lowpass filter mask of size 5x5 with standard deviation sigma is 0.9.

- Step 7) Apply Gaussian Filter to the noisy background subtracted binary image

In this step, we will apply Gaussian Filter by using Gaussian Mask to the noisy background subtracted image to remove the noise present in image. For this, we will use 'ss=imfilter(gn,m)'. This function filter an noisy image with Gaussian Mask (m) of size 5x5. It removes noise present in 'noisy background subtracted image'.

- Step 8) Apply Morphological Erosion on filtered image.

In this step, we will apply Morphological Erosion on filtered image. The basic effect of Erosion operator on binary image is to shrink the boundaries of regions of foreground pixels and holes within those regions will become larger. [3] To apply morphological erosion, we will create a structuring element, erosion is the Morphological operators that change the shape of particles. [13]. se=strel('disk',1). disk-shaped structuring element can be created by this function, in which 1 denotes the radius.

Then after, we can apply morphological erosion on 'noisy background subtracted image' with a disk-shaped structuring element, To apply erosion we will use Matlab define function 'ss1=imerode(ss,se)'. This function erodes the binary image ss, returning the eroded image ss1 by using a structuring element se. Erosion causes objects to shrink. The amount shrink is totally depends upon size of structuring element. Erosion makes an object smaller by removing or eroding away the pixels on its edges [9]. Purpose of Erosion that it will enlarge the holes enclosed by a single region and erosion making the gap between different regions larger. Erosion is used to remove the small extrusions on regions boundaries. The size of Structuring element changes the effect of erosion.

- Step 9) Apply Morphological Dilation on eroded filtered image.

In this step, we will apply Morphological Dilation on eroded filtered image. Dilation enlarge the boundaries of regions of foreground pixels in an binary image. Thus areas of foreground pixels will be larger in size while holes will become smaller [3]. Now, in this step morphological dilation is applied on eroded image to fill the the holes which are

enlarged by erosion. For that, we will use 'imdilate' function. To apply erosion we will use Matlab define function 'ss2=imerode(ss1,se)'. This function erodes the binary image ss1, returning the eroded image ss2 by using a same structuring element se. Objects could be erode or shrink in size due to erosion operation. The amount and the way that they grow depend upon the choice of the structuring element [50]. An object will get larger in size using dilation just by adding pixels around its edges. At the place at which the structuring element HITS the Input Image, the dilation operation creates new image showing all the location of a structuring element origin. In this dilation operator adds a layer of pixel to an object. The purpose of Dilation is to shrink the holes enclosed by a single region and it creates smaller gaps between different regions.

- Step 10) Apply Median Filter on Morphological Dilated filtered image.

There was still some noise after Erosion and Dilation. Due to noise and uneven object boundaries, object detection could be erroneous. So, to remove that noise, we will apply Median Filter on Morphological Dilated filtered image. Median filter erases black dots called the pepper and fills in white holes in the image, called salt. It preserves the sharp edges [23]. For that we will use medfilt2 function 'ss3=medfilt2(ss2)'. This function performs Perform two-dimensional filtering to remove noise which is present in an image.

- Step 11) Vehicle Detection.

In this way, after morphological operation and median filtering on the binary image, the moving objects or vehicles were clearly distinguished and hence vehicles could be detected easily.

#### 4) EXPERIMENTS AND SIMULATION RESULTS

The proposed algorithm is simulated using MATLAB R2013b software. The simulated outputs of vehicle detection. Fig 6 shows the results of vehicle detection using Proposed method for the given input video.

We tested the Proposed method in video feed from surveillance camera. A sample frame from the video is shown in Fig. 1. We did background subtraction to separate the moving objects from stationary background (Fig. 2). To show the quality of the new filter method, we had selected this frame due to presence of large noise in it. We also added Gaussian noise (Fig. 3). Control image (Fig. 4) was created manually by removing all the noise from Fig. 2. We planned to get the best result which is as similar as to the control image. The result of the Proposed method is shown in Fig. 3. Results of morphological open, close, erosion, dilation and median filters are shown in, respectively, Fig. 7, 8, 9, 10, 11. All these results were the best results that we manually chose from many different cases.

We are comparing the filter quality by finding higher PSNR value (Peak Signal to Noise Ratio). In order to calculate PSNR, first we found MSE (Mean Squared Error). The definition of the MSE is shown below: [22]

$$MSE = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N (Y_{i,j} - S_{i,j})^2$$

where, M, N are size of the frame, Y and S are frames to be compared, i and j are the coordinates of the pixel. PSNR is defined as: [22]

$$PSNR = 10 \log_{10} \left( \frac{255^2}{MSE} \right) \text{ dB}$$

#### (A) SIMULATION OUTPUT:



Fig.1. Original Image from video

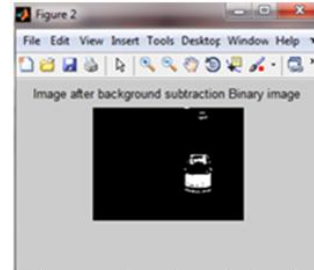


Fig.2-Image after Background subtraction Binary Image



Fig.3-Gaussian Noise added on Fig.2

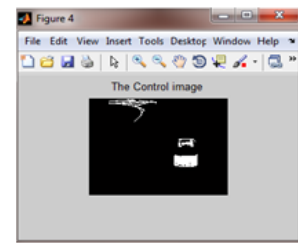


Fig.4-The control image, noises were manually removed from Fig.2

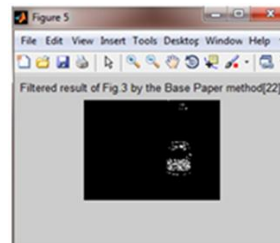


Fig.5-Filtered result of Fig.-3 by the Base Paper method [22]



Fig.6 -Filtered result of Fig.3 by Proposed Method

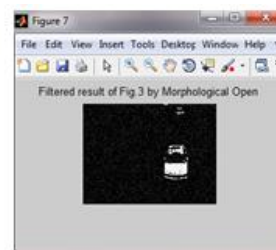


Fig.7 -Filtered result of Fig.3 by Morphological Open



Fig.8 -Filtered result of Fig.3 by Morphological Close

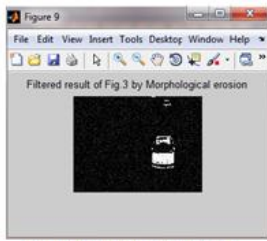


Fig.9-Filtered result of Fig.3 by Morphological Erosion

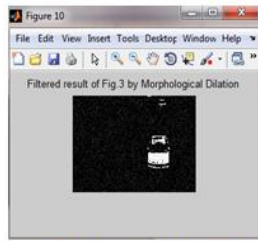


Fig.10-Filtered result of Fig.3 by Morphological Dilation

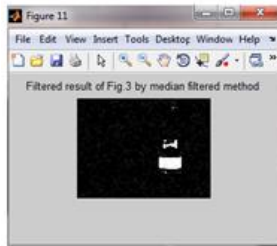


Fig.11-Filtered result of Fig.3 by Median Filter

(B) COMPARISON BETWEEN PSNR'S

PSNR values of all methods are shown in Table-1, results of base paper method[22],morphological erosion, dilation, open, close and median filter methods are included. Among the results, PSNR of the Proposed method is 66.1503 which is observed by performing the MATLAB simulation and that value is the highest one among the other methods. This PSNR value will be different for considering different combination of input frames from the different input video. Finally, we can say that, this PSNR value is found to be different for different input frame taken as input or different video taken as an input.

The PSNR value will be dependent on the different input frame from the different video taken. If input frame consists of maximum number of vehicle, then there will be different PSNR value for our proposed method, Base paper method[22],morphological open, close, erosion, dilation and median filters method.

Using our proposed method, we can achieve higher value of PSNR for all different input frame or all different input video .Here, we had achieved higher value of PSNR among other method using our proposed method & we had compared it in the following table.

Sr. No	Name of method	Observed PSNR Value by performing MATLAB simulation
1	Morphological Dilate	65.4039
2	Morphological Erode	65.4039
3	Morphological Open	65.4039
4	Morphological Close	65.4039
5	Median Filter	65.4039
6	Base Paper Method[22]	65.7683
7	Proposed Method	66.1503

Table-1.Camparison between PSNR

(C) GRAPHICAL REPRESENTATION OF COMPARISON BETWEEN PSNR'S

Fig.13 shows the graphical representation of comparison between PSNR value obtained.

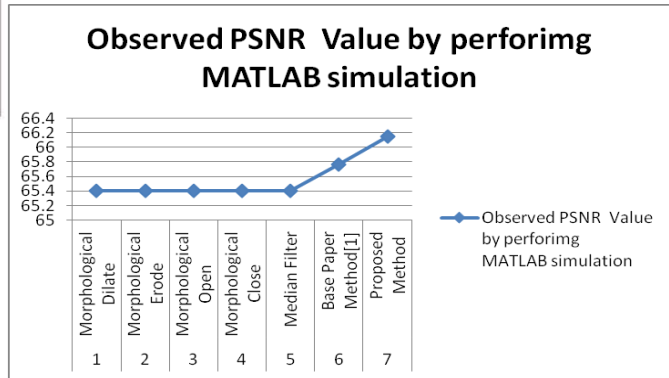


Fig. 13. Graphical Representation of Comparison Between PSNR's

(C)COMPARISON BETWEEN WHITE AND BLACK PIXELS HISTOGRAM

Histogram of the white and black pixels of all methods are represented in Table 2. We can see the new method removed more amount of white pixels among the others. However, removing excessive white pixels is not good when those white pixels were part of vehicle, in our case, we can easily recognize the vehicles from the filtered image with naked-eyes.

Here also, number of white and black pixels is found to be different for different input frame taken as input or different video taken as an input.

Sr.No.	Name of method	Number of White Pixels	Number of Black Pixels	Sum of the Pixels
1	Morphological Dilate	250	18950	19200
2	Morphological Erode	250	18950	19200
3	Morphological Open	250	18950	19200
4	Morphological Close	250	18950	19200
5	Median Filter	147	19053	19200
6	Base Paper Method[22]	250	18950	19200
7	Proposed Method	57	19143	19200

Table-2 Comparison between White and Black pixels Histogram

(D) CALCULATION COSTS OF THE METHODS

Calculation costs of the methods are shown in Table-3. In this experiment, we used laptop with Intel Core i3 processor 1.8 GHz , 4GB of RAM, Windows 07 OS. So, the calculation cost of our function was more than other methods.



Table-3 Calculation costs of the methods

Sr.No.	Name of method	Calculation costs of the methods in microseconds
1	Morphological Dilate	0.0019
2	Morphological Erode	0.0024
3	Morphological Open	0.0918
4	Morphological Close	0.1357
5	Median Filter	0.0149
6	Base Paper Method[22]	0.4819
7	Proposed Method	1.4074

## 5) CONCLUSION

New proposed method is developed, and evaluation experiments are performed in this study. The main motive of this Proposed Method is to achieve higher PSNR value than any other method. According to the experiment results, PSNR of the new proposed method was relatively higher than the other method. Thus we conclude our proposed method is suitable for de-noising binary image and for vehicle detection application.

## REFERENCES

- 1) Yang lirui, Ding Runtao "Morphological filters with multiple structuring element." China 1991 international conference on circuits and Systems, June 1991, Shenzen China
- 2) Che Hong, Sun Longhe "The optimized design and application of circular morphological filter" 2009 DOI 10.1109/GCIS.2009.119 pp. 257-261
- 3) Lijun Zhang, Lixin Zhang, Jianhong Yang, Min Li "Adaptive morphological filter to fault diagnosis of gearbox" National natural science foundation of China no. 51005015, 51004013, 50905013 pp. 70-73
- 4) F. Cheng and A. N. Venetsanopoulos "An Adaptive Morphological Filter for Image Processing" IEEE Transactions on image processing vol. 1 no. 4 October 1992 pp. 533-539
- 5) Wang Xiuli, Nan YiMin "A morphology filter to impulse noise based on adaptive optimizing the values of structure element" Advanced computer theory and engineering, August 2010, vol. 5
- 6) Zhang Xiang-guang LIU Yun Wang Chuan-xu "Filter design based on the theory of the generalized morphological filter with omnidirectional structuring element " Eight ACIS international conference on software engineering, artificial intelligence, networking, and parallel distributed computing pp. 255-258, 2007
- 7) Petros Maragos, Ronald W. Schafer "Morphological filters-part II: their relation to median, order-statistic, and stack filters" IEEE transactions on acoustic, speech, and signal processing, vol. assp-35, no. 8, August 1987
- 8) Kenneth R. Castleman "Digital image processing" NJ: Prentice-hall 1996
- 9) Ji Zhen "A novel mathematical morphology filter and its performance analysis in noise reduction" Chinese journal of electronics, 2005 pp.68-72.
- 10) Windyga P S. "Fast impulsive noise removal" IEEE trans, image processing, 2001 pp. 173-179
- 11) Quiling Wang, Lixin Wu, Zhihua Xu, Hong Tang, Ran Wang, Fashuai Li "A progressive morphological filter for point cloud extracted from UAV images" IGARSS 2014 pp. 2023-2026
- 12) K.Trinayani, Mrs. B.L.Sirisha, Moving Vehicle Detection and Tracking using GMM and Kalman Filter on Highway Traffic, International Journal of Engineering Technology, Management and Applied Sciences, Volume 3, Issue 5, May 2015.

- 13) Chanchal Srivastava, Saurabh Kumar Mishra, Pallavi Asthana, G. R. Mishra, O.P. Singh, Performance Comparison Of Various Filters And Wavelet Transform For Image De-Noising,IOSR Journal Of Computer Engineering (IOSR-JCE),Volume 10, Issue 1 (Mar. - Apr. 2013), PP 55-63
- 14) E. Atkociunas<sup>1</sup>, R. Blake<sup>2</sup>, A. Juozapavicius<sup>1</sup>, M. Kazimianec<sup>1</sup> "Image processing in road traffic analysis" Nonlinear Analysis: Modelling and Control, 2005, Vol. 10, No. 4, 315-332
- 15) M. Fathy a, M.Y. Siyal b "An image detection technique based on morphological edge detection and background differencing for real-time traffic analysis". Pattern Recognition Letters 16 (1995) 1321-1330
- 16) James G. Haran,<sup>1</sup> John Dillenburg<sup>2</sup> and Peter Nelson<sup>3</sup> "Real-time image processing algorithms for the detection of road and environmental conditions"
- 17) Pratishtha Gupta <sup>1</sup>, G.N Purohit <sup>2</sup>, Adhyana Gupta <sup>3</sup> "Traffic Load Computation using Matlab Simulink Model Blockset" International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 6, June 2013
- 18) Toufiq P., Ahmed Egammal and Anurag Mittal, "A Framework for Feature Selection for Background Subtraction", In Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'06), 2006.
- 19) P. Kaewtra Kulpong and R. Bowden, "An Improved Adaptive Background Mixture Model for Real-time Tracking with Shadow Detection", In Proceedings of the 2nd European Workshop on Advanced Video-Based Surveillance Systems, Sept. 2001.
- 20) W. Zhang, et al., "Moving vehicles detection based on adaptive motion histogram," Digit. Signal Process., vol. 20, pp. 793-805, 2010.
- 21) Luo-wei tsai, Jun-wei hsieh, member, IEEE, and Kuo-chin fan, member, IEEE, "Vehicle detection using normalized color and edge map", IEEE Transactions On Image Processing, vol. 16, no. 3, March 2007.
- 22) Munkhjargal Gochoo, Damdinsuren Bayanduuren, Uyangaa Khuchit, Galbadrakh Battur, Sy-Yen Kuo, Tan-Hsu Tan, Shih-Chia Huang, Design and application of novel morphological filter used in vehicle detection, Computer and Information Science (ICIS), 2016 IEEE/ACIS 15th International Conference, June 26-29, 2016

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