Traffic Load Computation using Matlab Simulink Model Blockset

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Abstract: Real time traffic signal control is a serious issue to be resolved to control the increasing traffic congestion. This paper outlines an efficient simulation model for counting the vehicles from the colored and gray-scale images through image processing techniques in Simulink environment. Video and Image Processing Blockset is a tool used for the rapid design, prototyping, graphical simulation, and efficient code generation of video and image processing algorithms. The approach used is morphological operation (Opening) which works very effectively for images captured. The developed process involves object feature identification, detection, and counting objects.

Keywords: Matlab, Morphological Operations, Vehicle detection, Simulink, video and Image processing

I. INTRODUCTION

In recent years, the application of image processing techniques in automatic traffic signal control has been investigated by several researchers. The major problem concerning automatic traffic signal control is to compute the traffic load from the images captured.

This document aims at counting the vehicles in the traffic images captured for real time traffic signal control using video and image processing Blockset in Simulink Environment of MATLAB. The Video and Image Processing Blockset contains blocks that perform morphological operations such as erosion, dilation, opening and closing. Simulink Blockset contains display block, label block, relational operator and constant block.

The combination of these blocks is used to perform morphological image analysis. Morphology is the study of the shape and form of objects. Morphological image analysis can be used to perform image filtering, image segmentation, and measurement operations.

A Simulink model has been developed using different image processing blocksets . The developed approach eliminates the tiny elements from the image, then creating segments and then counting the number of vehicles.

The remainder of the paper is organized as follows. Section 2 briefly presents the related work. Section 3 briefly describes the experimental environment being used for this study. Section 4 presents the approach developed to count the number of vehicles in the input image. Section 5 draws the conclusion.

II. RELATED WORK

Extensive work has been done in the field of image processing in order to make the traffic control system intelligent and real time. Here, a very brief overview of some of these research works has been presented.

Chen et al. [1] analyzed existing video object segmentation algorithms and found that most of the core operations can be implemented with simple morphology operations. Therefore, with the concepts of morphological image processing element array and stream processing, a reconfigurable morphological image processing accelerator is proposed, where by the proposed instruction set, the operation of each processing element can be controlled, and the interconnection between processing elements can also be reconfigured.

Christe et al. [2] focused on processing an image pixel by pixel and in modification of pixel neighborhoods and the transformation that can be applied to the whole image or only a partial region.

Al-amri et al. [3] have proposed segmentation algorithms based on one of two basic properties of intensity values discontinuity and similarity. First category is to partition an image based on abrupt changes in intensity, such as edges in an image. Second category is based on partitioning an image into regions that are similar according to predefined criteria.

Suthar A.C. et al. [4] have focused on pixel to pixel processing of an image and in the modification of pixel neighborhoods and of course the application of transformation to the whole image or only a partial region.

Shinde B. et al. [5] state that image processing operations can be roughly divided into three major categories, Image Compression, Image Enhancement and Restoration, and Measurement Extraction. It involves reducing the amount of memory needed to store a digital

image. Once the image has been digitized, it can be operated upon by various image processing operations.

Kastrinaki et al. in [6] present an overview of image processing and analysis tools used in these applications and we relate these tools with complete systems developed for specific traffic applications. Image processing also finds extensive applications in the related field of autonomous vehicle guidance, mainly for determining the vehicle's relative position in the lane and for obstacle detection.

Mahalanobis et al. [7] explain the detection and tracking of humans as well as vehicles is of interest. The three main novel aspects of the work presented in this paper are i) the integration of automatic target detection and recognition techniques with tracking ii) the handover and seamless tracking of objects across a network, and iii) the development of real-time communication and messaging protocols using COTS networking components.

Ramadevi et a1. [8] discussed in this paper image segmentation is to partition an image into meaningful regions with respect to a particular Application. Image segmentation is the process of partitioning/subdividing a digital image into multiple meaningful regions or sets of pixels regions with respect to a particular application.

Bhat et al. [9] discussed Object tracking is used to describe the process of recording movement and translating that movement onto a digital model. Simulink with Video and Image processing Blockset enable to run fast simulations for real-time embedded video, vision, and imaging systems.

Arora et al. [10] discussed two techniques for traffic light control. Firstly we have discussed morphological method of edge detection for real time traffic control and then fuzzy logic.

III. EXPERIMENTAL ENVIRONMENT

A. Matlab

MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems.

B. Video and Image Processing and Signal Processing

System objects are algorithms that provide stream processing, fixed-point modeling, and code generation capabilities for use in MATLAB programs. These new objects allow one to use video and image processing algorithms in MATLAB, providing the same parameters, numeric's and performance as corresponding Video and Image Processing Blockset blocks. System objects can also be used in Simulink models via the Embedded MATLAB Function block. Simulink environment provide platform for model-Based Design and code generation out of a user-Friendly block diagram environment. (Fig. 1and Fig. 2)Video and Image Processing Blockset blocks support floating-point, integer, and fixed-point data types. To use any data type other than double-precision and single-precision floating point, you must install Simulink Fixed Point.

C. Parameters

Opening Block Parameter: Use the Neighborhood or structuring element parameter to define the neighborhood or structuring element that apply to the image. Specify a neighborhood by entering a matrix or vector of ones and zeros. Specify a structuring element using the strl function. Alternatively, you can specify neighborhood values using the Nhood port.

Label Block Parameters: At the Label port, the block outputs a label matrix where pixels equal to 0 represent the background, pixels equal to 1 represent one object and pixels equal to 2 represent the second object, and so on. At the count port, block outputs a scalar that represents the number of labeled objects.
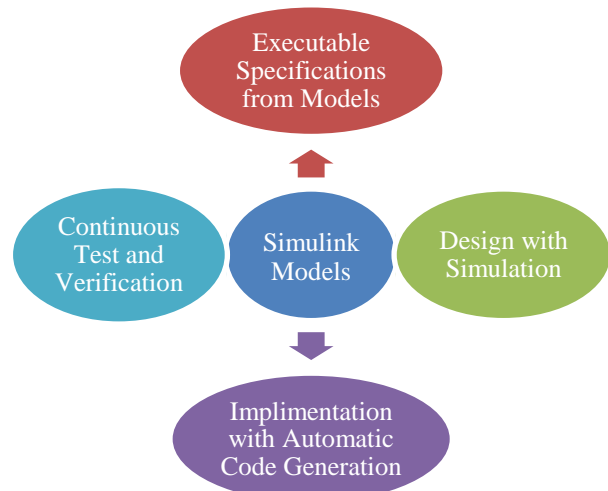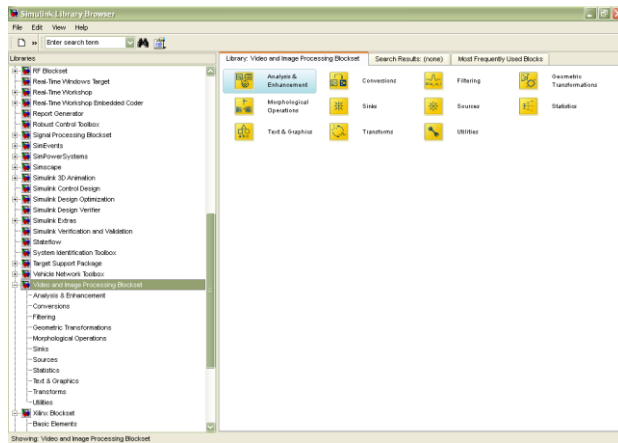

Figure 1:Simulink Model

Figure 2:Video and Image Processing Library Browser

D. Morphological Operators

Morphological operators have a wide variety of uses, including correcting non uniform illumination, enhancing contrast, removing noise, and thinning regions. Morphological operators in Video and Image Processing Blockset include:

▪ Erosion and dilation
▪ Opening and closing
▪ Labeling of connected components
▪ Top-hat and bottom-hat filtering

IV.   EXPERIMENT AND RESULTS

An intensity image of the traffic image is imported and converts it to binary. Then, using the Opening

Block	Library	Quantity
Image From Workspace	Video and Image Processing Blockset / Sources	1
Opening	Video and Image Processing Blockset / Morphological Operations	1
Label	Video and Image Processing Blockset / Morphological Operations	1
Video Viewer	Video and Image Processing Blockset / Sinks	2
Constant	Simulink / Sources	1
Relational Operator	Simulink / Logic and Bit Operations	1
Display	Signal Processing Blockset/ Signal Processing Sinks	1

Figure 4:Blocks Quantity

and Label blocks, the numbers of vehicles in the image are counted.

1. Import the target image from MATLAB workspace and view the image. (Fig. 3)
2. Create a new Simulink model, and click-and-drag the following blocks into it. (Fig. 4)
3. The unconnected blocks are arranged as shown in the figure. (Fig. 5)
    Block parameters are set by double clicking and modifying the block parameters values.
4. Image from Workspace block is used to import the target image from MATLAB workspace.
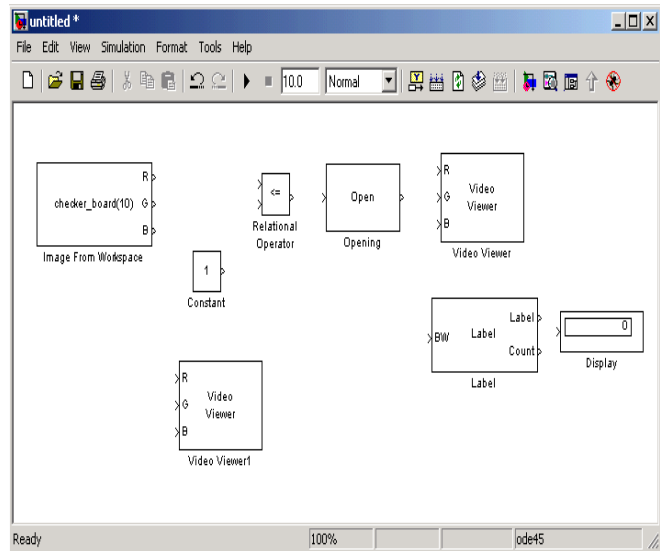

Figure 3:Original image

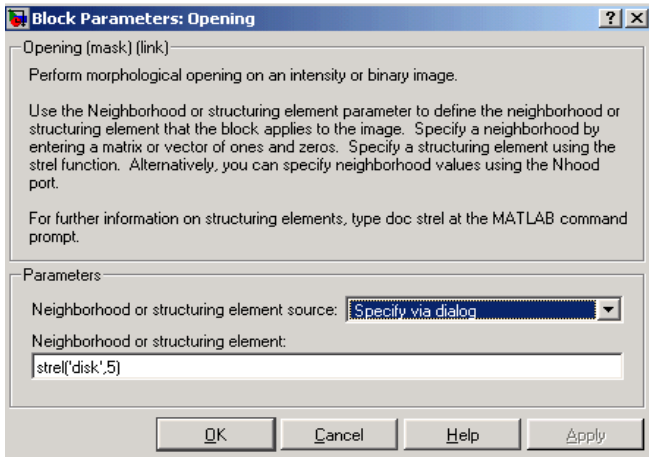Figure 5:Unconnected Blocks

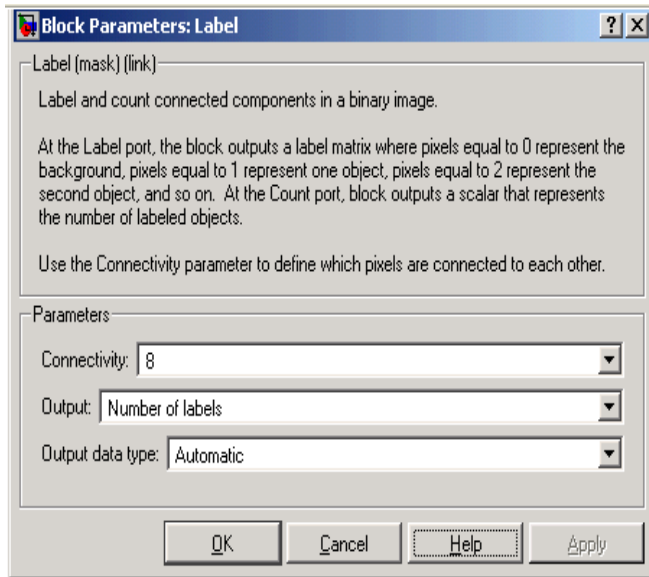Figure 6:Opening block parameters set

Figure 7:Label block parameters set

Block parameters are set as given below:
- Main pane, Value = I
- Main pane, Output port labels = Image

5. Constant block is used to define a threshold value for the Relational Operator block. Set the Constant value parameter to 200.
6. Video Viewer1 block is used to view the original image. Set the Input image type parameter to Intensity.
7. Relational Operator block is used to perform a thresholding operation that converts the intensity image to a binary image. Relational Operator parameter is set to <.
   If the input to the Relational Operator block is less than 200, its output is 1; otherwise, its output is 0.Threshold of intensity image is must because the

Label block expects binary input. Also, the objects it counts must be white.
8. The Opening block to separate the vehicles from the image and from each other at the image. Use the default parameters. (Fig. 6)
   The strel function creates a circular STREL object with a radius of 5 pixels. With the Opening block,
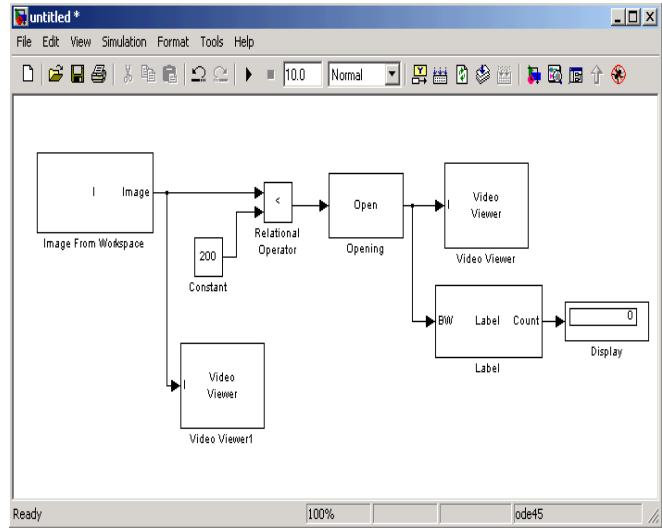
Figure 8:Connected blocks

Figure 9:Original image

Figure 10:Separated Vehicles

STREL object that fits within the objects to be kept is picked.

9. Video Viewer block is used to view the opened image. Input image type parameter is set to Intensity.
10. The Label block is used to count the number of vehicles in the input image. Set the Output parameter is set to Number of labels. (Fig. 7)
11. Displays the number of vehicles in the input image. Use the default parameters.

12. The blocks are connected as shown in the figure. (Fig. 8)
13. The configuration parameters are set. Configuration dialog box is opened by selecting Configuration Parameters from the Simulation menu. The parameters are set as follows:
    - Solver pane, Stop time = 0
    - Solver pane, Type = Fixed-step
    - Solver pane, Solver = discrete (no continuous states)

Result:

14. The original image appears in the Video Viewer1 window. (Fig. 9)
15. The opened image appears in the Video Viewer window. The vehicles are separate white objects (Fig.10)
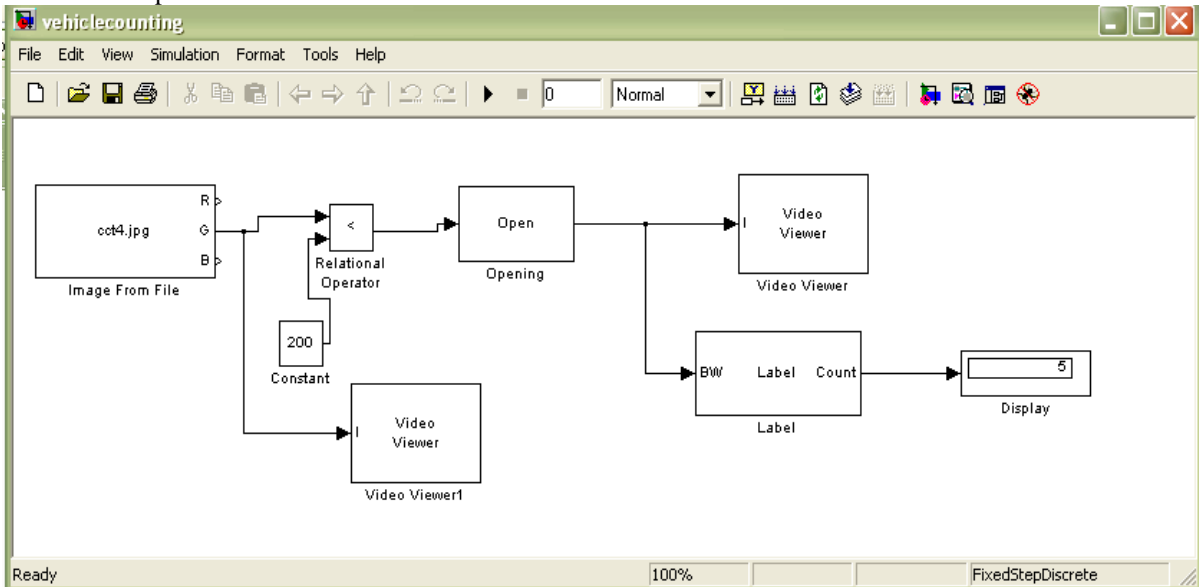16. The Opening and Label blocks to count the number of vehicles in an image. (Fig. 11)

Figure 11:Count number of vehicles (Final Result)

V.   CONCLUSION

In this paper, an image processing algorithm suitable for traffic load computation has been suggested and analyzed. The developed Simulink model is reliable and can perform vehicle counting on roads. This Simulink model will be useful to detect the traffic on road. Hence, the suggested algorithm proves to be an efficient solution for computing traffic load in order to make traffic signal control system dynamic.

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BIOGRAPHY

Prof. G. N. Purohit is a Professor in Department of Mathematics & Statistics at Banasthali University (Rajasthan). Before joining Banasthali University, he was Professor and Head of the Department of Mathematics, University of Rajasthan, Jaipur. He had been Chief-editor of a research journal and regular reviewer of many journals. His present interest is in O.R., Discrete Mathematics and Communication networks. He has published around 40 research papers in various journals.

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