The Traffic Congestion Investigating System by Image Processing from CCTV Camera

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***Abstract*—A main purpose of this research for the Traffic Congestion Investigating System by Image Processing from CCTV Camera is to check a traffic condition from a traffic image on the road. Then, a user can check in advance for a traffic condition in a specific time. The system brings a traffic image from a CCTV camera to process in the system as an input. After that, the system finds for traffic congestion and gets the results in three traffic conditions as Flow, Heavy, and Jammed. Finally, a user can use the system for a transportation planning or an intersection traffic control. For implementation, the system uses an image processing technique to analyze for a traffic condition. It detects how many objects or cars on the road. And then, the system connects a traffic condition result with a database for a transportation planning. Moreover, it can be used with other systems such as a traffic light control system on the intersection.**

Keywords—Image Processing; CCTV Camera; Traffic Condition; Transportation Planning

I. INTRODUCTION

Nowadays, a traffic congestion problem increases especially in a capital city such as Bangkok because of a population increasing. In consequence, it takes more time to transport and a traveler feels stressed. Then, there is a technological system to explain a traffic condition and suggest for a path to transport.

There are many methods to check for traffic congestion. For example, a car quantity and velocity detector on a roadside. This method expends a lot of money and difficult to break a trail. Since, each detector has one sensor for a car counting and the other two for car velocity detection. Another method is using a CCTV camera to take photographs of traffic. After that, a police analyzes a traffic condition from those photographs. Then, the researchers have an idea to create the system that can notify and analyze traffic instead of by a police. Furthermore, the system processes by a computer and send a result of traffic congestion to the system. After that, a police uses that result to plan or control a traffic light system.

Here are two objectives of this research, first is to check a traffic condition and second is to develop the Traffic Congestion Investigating System by Image Processing from CCTV Camera. The system implementation has 2 main steps. First Step: The system receives an input from a CCTV camera. On the other hand, an interface part sends a data file and an image frame from a camera. An image is photographed from a camera in a high position that can see an overview of traffic clearly. Moreover, a camera takes photographs in the same angle at all. Second Step: The system calculates for finding traffic congestion and a car velocity also evaluates for a traffic jam later. In the research, the system checks traffic in a day time that having a static light density. Since, the system uses a background subtraction implementation to detect an object on a road. In addition, the system cannot implement in a raining condition because of unclear visibility. As a result, the system can be used to investigate traffic congestion by an image processing from a CCTV camera. As well, the system can be used for planning a transportation path.

II. LITERATURE REVIEW

A. Grayscale Image

A grayscale image is an image from a color sampling only one channel in each pixel. This kind of image composes of black, gray shade, and white colors. It is different from a black and white image that has only black and white colors to restore an image data. Furthermore, a grayscale image is a result from a light density measurement in each pixel in a magnetic wave frequency such as a white light. A visual grayscale image uses 8-bits data to restore in each pixel in a range of 256 density levels. But for other technical uses, an image uses 10 or 12 bits for a data restoration. [1],[14]-[20]

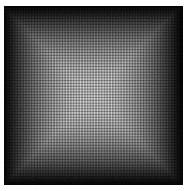

Fig. 1. *A Grayscale Level*

B. Pixel Difference

A pixel difference or pixel subtraction is a process to find the third result image from the first and second input images. This method subtracts pixels of first image by pixels of second

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image. Sometimes, it is possible to have only one input subtracts with a statistic value. [1], [16], [19]

C. Background Substraction Technique

A background subtraction technique is a method to categorize a considering objects for computation after that such as a security system. There are many processes for this technique. In this research, the researchers use Heikkila and Olli Method to implement in the system. [2], [21]

Fig. 2. *Different Threshold Values for A Backgroud Substration*

D. Median Filtering

A median filtering is a method in an image processing technique. This method reduces noise or some dots in an image especially for salt and pepper noise. A mask in an odd size places on an image. After that, Pixels are arranged in an image frame. A medium pixel value is instead of a pixel in a considered position. [3], [15]

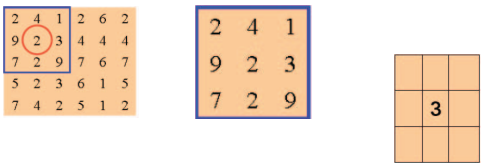

Fig. 3. *A Median Filtering Result Example*

Fig. 4. *A Median Filtering Example for An Image Adjustment*

E. Dilation Operation

A dilation operation is a comparison between a structuring element in various sizes such as 3x3 or 5x5 and each pixel in an image. This process updates a pixel value in a center position of a mask. It considers a pixel that has the highest value to put in that center position of a mask. For a black and white or binary image, it considers only a pixel that has 1 in value but not 0 at all. [3]

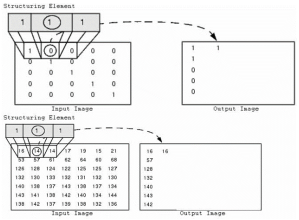

Fig. 5. *A Dilation Operartion Implementation*

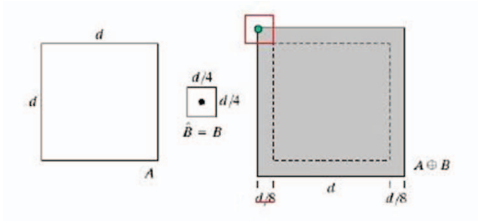

Fig. 6. *An Image Result from Dialation Operations*

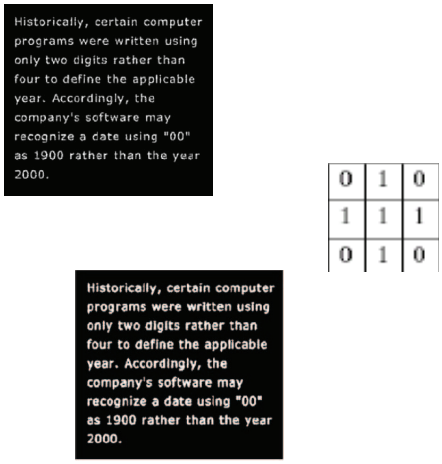

Fig. 7. *An Example Use of Dialation Operations*

F. Erosion Operation

An erosion operation is similar to a dilation operation. The difference is erosion is interested in a lowest value of a pixel. It means that a pixel will be 0 in value if a value in an image frame is 0 in a binary image. [3]

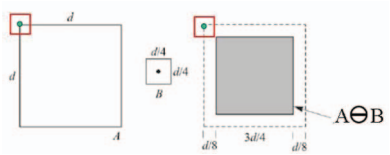

Fig. 8. *An Image Result from Erosion Operations*

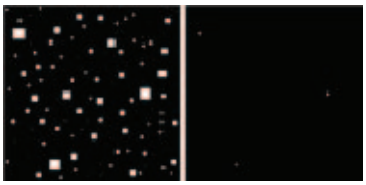

Fig. 9. *An Example Use of Erosion Operations*

G. Closing Operation

A closing operation is a composition between dilation operations at first and continues with an erosion operation after that. This method fulfills a curve area of an image that a mask can place on an image background. It stretches an image area in white color and decreases a background area that some shapes in an image are changed just a little. [9]

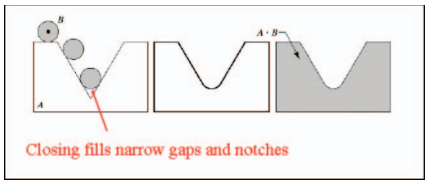

Fig. 10. *A Result from Closing Operations*

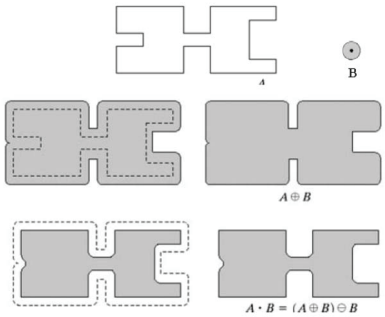

Fig. 11. *An Image Result from Closing Operations*

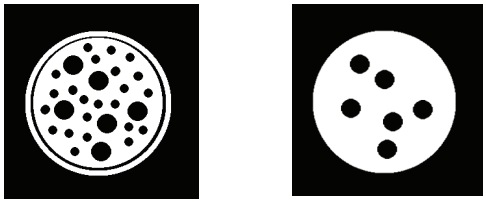

Fig. 12. *An Example Use of Closing Operations*

H. Edge Detection

An edge generally identifies how large of an area. By the way, the meaning in the system is a change in a grey level when measure a value of edge by an ideal edge. This kind of edge is a group of pixels connecting together in a vertical line. This line is perpendicular with a change in gray level in an ideal way. But in an operation way, any images have blurred edges or not clear like an ideal image. The edges of those images are ramp like. A value of an edge density can find from a ramp. Also, a ramp is the beginning and the end of a change in a gray level. As well a length of a ramp can find from its slope. [9]

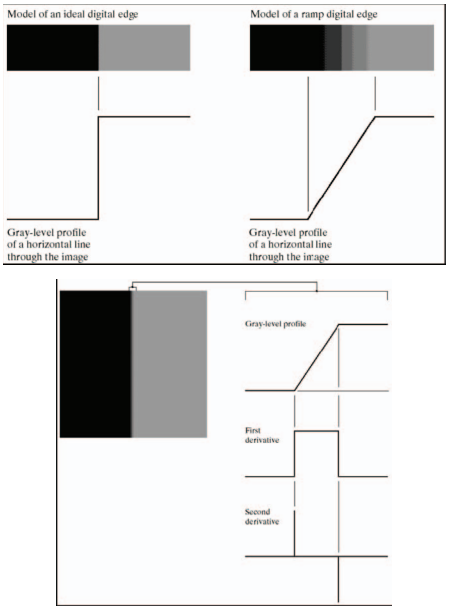

Fig. 13. *Model of Ideal and Ramp Digital Edges*

H. Contour-Based Method

A contour-based method finds an edge from each pixel in the same color level than can separate between image edge and background. In addition, this method finds all image edges and deletes pixels on those edges at all except the ones specify for image continuity. And this method uses 3x3 templates to find pixels for subtraction. [6], [22]

There are four processes for a contour-based thinning algorithm: First, finding all contour pixels. Second, specify on any contour pixels that cannot delete. Third, delete all pixels in a contour except those pixels in the second step. Forth, if there are any deleted pixels in the third step, the algorithm will repeat on the first step. [6], [22]

This process of finding an outer edge is similar to a process of finding a chain code. It begins with any black pixels having similar pixels in a plane for a background. Each pixel is counted clockwise until meets a first count pixel again. Each counted pixel restores in a list that is easier to access later. After that, the process specifies an edge. As well, it repeats an implementation by itself in order to find an inner edge from a holed object until no more pixel in the beginning. [6] ,[23]-[26]

III. SYSTEM IMPLEMENTATION

A. Overview Processes

The Traffic Congestion Investigating System by Image Processing from CCTV Camera is separated in three main parts in an overview. First part is an image categorization by background subtraction and vehicle detection techniques. Second part is a traffic density computing from a traffic image. Third part is collection and representation of a traffic condition.

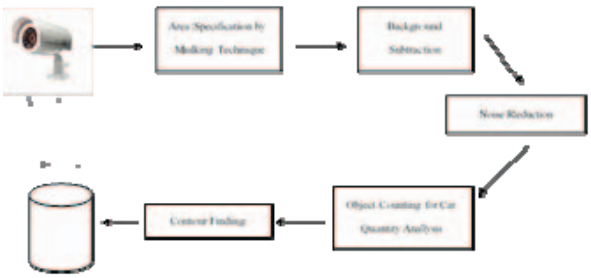

Fig. 14. *Overview Processes of the Traffic Congestion Investigating System*

B. Processes in Step by Step

Step 1: Use a masking technique to delete unnecessary parts out for the system computing from CCTV camera images in each frame. Those example unnecessary parts are an opposite site of the road or a sidewalk.

Fig. 15. *A Masking Function for an Edge Specification*

Step 2: Change an image to a form of grayscale for finding threshold.

Fig. 16. *Grayscale Images for Background and Object*

Step 3: Use a background subtraction technique to find for objects or cars on the road.

Fig. 17. *A Binary Subtraction and a Binary Image*

Step 4: Use an erosion technique to reduce noise and connect object pixels together with a dilation method.

Fig. 18. *A Result Image from Erosion and Dilation*

Step 5: Use a contour technique in order to find out an edge in each object from an image.

Step 6: Analyze an object from a distance with a CCTV camera. If an object is near from a camera or in a lower part of an image, that object will be big. In an opposite way, if an object is far from a camera or in an upper part of an image, that object will be small. After that, the researchers analyze in case of a size of an object does not relate to a distance from a CCTV camera. For example, a too small object maybe is not a car. Also, a too big object is more than one car especially when traffic is congestive. In consequence, there is an overlap between each car in traffic. Then, there is an estimated value for a car quantity that sticking together. Here is a calculation for that estimation.

First, from (first pixel in y axis) to (last pixel in y axis) do. Second, an estimating formula is Number of Cars in This Range = Contours Size / Size of One Car in This Range. Third, increase output by adding number of cars in this range. Forth, adjust y axis pixel to another range. A pixel in y axis represents a distance from a CCTV camera. A contours size represents how large for contours in an image. A size of one car in this range represents a distance between a car and a CCTV camera. A number of cars in this range represent a rough car quantity from a CCTV camera. An output represents a rough car quantity in an image frame.

Step 7: This step is an implementation for a traffic congestion notification as flow, heavy, or jammed. After getting an output as a roughly car quantity, the system computes that output with a previous image frame to find for an average value and do a ratio calculation with an entire area after using a masking technique. This method supposes that a whole area is full of cars and how many cars in that area in the same way to suppose that all the pixels have an object. As a result, if a ratio value is similar to 1, it means that traffic is jammed. If a ratio value is between 0.4 and 0.7, it means that traffic is heavy. And if a ratio value is less than 0.4, it means that traffic is flow.

Step 8: Transfer a traffic congestion data to a database of the system for a traffic planning.

C. *System Results*

There are 3 kinds of result to notify for a traffic condition as flow, heavy, and jammed.

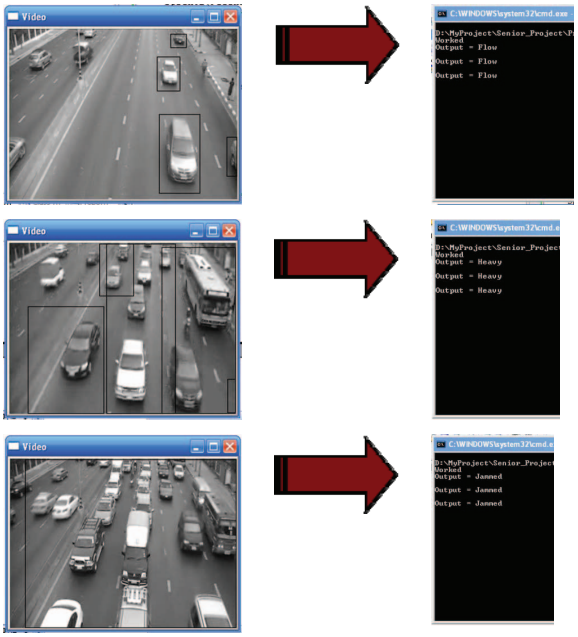

Fig. 19. *System Results from the System Implementation*

IV. CONCLUSION AND SUGGESTION

The system uses an image processing technique to analyze for a traffic condition. It detects how many objects or cars on the road. And then, the system connects a traffic condition result with a database for a transportation planning. Moreover, it can be used with other systems such as a traffic light control system on the intersection.

Here are two suggestions of the system. First, a user should understand clearly in details, probability, and limitation to implement the system more simply. Second, a user should understand in all processes of the system also manage for timing while implementing the system.

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