CCTV Based Surveillance System for Railway Station Security

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Abstract—This paper proposed the image enhancement method using the data matching with histogram shaping technique. The experiments were conducted using images with 1,280 × 720 pixel collected from CCTV surveillance video system. Type of images (.jpg) is in RGB24 form and first frame's surveillance video file (.avi). The results showed that the proposed method using images enhancement technique can improve the quality of images from surveillance video system using the proposed image enhancement based on histogram shaping technique.

Keywords— CCTV; Image Enhancement; Histogram Shapes; Data Matching

I. Introduction

In 2017 research survey on risky train station in Melbourne, Australia participated by woman passengers, it turns out that Flinders Street railway station in the heart of Melbourne was found to be the highest risky station with the lowest security. Between October and December of last year 2016, Melbourne girls and women have been voluntarily asked to cooperate in sharing the good and bad experiences of using Melbourne's public places in free to be, an online map developed by Plan International Australia or Plan, an independent humanitarian development and humanitarian organization based in 71 countries around the world as the photo sample of risky rail-roadside shows in Fig.1 and train passenger accidently fell into the train tracks shown in Fig.2. This study has an aim to develop the automated accident alerting system based on the surveillance camera system and to maximize the coverage efficiency. The system we proposed consists sets of CCTVs, motion sensors, recorder kits and alarming system. The motion of object will be detected by our system when an object or human appears in the danger zone. The detection then commands the alarm system to alert the station security to notify or until the detected object or human steps out of the danger zone. The researcher has aimed to the benefit and analyzed to minimize the risk of the accident. The purposes of our system are to enhance the security and safety system for railway passengers with minimizing the risk of accident, to protect the property of railway system, and to provide the benefits to development of the railway transportation system. Moreover, our study focuses on evident recording in case of investigation and incident protection on time to save passengers' life.

Fig.1. Dangerous scene with approaching train.

Fig.2. Train commuter accidently fell into the railroad tracks.

The organization of paper is described in sections following by related literature, proposed method, experimental results and finally conclusion.

II. Related Literature

A. CCTV principle process

CCTV works beginning with the camera receiving the image which is the reflection back of the light projection onto the object. Performance of the camera depends on the light sensitivity resulting in a different quality of videos and images. In CCTV system, there will be a video signal transmitted in the cable connected between camera and digital video receiver (DVR), and video signal sent to the monitor to display the image captured by camera. The camera and monitor are usually placed in remotely different locations. The CCTV system is shown in Fig.3.

Fig. 3. CCTV System.

Ahmad et al. [1] discusses a new type of closed-loop television camera system with functions generated from innovations in modern science. The use of closed-loop system was applied in work of tracking and monitoring the human activities, movements or objects. In public environment, both safety and crime are monitored for both indoor and outdoor areas by means of infrastructure such as on highway. The parking lot and the shopping mall were found to be the most vulnerable areas that have been researched for disaster alert, crime prevention and management by a group of researchers at the Hibell Research Institute [2] for improving image quality.

B. Illumination - Reflectance Model

Pang et al. [3] found that Illumination -Reflectance Model is a function image. The 2-dimensional model of the function image F(x, y) with positive values (x, y) is the positive number of scales. The physical meaning, which is determined by the source. The image is an array of light intensity and a function of the amount of light reflected from the object in the scene that can be used in the development of frequency shown in Fig.4. F(x, y) can be represented by a product of illumination and reflectance components reported by A. Ein-shoka et al. [4]. The illumination is an amount of light from sources that arise from the perspective scene, displaying in value of I(x, y) and the reflectance is an amount of light reflected from the object defined by R (x, y). The product can be formulated according to (1).

$$F(x,y) = I(x,y)*R(x,y) \tag{1}$$

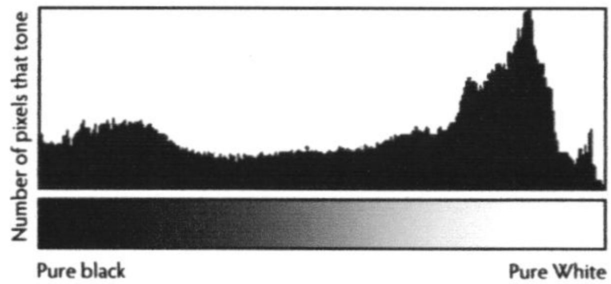

Fig. 4. Histogram depicting the frequency distribution.

C. Homomorphic Filtering

P. S. Vikhe and V. R. Thoo [5] said that homomorphic filters are generally the techniques for signal processing and image processing that convert image to different domains and inversely transform back to the original domain. It works simultaneously to add full-frame imaging and sharpening. The procedure of homomorphic filter can be implemented in five steps depicted in Fig. 5 that can be described as following.

$$F(x,y) \rightarrow \boxed{\ln} \rightarrow \boxed{FFT} \rightarrow \boxed{H(u,v)} \rightarrow \boxed{IFFT} \rightarrow \boxed{EXP} \rightarrow G(x,y)$$

Fig. 5. Steps of Homomorphic Filtration.

Step 1: Taking logarithm on both sides of Z(x,y) to separate two elements of I (x, y) and R (x, y).

$$Z(x,y) = \ln[I(x,y)] + \ln[R(x,y)] \tag{2}$$

Step 2: Converting the imported image into a frequency domain by Fourier Transforming according to (3).

$$Z(u,v) = FFTi(u,v) + FFTr(u,v) \tag{3}$$

When FFTi (u, v) and FFTr (u, v) are the Fourier transformation of ln[I (x, y)] and ln[R (x, y)], respectively.

Step 3: Filtering the High Pass of Z(u, v) by using a filtering function of H(u,v) in frequency domain, obtaining the filtered S(u, v) as following.

$$\begin{aligned} S(u,v) &= H(u,v)Z(u,v) \\ &= H(u,v)FFTi(u,v)+H(u,v)FFTr(u,v) \end{aligned} \tag{4}$$

Step 4: Inverting the filtered image in the spatial domain S (x, y) by Inverse Fourier Transform according to (5).

$$S(x,y) = IFFT\{S(u,v)\}$$
$$= IFFT\{H(u,v)FFTi(u,v) + H(u,v)FFTr(u,v)\} \quad (5)$$

Step 5: Taking Exponential conversion to improve the image G (x, y).

$$G(x,y) = Exp\{S(x,y)\} \quad (6)$$

D. Gaussian High-Pass Filter

For the filter function H (u, v) used in the filtering step Y. B. Yuan et al. [6] proposed a Gaussian High-Pass Filter sharpening that achieved in the frequency domain. By using the high frequency filtering process through high frequency filter the passive low frequency components are not disturbed. High-frequency data in a Fourier transform results in an image. Blurring was used to reduce interference made from change. The two-dimensional Gaussian model is derived as (7).

$$H(u,v) = 1 - e^{-D^2}(u,v)/2D_0^2 \quad (7)$$

D (u, v) is the distance from the origin of the transfer and σ is the Gauge Indicator for $\sigma = D_0$.

III. Proposed Methodology

The system was designed to alerts the accident events at train station and to prevent potential accidents and its system diagram is shown in Fig. 6.

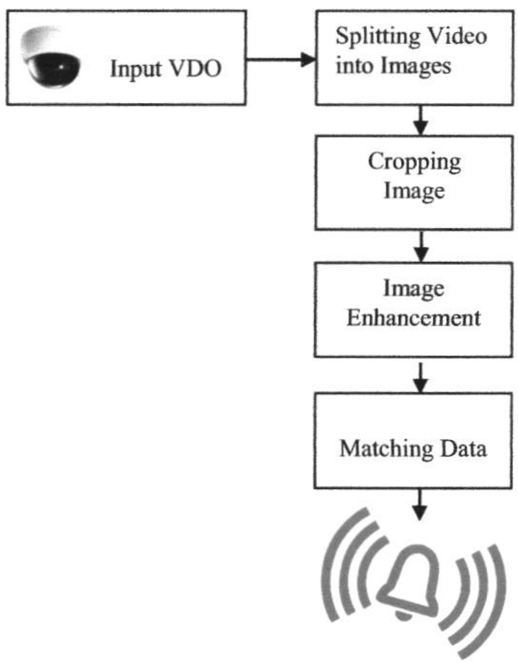

Fig. 6. Surveillance system on train station based on CCTV diagram.

The system is able to record events occurring at the train station however the quality may be reduced when having less light such as in the evening time approximately 6:00 pm and the data matching will be less accurate. The process of how surveillance system works can be described as follows.

Step 1. Splitting video into images in RGB24 .jpg type with dimension of 1,280 × 720 pixels from the video file that the CCTV camera will detect the object for 30 frames per second and stored them in a 3D array.

Step 2. Cropping image with region of interest (ROI) on the interested area and white line area (Critical Area) or warning area.

Step 3. Converting the RGB to binary, the principle is simple. First starts to find the average color of the three colors: blue, green and red as (8).

$$G = (B + G + R) / 3 \quad (8)$$

However, we find that our eyes respond to three different colors. Therefore, Craig Mark Wart proposed [7] the following (9)

$$G = 0.114B + 0.587G + 0.299R \quad (9)$$

If we want to implement the program in OpenCV to solve the different response to colors, we need to create a grayscale image to capture such results. After that calculating the sum of pixels from the image. Then save it to the grayscale pixel at the same location.

Step 4. Applying image enhancement technique with the original image by using homomorphic filter with Gaussian High-Pass Filter when $D_0 = 0.25$. The output image obtained from Homomorphic filtering was shown in Fig. 7.

Fig. 7. Homomorphic filter images (HM).

Step 5. Estimating histogram of image after image enhancement.

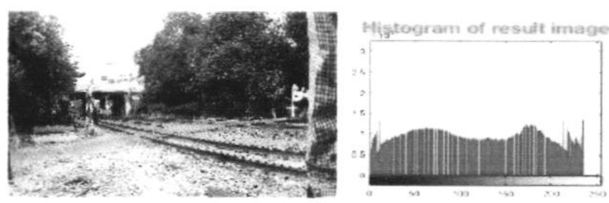

Fig. 8. Histogram shape from the image enhancement.

Step 6. Matching the data determine the relationship between the original image and the image captured at the railway station area. The image will be compared to the value F (0,1) and stored automatically. The prototype image stored in variable G is set to zero and it will not be changed. Then used the value of variable to find the difference between the prototype and the image to be compared by following equation formulated in (10) and the image result at value F was equal to 0 shown in Fig. 9. The images used in comparison were stored in variable G shown in Fig. 10.

$$f(x,t)\cdot g(x,y) \leftrightarrow F*(u,v)\cdot G(u,v)$$

$$F(u,v)=\frac{1}{MN}x\sum_{x=0}^{M-1}\sum_{y=0}^{M-1} f(x,y)\cdot e^{-1Zn(\frac{ux}{M}+\frac{vy}{N})} \tag{10}$$

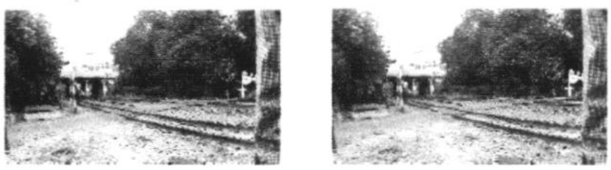

Fig. 9. The original image stored in variable F is 0.

Fig. 10. The images used in comparison stored in variable G.

Sample image tested by histogram is split into a frame image at a time so that it can display the shape of the histogram.

Event 1.

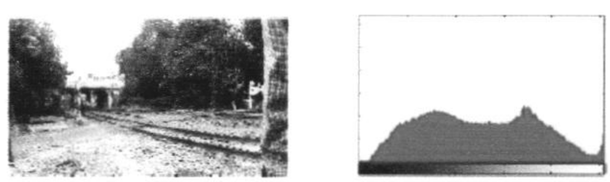

Fig. 11. Original Image with normal event image that holds a value of 0.

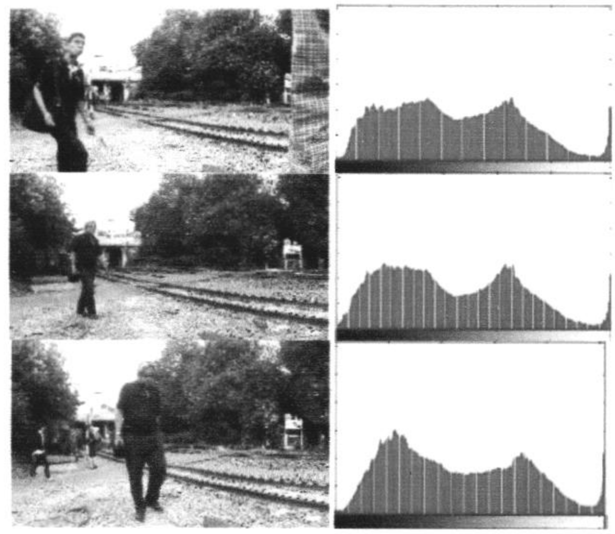

Fig. 12. A typical event image that holds a value of 0.

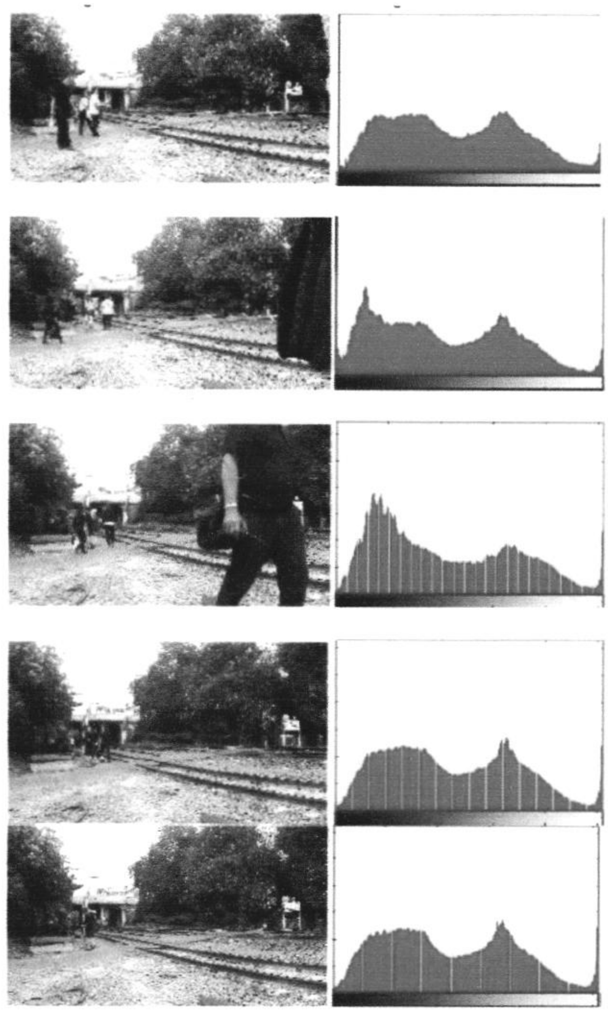

Fig. 13. A typical event image that holds a value of 1.

Event 2.

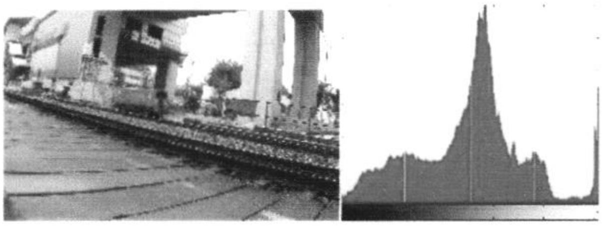

Fig. 14. Original Image with normal event image that holds a value of 0.

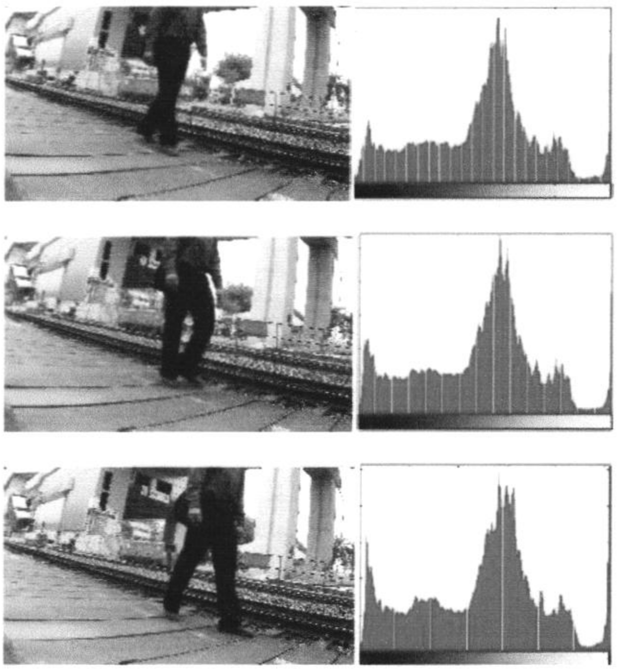

Fig. 15. A typical event image that holds a value of 1.

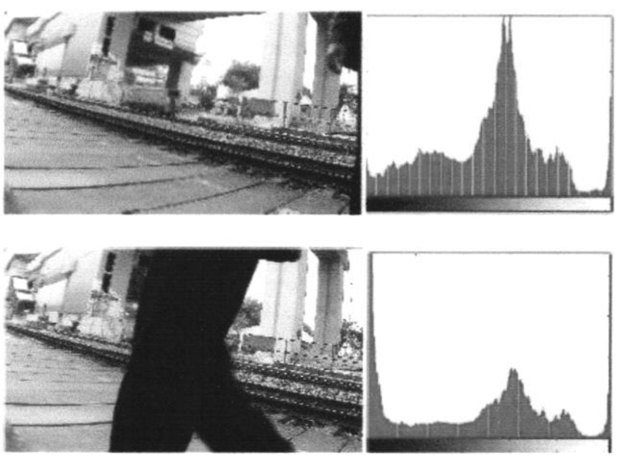

Fig. 16. A typical event image that holds a value of 1.

In the test case. The database was ten saved to system for decision making. The rules are as follows in Table I.

TABLE I. MATCHING DATA WITH "OR" RULE

CASE	ORIGINAL IMAGE	NEW IMAGE	RESULT	SURVEILLANCE
CASE 1	0	0	0	NO
CASE 2	0	0	0	NO
CASE 3	0	1	1	YES

If the value is 0, it means the object not in the control area which is considered to be not surveillance. In the case of a value of 1, the object is in the control area and it considered to be incident and accident then the surveillance system will be activated.

IV. EXPERIMENTAL AND RESULTS

In our experimental results, we set our system installed at the railway station with devices used in Table II.

TABLE II. DEVICES CONFIGURATION

Hardware	Amount
CCTV	1 set for 1 location
Motion Sensor Kit	1 set for 1 location
Electromagnetic switch	1 set for 1 location
Siren Signal LED	1 set for 1 location
Surveillance system	1 set for 1 location

The experiments were tested for several periods of time. And the results are presented in Table III.

TABLE IV. RESULTS OF IMAGAE DETECTION

Test cases	Number of time	Detected images	Accuracy
Normal daylight broad light	20	12	80%
Time between 6.00 pm – 6.00 am	20	10	50%
Night time with cloudy and rain.	20	16	60%
Night time with lighting from the lamp.	20	10	50%

In our experiment, there are four testing cases with twenty repetitions in each case. First case is normal daylight, our system can detect all twelve images with 80% in accuracy. Second case was tested during time interval between 6.00 pm. – 6.00 am. Our system can detect ten images with accuracy of 50%. Third case is the night with cloudy and rain our system detected sixteen images suddenly the accuracy is 60%. The last is night time with light from the lamp, our system can detected ten images the accuracy is 50%. From all testing cases in our experiment, the highest performance accuracy can be found form the case of normal broad daylight and the rest is not highly effective regarding lighting illumination. The images from CCTV camera is quite sensitive with illuminance.

V. CONCLUSION

This paper presented a surveillance system on railway station based on CCTV. The efficient security camera system can benefit and usable to increase safety of life and property. The results of the experiment on railway station surveillance system based on CCTV showed the satisfied performance of image detection under light condition. However, this system will be improved for sensitive cases of night time surveillance which is our future step.

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