Classification of Walking Cars and Pedestrians for the use of Automatic Incident Detection as an Effort to Reduce Risk of Accidents on the Highway

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ABSTRACT

Traffic problems become very important to minimize the number of accidents. Recorded in 2017, the death toll from accidents reached 703 people. While in 2018 503 people died or fell by 28%. This figure is considered to be the third largest killer, under coronary heart disease and tuberculosis / tuberculosis. Among several causes of accidents such as against the flow of traffic, stops on the road, pedestrians and speeds that are too low compared to other vehicles. Even though the traffic signs are already installed. The low level of awareness of road users will increase the number of accidents. A detection system for potential accidents is needed to reduce the risk and can be used for the investigation process if an accident occurs. The application of a traffic accident prediction system will be a solution to provide a warning of potential accidents. Early detection of incidents is very important to limit consequences such as delays for other road users, lower costs, less time commitment to emergency services, as well as to prevent accidents. Video processing obtained from CCTV installed at intersections, highways, bridges and tunnels will detect pedestrians and oncoming cars automatically. Detection is done by processing each video frame to determine the foreground by the Gaussian mixture models method of each video frame.

I. Introduction

Traffic problems become very important to minimize the number of accidents. Recorded in 2017, the death toll from accidents reached 703 people. While in 2018 the death toll was 503 or fell by 28%. In 2017, there were 732 people seriously injured due to traffic accidents. While in 2018, the number of victims fell by 37 percent or as many as 458 people [1]. This figure is considered to be the third largest killer, under coronary heart disease and tuberculosis / tuberculosis [2].

Among several causes of accidents such as against the flow of traffic, stops on the road, pedestrians and speeds that are too low compared to other vehicles. Even though the traffic signs are already installed. The low level of awareness of road users will increase the number of accidents. Some solutions to reduce the number of accidents such as limiting speed, imposing an open-close system and installing traffic lights at each intersection have been done, but the number of accidents is still high [3]. A detection system for potential accidents is needed to reduce the risk and can be used for the investigation process if an accident occurs.

The application of a traffic accident prediction system will be a solution to provide a warning of potential accidents [4]. Early detection of incidents is very important to limit consequences such as delays for other road users, lower costs, less time commitment to emergency services, also to prevent accidents [5][6]. Video processing obtained from CCTV installed at intersections, highways, bridges and tunnels will detect pedestrians and moving vehicles. Detection is done by the first few stages of determining the foreground of each frame as an effort to detect the observed

object, the second stage is carried out cleaning the noise from the foreground detection process [7]. The last step is the detection process of cars and pedestrians by giving a sign to each object.

II. Literature Review

A. State of art

Research on automatic incident detection (AID) has been carried out, such as in table 1.

Table 1. *State of art*

Model	Research problem	Method	Result
Humphreys, James Anthony Hunter; Holliman, N (2004)	create a real-time tracker capable of robustly classifying and tracking pedestrians and vehicles on a static CCTV scene	SOMs	99.2%
Motamed, Moggan; Machemehl, Randy (2014)	The algorithms using loop data suffer from high rates of false alarms.	dynamic time warping (DTW) and support vector machine (SVM)	Base-RBF Training : 98.36% Validation: 97.95%
Hadi, Raad Ahmed; Sulong, Ghazali George, Loay Edwar (2014)	A review present a concise overview of image processing methods and analysis tools which used in building these previous mentioned applications that involved developing traffic surveillance systems	Region-Based Tracking Methods Contour Tracking Methods 3D Model-Based Tracking Methods Feature-Based Tracking Methods Color and Pattern-Based Methods	
Acharya, D. Khoshelham, K. Winter, S. (2017)	The extracted features serve as a strong basis for a variety of object recognition tasks and are used to address a tracking problem detection of the pedestrian	convolutional neural networks	71.13 %

B. Automatic Incident Detection (AID)

when monitoring is done manually, it is not possible to watch more videos than the actual number of monitors, which can cause delays in handling, for the supervisory staff it becomes a burden to consistently maintain concentration to detect abnormalities in traffic[8]. Because the AID system is constantly processing image data, there is no limit to the number of monitors, and an incident can be detected in real time [9]. Supervisory staff can carefully examine the location of an incident or circumstances before and after an incident based on information provided by the system and by using the CCTV camera's zooming and playback function. This makes it possible to effectively provide information to other drivers through information boards and also immediately notify police and patrol cars about the incident.

C. Gaussian mixture models

Gaussian mixture models (GMM) consist of multivariate k normal density components, where k is a positive integer [10]. Each component has a d-dimensional average (d is a positive integer), d-per-d covariance matrix, and mixing proportions. The proportion of mixing j determines the proportion of the population arranged by components j, j = 1, ..., k.

$$p(\vec{x}) = \sum_{i=1}^{K} \phi_i \mathcal{N}(\vec{x} \mid \vec{\mu}_i, \Sigma_i) \tag{1}$$

$$\mathcal{N}(\vec{x} \mid \vec{\mu}_i, \Sigma_i) = \frac{1}{\sqrt{(2\pi)^K |\Sigma_i|}} \exp\left(-\frac{1}{2}(\vec{x} - \vec{\mu}_i)^{\mathrm{T}} \Sigma_i^{-1} (\vec{x} - \vec{\mu}_i)\right) \tag{2}$$

$$\sum_{i=1}^{K} \phi_i = 1 \tag{3}$$

The Gaussian mixture model is parameterized by two types of values, the weight of the mixture component and the component / covariance average. For the Gaussian mixture model with the component K. the Kth component has a mean of μk and variance of σk for univariate cases and averages of $\vec{\mu}k$ and covariance matrix of Σ_k for multivariate cases. The weight of the mixed component is defined as ϕk for the C_k component, with that limitation $\sum_{i=1}^{K} \phi_i = 1$ so that the total probability distribution becomes normal to 1. If component weights are not studied, they can be seen as distributions of components so that p (x is produced by component C2).

III. Method

A. Methodology

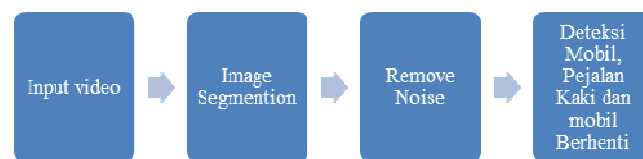In the research that has been done has several stages shown in Figure 1.

Figure 1. Research Methodology

Video results from CCTV will be processed in several stages, the first stage is the 30fps video input obtained from cctv capture placed on the side of the road. CCTV installation scheme as in figure 2.
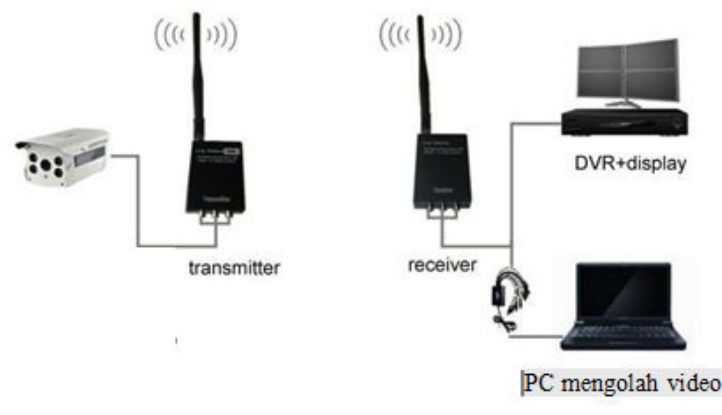

Figure 2. Input process Video

Each frame is processed to be identified. The second stage is detecting the existing road segments in the video, the process carried out such as detecting the curb line and the center line of the road. The third stage is the segmentation section to determine the ROI (region of interest) of the object to be detected, ROI in this process is like cropping cars and pedestrians. In this process, the Gaussian mixture models (GMMs) are used to determine the foreground of an image frame.

After the segmentation stage, the remove noise phase, which removes the pixel that is not considered to be from an object, this noise is caused by the same pixel value as a car object by using morphologically open image, this stage is very important to retrieve and collect features from the object. The final stage is tracking objects that have been marked like a stopped car, pedestrians and a car that is speeding. The object will continue to be monitored and marked by the system.

IV. Result And Discussion

From the results of research that has been done, obtained results of streaming video from CCTV as shown in the picture. In this experiment the internet speed reached at least 100Kbps.

Figure 3. CCTV Capture Results

From the results of CCTV streaming, the video is processed with the application of GMM, so as to produce the image shown in Figure 4.
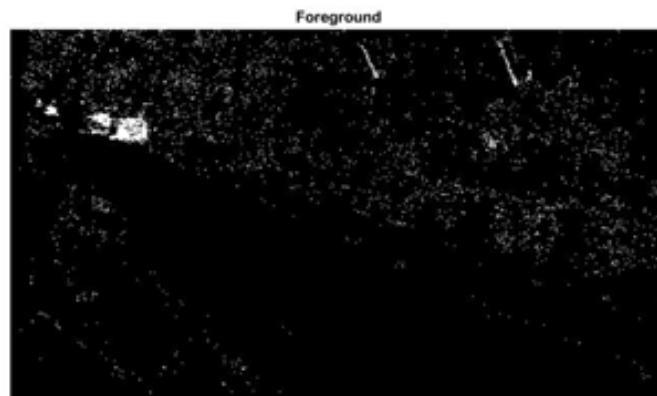

Figure 4. Results of the GMM process.

Figure 4 is the result of using the first 50 frames to initialize three GMM modes.
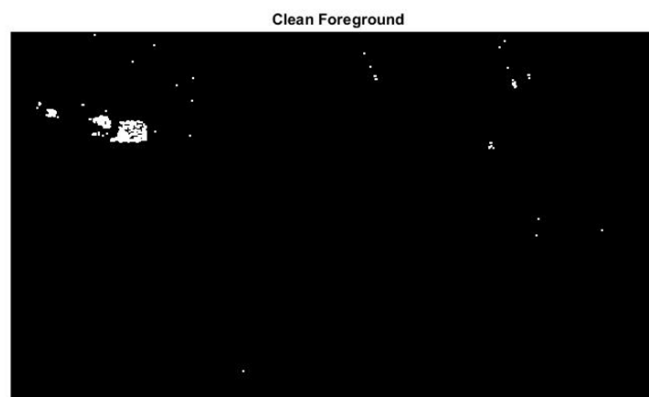

Figure 5. Remove Noise Results

In picture 5 which is the result of cleaning the noise is done by morphologically open image where the cleaning is carried out a square that is 2 pixels wide. The next step is marking the white object with a value of 255 in the noise cleansing image as in Figure 6.
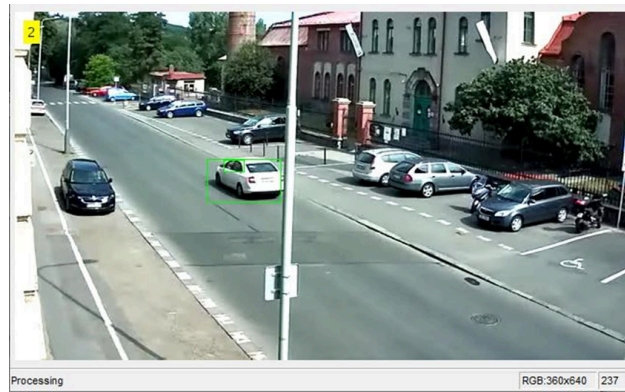
Figure 6. Car tracking results.

Marking will continue to follow moving objects contained in the video input from the CCTV streaming results. There are some marking errors that occur due to imperfections in cleaning the noise in each frame as in Figure 7.
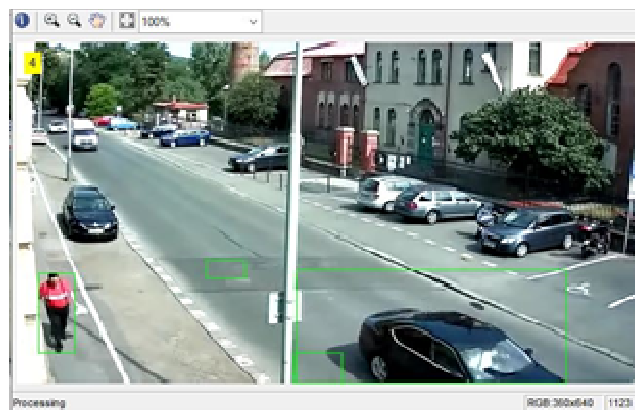

Figure 7. Results of tracking cars and pedestrians

V. Conclusion

After the trial process the video streaming from CCTV goes well at a minimum internet speed of 100Kbps. The results of tracking cars and pedestrians were successfully carried out by marking each object per video frame. There is a marking error caused by a noise cleaning failure. In the future, the research will continue to give warnings to car objects that are indicated to collide. This can be done by analyzing the movement and pixel width of moving objects.

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