TECHNOLOGY THE FIRE DETECTION SYSTEM ON THE RAILWAY LINE IS BASED ON IMAGE PROCESSING WITH THE COMPUTER VISION METHOD

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ABSTRACT

The rail transportation system plays a role important as a medium of transportation for the movement of goods and people in large quantities and is one of the modes of cheap transportation, this transportation model evolved from a steam train until it evolves to become more sophisticated using electric and magnetic technology, trains system works well with support from several the first factor is human resources, supporting technology and facilities. The problem with the rail system is that damage to the rails can cause result in the transportation route being blocked and can cause a very fatal accident, Based on these problems, besides the feasibility of the rail system, rail maintenance is a very important key, the railroad track maintenance system is usually carried out periodically. The solution to handle this problem is to use a computer vision method by utilizing surveillance cameras or CCTV installed on railroad crossings able to detect damage, the detection of damage is categorized into a few types first is track damage, due to shifts, fires on rail lines and finally structural damage due to earthquakes or landslides in the railway line area, this technology has been applied to several developed countries. and can monitor a large area and can provide a quick response if a malfunction occurs, the system will be a smart monitoring system but doesn't replace the role of a railway officer but as a tool that will provide complete information where the location of the damage is so that prompt and more effective repair action can be taken.

Keyword: ***Railway , Computer Vision, Maintennance***

1. INTRODUCTION

The train transportation mode is still the main choice of the community today because it has an excess of large transportation capacity and very affordable prices, the rail transportation mode has been present since the Dutch colonial era which was originally used as a means of transporting plantation products and logistics, at this time in Indonesia still uses the Dutch heritage rail line, the rail has a very long life so that a maintenance and repair system is needed seriously that is currently spread across the islands of Java and Sumatra.

In the railway system modern

railways are divided into two parts, namely surface rails and subway underground tracks, the length of the railway line requires a process of maintenance and repair, this treatment can use human assistance workers or use the help of conventional-based cctv stored in accident-prone areas caused by human actions or caused by natural disasters, damage to the railway line requires a proper handling process because the line used will be reused by other trains, the damage detection system on the current railway line uses the help of electronic sensors, the sensor is usually installed on the railroad sleeper and will respond if there is a vibration outside the normal frequency, the sensor will provide information to the central station.

The most recent monitoring system is camera-based or uses drone monitoring videos, the use of drones is expected to provide a broad picture of damage detection methods on railways can use image processing methods, these methods and technologies are widely used in industry because they have a high level of accuracy and are easy to configure. A remote sensing process that can be used to detect damage to the railroad tracks based on image processing assistance using remote sensing, this method is very necessary because it can read objects or a very wide area of surveillance, this technology is widely used to analyze the space of forest fire areas so that the information obtained becomes detailed and clear. In later developments, this method can also be applied to monitor and analyze the damage that exists in the path of fire. One of the technologies that offer a remote sensing system that we often use is to use LandSat satellite imagery, this satellite imagery offers several advantages, namely having more detailed images at a cheaper price and compatibility if used using other applications.

The current railway detection system has attracted several researchers who are closely related to local behavior and customs to open up land, one of which is in Indonesia, so that the emergence of several hotspots or hotspots that

can be monitored directly by satellite imagery and can be directly identified the type and area of fire, especially those passed by railway lines, from these data, from the emergence of fire points in the fire area on the railway line can be identified and calculated directly on the landsat image object will be displayed different pixel points and have a temperature displayed with a temperature value of brightness temperature or with the formula (Temperature Brightness = Tb), with the appearance of this hot spot will be used as a reference for the presence of a difference in the form of an image or pixel, According to the Temperature Brightness technique, the fire area can be categorized into two parts of the lower fire (Crown fire), and surface fire (Surface fire)

2. LITERATURE REVIEW

In the process of detecting fire images, you can use the help of an algorithm that has the ability to read features effectively. One of the algorithms used is CNN, This type of algorithm has attracted great attention due to poroses accuracy and excellent data reading on the search and reading of objects visually. Therefore, some studies combine the capabilities of CNN into the field of fire detection, thus this algorithm can read in a collection of fire image features that are often used to detect fire points in forest fire areas (K. Muhammad, J. Ahmad, I. Mehmood, et al., 2018)

Although the fire detection algorithm based on CNN has more ability in detection accuracy in reading fire areas, this algorithm also has several disadvantages, namely First, this algorithm works using machine learning techniques when a fire occurs, this algortima can read more than one place and is classified in the form of hotspots or fire points in fire areas in one or more areas.

The CNN algorithm can classify the entire image into one class. By being distributed into several conditions, namely burning fires, large fires, and fires in the form of smoke. If the smoke feature then the fire object will not be read clearly, this will cause the reading and accuracy feature to be lower using all image features without regional proposals will decrease the detection accuracy.

To overcome the weaknesses of some previous researches, a system was created that could classify images to improve the ability of algorithms to detect fire objects accurately and clearly. The second stage is to design an algorithm that generates features manually and classifies using CNN, at this time some algorithms produce a slightly slow computation time through computing one by one, otherwise using the CNN method for the detection process with a wider scope than, will cause a large amount of computation and detection speed to be slow (Pu Li ; Wangda Zhao, 2020).

Accidental and accidental fires cause severe economic and ecological damage and threaten human life. To avoid fire disasters, at this time a fire detection system was developed and was based on particle sampling, and temperature sampling, in addition to using radiational ultraviolet and infrared flame detectors and sensors. Sensor-based smoke detection systems work effectively and are very effective if they are placed close to the smoke source. one of the limitations of this system is its inability to identify and find the source of smoke, especially if it is placed in an outdoor environment as well as in a relatively large area (Bosch, I., Serrano, A., & Vergara, L., 2013).

In the image processing technique, various types of RGB-based models have been tried that can be used by the system to detect fire/smoke, including the YCbCr and YUV color models. The YCbCr color model is effective for fire and smoke detection using image processing techniques However, to minimize the possibility of selecting moving objects, grouping algorithms such as the K-means algorithm are used. (**J**inghong, L., Xiaohui, Z., Lu, W. , 2012).

In presenting the image-based smoke detection method using image-based techniques. This method relies on considering the static and dynamic features of fire smoke. Dynamic traits are capriciousness, growth, and frequent blinking, while static traits are the similarity of self and wave energy. The first step is to detect a moving target on the image. This is done through the use of a median filter algorithm to retrain noise. As a result, background reduction techniques based on adaptive

background updates are applied. (Xu, Z. , 2007)

The author presents alternative smoke detection methods based on the visual characteristics of smoke, including movement, color, gray tones, etc. When a region with motion is detected, pixels within that region are estimated and analyzed to determine the possible smoke of the region. For higher accuracy, this method uses a local binary pattern to characterize each region. The evaluation results showed that this method achieved an average smoke detection accuracy rate of 98.84%. (Mercado, J., Medina, K., Perez, G., Suarez, A., Meana, H., Orozco, A., Villalba, L., 2019.)

Traditional smoke/fire sensors based on photometry, thermal, or chemical detection can react within minutes, requiring large amounts of fire/smoke to trigger an alarm. In addition, they cannot provide information about the location of the fire and the size of the fire, and they cannot work for outdoor scenes. The development of new camera-based solutions improves the robustness and reliability of smoke and fire detection by filling the gaps in previous systems. Cameras and closed circuit television (CCTV) systems are already installed for surveillance purposes in large parts of the human environment, such as: such as city streets, industry, and existing public transportation, Infrastructure includes hundreds of video cameras, network communications, possible processing units, and screen monitors in the control room. Its utilization will allow a reduction in the cost of purchase and installation as there is no need for additional products. Fire detection algorithms can be easily integrated into this infrastructure with the installation of additional software. A possible low-cost alternative could be an ad-hoc architecture installation based on the IoT node system distribution of video cameras. Such IoT distribution systems can provide a web platform for video streaming and can trigger fire alarms by themselves (Gagliardi, A., Saponara, S., 2020).

3. METHODS

- **Image**

In this section, the data retrieval process is carried out by cctv cameras installed along the

railway line, the data can be taken in real-time according to conditions in the field, and the retrieval process the first time is constrained by weather and different lighting processes so that the accuracy process is reduced, the use of various types of Cctv cameras causes noise or prediction of error readings to be higher, To solve the problem, a process of standardizing the capture of image objects using image acquisition is carried out.

```
data = imread('rel03.jpg');
    diff_im = imsubtract(data(:,:,1), rgb2gray(data));
    %Use a median filter to filter out noise
    diff_im = medfilt2(diff_im, [3 3]);
    diff_im = im2bw(diff_im,0.18);

    diff_im = bwareaopen(diff_im,300);
```

Picture 1.1 Aquicisio Image Processing

Keterangan :

In figure 1.1 is the standard process of shooting by default by the system so that the number of pixels and the size of the data can be taken with the same size, in that code, the data is converted into RGB format (Red: Green: Blue) by displaying a red color texture that is more dominant because it will be used to detect fire. By the method, any red color changes to the created image object will be displayed and represented as a fire object.

- **Background Subtraction**

```
%Read Current Frame
CurrentFrame=imread('rel01.jpg');
%display both the background and the current frame

%Display Background and Foreground
subplot(2,2,1);(imshow(Background));title('BackGround');
subplot(2,2,2);imshow(CurrentFrame);title('Current Frame');
%Convert RGB to HSV Conversion of both background and current frame

%Convert RGB 2 HSV Color conversion
[Background_hsv]=round((rgb2hsv(Background)));
[CurrentFrame_hsv]=round((rgb2hsv(CurrentFrame)));
Out = (bitxor(Background_hsv,CurrentFrame_hsv));
```

Picture 1.2 Proses Subtraction

Keterangan :

The background subtraction method is the right method for motion detection, this movement is used to detect the movement of fire on the railroad tracks because this system uses capture in the form of a static camera and does not change places, because the function of this method is used to describe pixels from the background so that the main object can be detected and analyzed by a computer which will later be described as a fire object, This method is also used in the form of a multimodal background, which distinguishes the initial object of a railway line which later the image will respond if later a pixel change is found which automatically changes pixels occur and this is in the form of a fire object, so that the model used for movement will repeat in the background element on a slow-moving object.

- **Pre-processing**

This process scans each pixel of the HSV image and then the value will be compared with the desired HSV color range, in the format of the railway object the data is stillin black and white then converted into the form of the HSV value value value in which the pixel being scanned is in the desired HSV color range, then on the pixel will be marked with pixel-1, Otherwise, it will be marked pixel-0. This process continues until the last HSV image pixel, in this case, the fire object must have a different pixel value which is seen from the degree of grayness value with a total value of 0: 255.

- **Contour Detection**

The last stage of this process is to remove unwanted objects by performing an opening morphology on the binary image with an element structure (SE). The SE argument becomes a single object element structure, as opposed to an array of objects. Opening morphological operations are erosions followed by dilation, using the same elemental structure for both operations. The structure of the elements used is in the form of disks with a radius of 1 and 4 neighbors. This makes it possible to delete objects with a smaller size than the element structure.

- **Haar cascades Classifier**

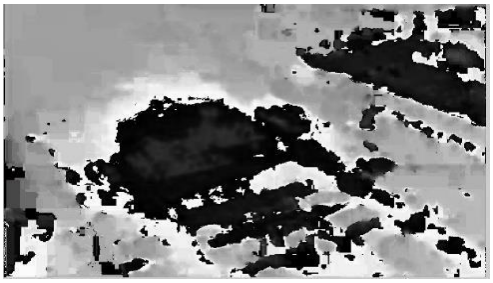
Haar-like features are rectangular features, which give a specific indication to an image or images.

The principle of Haar-like features is to recognize objects based on simple values of features but not pixel values of the object image, railway objects are taken from various angles so that the results of data processing can be wrong so that the algorithm can be wrong, to solve the problem a concept of training data and testing data is made, the data contains railway data of various shapes and sizes stored in a database, the more testing data, the higher the accuracy of reading the data.

- **Result Image.**

In this section is the final process of the accident and fire detection system on the railway line, the system can read the change of the object in the main image in this case the railway object, and the appearance of the new object will affect the value of the main pixel which will later be identified as a fire object and will be measured directly by the system to calculate the impact of damage caused by the fire in the form of measurements of the dimensions of the width and height of the blaze using the values of the (x) and (y) axes

(a) Hasil pengambilan image



(c) HSV Change Process

(d) Contour and Surface Detection Proses

(f) Haarcascade Clasifier Process

4. RESULTS AND DISCUSSION

In the implementation part of the railway fire support system, it can be done with two methods, namely using Cctv cameras or using LandSat satellite imagery, the image data is then processed with image processing with a grayscale process and color segmentation, with this method the image can be analyzed in detail so that information and the area of the area of the fire on the railway line can be calculated and analyzed which can later predict the area of the burned area and distribution fire points are scattered in several areas of the railway line.

- The railway drawing object has a matrix value consisting of columns with x-axis and y-axis values, the point consists of a pixel value that is the basic element in the image, and the color change in the object will have the value of different pixels, in other words, each object in the image is a combination of several different pixels adjusted to the f(x y) coordinate and the spatial coordinate value of the value of f(x), y) for the image intensity value.

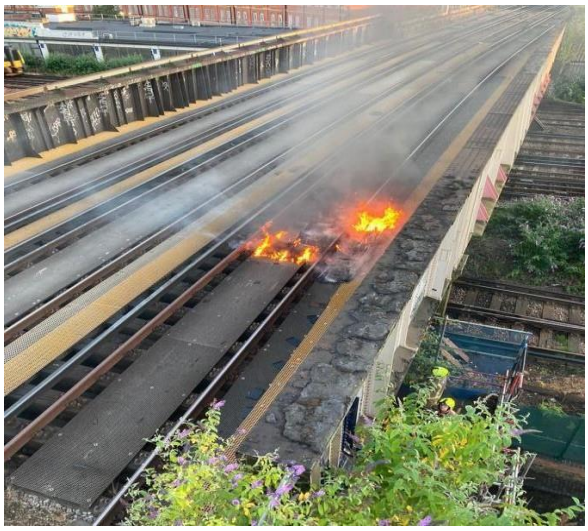
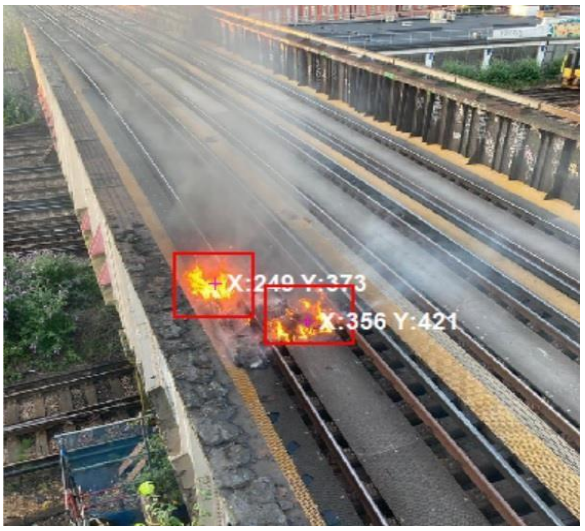
- Grayscale

  In this method, the grey-scale function is used to calculate the degree of grayness on the railway image object, this method can lower the lowest light intensity to the highest, and the fire object has the highest intensity so that it can be distinguished from the surrounding objects, the value of this image pixel reaches 8 bits or equivalent to a value of 256 of the gray degree, this method is indispensable because it has the highest accuracy and accuracy values.

- Segmentation Citra

  After the railroad object from the Landsat, the camera is processed using the grayscale method, then the reading process is carried out to carry out the segmentation process on the railway object, this process uses two stages of segmentation, namely the full method and the spacial method, in the separation of the object the system will automatically display an ID or label in a visual form that indicates the distinction of the fire object and smoke in the railroad area

Table 1.1 Pengujian sistem

Citra Asli	Hasil pemrosesan
	
	

5. CONCLUSION

Broadly speaking, this study aims to prevent damage and fires on railroad tracks that can be caused by inadequate maintenance and due to natural disasters that result in obstruction of rail transportation lines and can cause accidents and very fatal losses for its users. Therefore, to overcome this problem in this study, the author created a system that will later be configured using CCTV on each railway line. The way this system works is by utilizing image processing methods and the help of CNN algorithms with machine learning techniques. From the results of this study, the system works by taking images through CCTV, and then the standardization process of image acquisition is carried out then the image is

changed to an RGB format with a more dominant red color display that will be useful for fire detection, followed by carrying out a background subtraction method that is useful for detecting fire movement on railway lines, the process continues until the analysis and calculation stages are completed. This research has a high level of accuracy because the research testing is carried out repeatedly to get precise and accurate calculations. In the future, the author will carry out further development of this fire detection system. The author hopes that this research can help train travel control technicians in preventing damage and fires on railroad lines.

6. REFERENCES

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