Photo splicing detection using error level analysis and laplacian-edge detection plugin on GIMP

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Abstract. There are several types of photo manipulation, one of them is splicing manipulation. The problem was nowadays the image manipulation software is used by the person who has not an expert may manipulate the photo. The question was how we can be sure whether the photo is original or not. Therefore, this paper tested the photo splicing detection using two methods: error level analysis and laplacian-edge detection by the plugin of GIMP. The result was to detect photo splicing that has several variables which may enable the method to work better, i.e., the characteristic of the camera and the JPEG compression that characterized by the camera. This experiment and analysis can be used as a reference for photo forensics investigation.

Keyword—Photo splicing detection, Error level analysis, laplacian-edge, photo forensics.

1. Introduction
Photo forgery has several types include splicing, inpainting, enhancement, and geometric transformations. The use of word forgery has different meanings based on the context. The editing process of an image can be just for fun or to improve the quality of the photo. Based on that, it may not be considered a forgery. However, photo manipulation is often used to misrepresent the originality of the photo content, which is it's no longer trusted. In photo forensics, there are two types of photo authentication approaches to verify the authentication of the photo, i.e., active approach and passive approach[1]. In the investigation of photo forensics, we can not use only one method such as ELA method to confirm whether the photo has manipulated. To confirm the first method, we also need another method to approve and then find the manipulation in the photo. In this case, we use Laplacian-edge detection method as the second method to check the manipulation.

This paper represents the passive approach on how to detect the photo splicing by using error level analysis (ELA) and Laplacian-edge detection. The steps to investigate the photo forgery are using an analysis, method evaluation and comparison referring to the ACE-V method. We use GIMP plugin to do an ELA and Laplacian-edge detection. The use of GIMP is to show that it enables for the investigator investigates the photo using the application. Another reason is this application is allowed to set the plugin as we want and it is an open platform. The result of this paper is the splicing detection has several variables for the detector to works better, such as the type of camera that used to capture and the use of the compression characteristic. The more the photo has near to raw characteristics, the better result in the detection. Otherwise, the different type of camera inturns the different use of the detection algorithm in order to make detection work better.

The contribution of this paper is the experiment on this paper can be used as a reference for an investigator of photo forensics to examine the photo authentication from splicing manipulation. As we
explain the experiment on this paper, further improvements of the method are needed to get the reliability.

2. Materials and Method

2.1. Material
The software material that we use in this paper is GIMP 2.10.4, and we use edge detection and ELA method using the plugin that provides in the GIMP. The reason using GIMP is because it’s an open platform. Furthermore, the modification of the method will be straightforward in the setting. The photo used in this paper comes from Nikon and Canon camera. The raw image file is collected from the various camera then compressed into JPEG or JPG format which percentage of compressed is 90%. The experiments of image splicing are using the paint.net application based on Windows 10, the tools that we use to do a splicing photo in this paper are lasso selection magic wand, and the splicing selection paste in the photo which aims to be as a tempered photo.

2.1.1. Error Level Analysis (ELA). ELA is used to identify the areas in the image that have different compression rates. A JPEG image should have a similar level of overall image[2]. If a part of the image has a very different error rate, then it may indicate a digital modification. A JPEG image can be resaved for an average of sixty-four times with no visual changes until the image has modified. The indication of image forgery by using ELA is by seeing the significant different error level of a JPEG image. The disadvantage of ELA is giving a false identification when it comes to the image with a low quality of JPEG and significant recoloring.

2.1.2. Laplacian Edge Detection. The Laplacian method is a method that looks for zero crossing by using the second derivative formula of an image to find the edge. An edge of an image has a one-dimensional ramp format, and by computing the derivative of the image, it can highlight its location [3].

2.1.3. Photo Forensics. From a forensic point of view, image manipulation is classified as splicing, copy-pasting or cloning, erasing, or retouching. Splicing action is the transfer action of an object from an image to another image. It can also be done by cutting and pasting or using advanced techniques, so that is appropriate with the gradient of the target image.

According to, the framework of multimedia forensics consists of several stages, i.e., preparation, preservation, examination, enhancement & analysis, and output. The stage that needed to implement this method is in the stage enhancement & analysis.

2.2. Method
In order to successfully investigate the photo splicing in the image, this paper utilizes the ACE-V method, which is the method that we utilize in this paper is according to [4]. This method stands for Analysis, Comparison, Evaluation, and Verification. In this paper, we only discuss the stage of Analysis, Comparison, and Evaluation. The verification stage is not included. Figure 1 depicts the stage of the method.

![Figure 1. Method of the research](image-url)
3. Sample Data
The objective of this paper is to detect the manipulation in the photo, the type of manipulation is splice manipulation. Splice manipulation is a cut and paste process from the crop area in the same or separate sources. The detection of the manipulation process uses ELA and Laplacian edge detection. In this paper, we use 20 photos as sample data, in which ten photos has manipulated by using paint.net. The photos of sample data are divided into two types, i.e., original photo and manipulated photo.

The photo captured from the different type of camera as summarized in table 1. The photo one captured with Nikon camera, while the photo two captured with Canon camera. The type of manipulation in photo 1 and photo two is splicing and copy paste. In photo 1, the original photo is manipulated by splicing another photo that taken from Nikon camera and pasting it. In the photo 2, splicing photo comes from the same object in the photo. The manipulation in photo 1 shows that there is additional flower between the ducks, while there is many clock on wall in the photo 2.

| Scenario        | Photo 1                                      | Photo 2                                      |
|-----------------|----------------------------------------------|----------------------------------------------|
| Original        | ![Original Photo 1](image1)                    | ![Original Photo 2](image2)                    |
| Manipulated     | ![Manipulated Photo 1](image3)                 | ![Manipulated Photo 2](image4)                 |
| Histogram       | ![Histogram Photo 1](image5)                   | ![Histogram Photo 2](image6)                   |
| Manipulated     | ![Manipulated Histogram](image7)               | ![Manipulated Histogram](image8)               |

The histogram of each photo also shows in table 1, as we can see in the photo 1, the color spreads in the midtone part of the histogram. In the photo 2, the histogram looks darker than the histogram of photo 1. This shows the average photo is in the midtone part, and there is a few or none of the contrast histogram on the photo 2. Therefore, This histogram will have a different result when the photo has detected with the ELA and Laplacian method.

4. Result
All the result of the analysis in table 2 using GIMP application is the ELA method which is an add-on, while the sample data is processed with the flow according to figure 1 below. Before we begin inputting the photo, the RAW photo that taken from the camera is converted into JPEG format by using Raw Therapee application. Then, the JPEG format is analyzed using the ELA detection with the setting value is 0.70, while for the Laplacian detection, we use 1,000 of the value of the setting.
Those value setting are the appropriate value to see whether there is any manipulation on the photo, then the result of the photo summarized in table 2.

![Diagram of workflow](image)

**Figure 2.** The work flow of ELA method and Laplacian edge detection

To analyze the photo, first we can take a look at table 2 in the photo 1, there are two types of photo, i.e., ELA detection and Laplacian edge detection. As we can see in the ELA result, there is a contrast result around the photo according to the histogram photo 1, the characteristic of the photo 1 is in the dark part. The flower on the photo suspected as a manipulation part refers to the high contrast result in the area of the dark characteristic histogram. Then, in the Laplacian edge detection, the contrast part of edge detection also refers to the flower, the same result shown by the ELA detection. This condition also has the same result in the photo 2, ELA detection has the high contrast part on the left-right clock. To confirm the manipulation, Laplacian edge detection also gives the same result that the high contrast part is in the left-right part of clock wall.

| Photo  | Error Level Analysis | Laplacian Edge Detection |
|--------|----------------------|--------------------------|
| Photo 1| ![Histogram](image)  | ![Histogram](image)       |
| Histogram Photo 1 | ![Histogram](image)  | ![Histogram](image)       |
| Photo 2 | ![Histogram](image)  | ![Histogram](image)       |
According to the table 2, we can see the different characteristics of the camera based on the histogram. In the histogram of photo 1 and photo 2, the characteristic of the photo is in the same part at the dark part on the left, but if we see it more careful the distribution of the dark part in the histogram is different. The distribution of the dark part in photo 1 is more comprehensive than the photo 2.

5. Conclusion
An experimental study of photo splicing detection by using the ELA method and Laplacian method presented. However, in the experiment, the Laplacian method can perform as a second opinion to confirm any manipulation in the photo such as splicing. Furthermore, in the investigation of photo forensics, we can not use only onemethod to check the originality of the photo by using ELA method only it needs to add another method to confirm the result. Detection of the splicing manipulation can be affected by the algorithm that is utilized to temper the photo; otherwise, the setting of JPEG compression and characteristic of the camera also affected. Therefore, for future works, studying another method to detect splicing image based on the hardware that is used to capture the photo and compression type of photo.

References
[1] Battiat S, Giudice O, Paratore A2016 Multimedia Forensics: discovering the history of multimedia contents pp 23–4
[2] Factor H 2012 Foto Forensics Online: http://fotoforensics.com/tutorial-ela.php
[3] Maini R and Dr. Himanshu A Study and Comparison of Various Image Edge Detection Techniques Int. J. Image Process Online: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.301.927&rep=rep1&type=pdf
[4] Brewer S B 2014 Ace-V Examination Method Training Manual (Sacramento: California State University)