

**IMAGE FORGERY DETECTION USING STRUCTURAL SIMILARITY INDEX
(SSIM), ORIENTED FAST AND ROTATION BRIEF (ORB) AND SCALE –
INVARIANT FEATURE TRANSFORM (SIFT)**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN

JUDUL: IMAGE FORGERY DETECTION USING STRUCTURAL SIMILARITY INDEX (SSIM), ORIENTED FAST AND ROTATION BRIEF (ORB) AND SCALE-INVARIANT FEATURE TRANSFORM (SIFT)

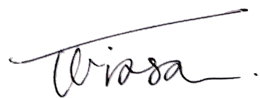
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(TANDATANGAN PELAJAR)

Alamat tetap: No 29, Jalan Cernai 6,

Taman Teluk Merbau, 43950, Sungai Pelek, Selangor

Tarikh: 15/9/2021



(TANDATANGAN PENYELIA)

DR. NUR FADZILAH OTHMAN

Nama Penyelia

Tarikh: 15/9/2021

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(SSIM), ORIENTED FAST AND ROTATION BRIEF (ORB) AND SCALE –
INVARIANT FEATURE TRANSFORM (SIFT)



THIASAN S/O CHANDRAN

This report is submitted in partial fulfillment of the requirements for the Bachelor of
Computer Science (Computer Security) with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I hereby declare that this project report entitled

**IMAGE FORGERY DETECTION USING STRUCTURAL SIMILARITY INDEX (SSIM),
ORIENTED FAST AND ROTATION BRIEF (ORB) AND SCALE – INVARIANT
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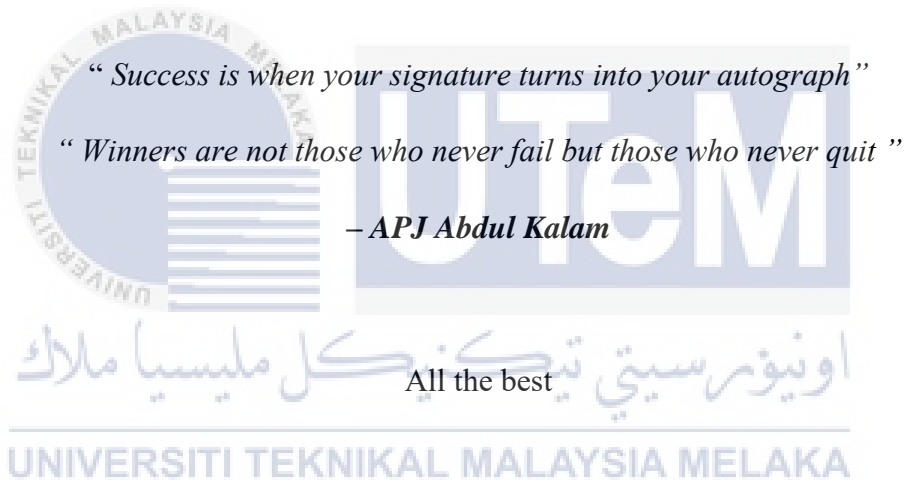
Fadzilah

Date : 15/9/2021

(DR. NUR FADZILAH BINTI OTHMAN)

DEDICATION

I would like to dedicate this dissertation to everyone who has worked towards the improvement of technologies and those who have been involved in digital crime investigation. Beside that, I would like to dedicate to all my motivators especially my family members, lecturers and each of everyone I have met. It is because everyone that came across our life are meant to teach us something. It is very important also to gratitude and dedicate this dissertation to the Almighty God whom always keeping me healthy and happy.



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I would also like to thank everyone whom being my supports and motivators especially my friends and course mates. Their willingness to share their knowledge and guidance make me more motivated to complete this thesis successfully. At the same time, I would thank everyone that came across my life because everyone that came across our life meant to teach us a lesson for the future.

Last but not least, I should praise and thank the Almighty God and the mother nature to allow me complete this thesis successfully without any mental or physical issues. Thank you for always giving me the strength and a happiness life so that I can successfully complete this thesis.

ABSTRACT

Digital images are widely used in everywhere in the world. It is very helpful to mankind in solving many problems especially in the communication field. Nowadays, almost every human being is owning a smart device which is able to capture photos and videos easily. Almost millions of photos are uploaded every day in media socials such as on Instagram and Facebook. Previously, photos have been used only for educational purposes and as moments memories. There is no problem until the images are used genuinely without any crime involvement. On the other hand, the images are playing important roles in the crime scenes. Images are being used as photographic evidences in crime cases. So, it is important to maintain the integrity of the images. Unfortunately, the advancement of technologies has introduced various photo editing software such Adobe Photoshop which is able to modify the images and alter the contents easily. People are getting more skills on manipulating the original images where it directly effecting the integrity of an image. So, it is difficult for digital forensic department to identify between the original images and manipulated images. In this project, a system with 3 image forgery detection algorithms have been used to identify the similarities and differences between two images. The algorithms are Structural Similarity Index (SSIM), Oriented FAST and Rotated BRIEF (ORB) and Scale-Invariant Feature Transform (SIFT). This system is developed using Python as the programming language to integrate with those algorithms to perform image forgery detection. As a result, the system is able to identify the similarities and differences between two images in term of similarities score values and running time. Finally, this project concluded that the best image forgery detection for rotated images is ORB and for copy move forgery images is SSIM. This thesis helps to find out and recommend the best algorithms among SSIM, ORB and SIFT in terms of similarities score value, running time and detection areas.

ABSTRAK

Penggunaan gambar digital semakin meningkat di seluruh dunia. Ia amat membantu umat manusia dalam menyelesaikan pelbagai masalah terutamanya dalam bidang komunikasi digital. Pada masa kini, hampir semua manusia memiliki peranti pintar di mana peranti tersebut dapat menangkap gambar dan merakam video dengan mudah. Hampir jutaan gambar dimuat naikan ke media sosial seperti Instagram dan Facebook. Sebelum ini, gambar atau imej digunakan untuk tujuan pendidikan dan sebagai simpanan memori sahaja. Penggunaan gambar digital tersebut tidak menimbulkan sebarang masalah sehingga gambar tersebut digunakan tanpa melibatkan jenayah. Pada masa yang sama, bukti forensik dalam bentuk gambar amat penting dalam sesuatu kes jenayah. Oleh kerana itu, menjaga integriti sesebuah gambar adalah sangat penting. Malangnya, situasi menjadi bertentangan apabila kemajuan teknologi memperkenalkan pelbagai jenis perisian penyuntingan gambar seperti *Adobe Photoshop* di mana ia dapat mengubah dan menyunting isi kandungan sesebuah gambar dengan mudah. Ramai orang semakin mahir dalam mengubah kandungan gambar dan perkara tersebut menyebabkan integriti gambar terjejas. Oleh kerana itu, pihak forensik digital menghadapi kesukaran untuk mengenal pasti antara imej sebenar dan imej yang telah diubah suai. Dalam projek ini, satu sistem telah dibangunkan menggunakan 3 algoritma untuk mengesan pemalsuan gambar. Sistem ini dapat mengesan persamaan dan perbezaan antara dua gambar dari segi skor persamaan dan masa yang diambil untuk mengenal pasti perbezaan antara dua gambar. 3 Algoritma tersebut adalah *Structural Similarity Index (SSIM)*, *Oriented FAST and Rotated BRIEF (ORB)* dan *Scale-Invariant Feature Transform (SIFT)*. Sistem ini dibangunkan menggunakan bahasa pengkod Python. Sebagai keputusan, sistem ini dapat mengenal pasti persamaan dan perbezaan antara dua gambar dari segi nilai skor persamaan dan masa yang diambil. Akhirnya, projek ini dapat membuat kesimpulan bahawa algoritma yang paling sesuai untuk mengesan gambar yang diputar (*rotated image*) adalah ORB dan algoritma yang paling sesuai untuk gambar pemalsuan (*copy move forgery*) adalah SSIM. Tesis ini dapat membuktikan algoritma yang terbaik antara SSIM, ORB dan SIFT dari segi skor persamaan, masa yang diambil dan kawasan pengesanan.

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LIST OF ABBREVIATION

SSIM	Structural Similarity Index
ORB	Oriented FAST and Rotated BRIEF
FAST	Features from Accelerated and Segment Test
BRIEF	Binary robust independent elementary feature
SIFT	Scale Invariant Feature Transform



اونيورسيتي تیکنیکل ملیسیا ملاک

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CHAPTER 1 : INTRODUCTION

Digital images are widely used in everywhere in the world. It is very helpful to mankind in solving many problems especially in the communication field. Nowadays, almost every human being is owning a smart device which is able to capture photos and videos easily. Almost millions of photos are uploaded every day in media social such as on Instagram and Facebook. Previously, photos are been used only for educational purposes and as moments memories. There is no problem until the images are used genuinely without any crime involvement. On the other hand, images are playing important roles in crime scenes. Images are being used as photographic evidences in crime cases. So, it is important to maintain the integrity of the images.

As the technologies are getting improved and innovated, the demands for the digital images are getting increase. Unfortunately, the advancement of technology has introduced various photo editing software such as Adobe Photoshop which allow users to modify and alter the content of the images easily. The trend image editing also getting popular among the people in digital media world. The editing tools are able to modify, delete, add and edit the original images to something else. This kind of actions led to the digital image forgery. In some cases, image forgery leads to phishing attacks and some other cybercrimes.

The manipulated images are considering a serious crime since some of the images are counted as evidences in the court. Image forgery led to spoiled the authenticity and integrity of the images. The digital images that changed and altered might purposely done for remove or hide important evidence or information with the help of editing software

like Adobe Photoshop. So, there is a difficulty for the forensic department to identify the original and altered images. Since the image forgery takes place in digital world, digital forensics department also introduced to investigate and find out the real and modified images. There are few types of image forgeries that has been identified until now. The types of image forgery are :

- i. Image Retouching
- ii. Image Splicing
- iii. Image Morphing
- iv. Image Enhancing
- v. Copy Move
- vi. Scaling
- vii. Cropping
- viii. Geometric Transformation
- ix. Selective Color Change
- x. Merging Another Image or some parts of similar or different image.

Since the number of image forgery cases are increasing, the world has been introduced with Image Forgery Detection Techniques. This detection techniques we need in many fields to protect and maintain the integrity and originality of the images. It can be used to preserve the copyright of the images. The main problem in image forgery is human cannot differentiate the original and tampered images with naked eyes. It is because that's how perfect software and tools help to modify the images. To win against this image forgery, we need also some software and tools especially some techniques to identify the tampered images. There are two main categories of the image forgery detection techniques that are existing now which are :

- i. Active Method
- ii. Passive Method

Active Method forgery detection is referring to digital signatures and watermarking. These methods have been used widely in photography world to

authenticate the originality of an image. There are several techniques have been used in the digital world to identify the tampered images. The techniques are :

- i. Pixel-Based Image Forgery Detection
- ii. Format-Based Image Forgery Detection
- iii. Camera-Based Image Forgery Detection
- iv. Physical environment-Based Image Forgery Detection
- v. Geometry-Based Image Forgery Detection

1.1 Problem Statement

The tampered images are hard to be identified by normal naked human eyes. Some detection techniques have been introduced and implemented to identify the differences between original and tampered images. In some cases, the image forensic department need both original and tampered images to identify the difference between them. Moreover, in some image forgery cases the original images are hard to be found. Unfortunately, some detection techniques are not giving the accurate results. Sometimes, some information has been failed to be identified using some detection techniques. Low accuracy result will make harder to distinguish between original and tampered images.

Table 1.1 : Problem Statement

Problem Statement	
i.	Some image forgery detection techniques and algorithms are not efficient in producing the differences between original and tampered images.

1.2 Research Question

This study attempts to answer the following research questions:

Table 1.2 : Research Question

Research Question	
i.	How to identify between original image and manipulated image with a high accuracy result?
ii.	Which detection algorithm is the best and efficient in terms of similarities score values and process runtime?

1.3 Research Objective

The objectives of this project are :

- i. To explore and apply the Structural Similarity Index (SSIM), Scale Invariant Feature Transform (SIFT), Oriented FAST and Rotated BRIEF (ORB) algorithm to identify the similarity of two images.
- ii. To identify and detect the differences between original and manipulated images.
- iii. To recommend and propose the best algorithms between 3 of the algorithms based on the similarities score value and process runtime.

1.4 Project Scope

The scopes of this project are listed below :

- i. This project will implement the OpenCV, Scikit – Image and Imutils along with Python programming language to develop the system.

- ii. This project will develop Image Forgery Detection systems using Structural Similarity Index (SSIM) Approach, Scale Invariant Feature Transform (SIFT), Oriented FAST and Rotated BRIEF (ORB) algorithm.
- iii. This detection program will turn the color images into a grayscale in order to identify and compute the differences between original and manipulated images.
- iv. Drawing module will be added in this program. Once the differences were identified, the system will draw out the differences places with a rectangle shape or circle shape or lines according to their own searching methods.
- v. The algorithms will be tested for two image categories which are rotated images and copy move forgery images.

1.5 Project Contribution

The project contribution is mainly to the forensic department which are able to find the differences between original and manipulated images. This program is able to identify and mark the differences between two images. The project contributions are as shown below:

- i. A program that able to help forensic department to identify the differences between original and manipulated images.
- ii. A program that able to find matching patches in stereo images and to track the pattern through an image sequence and determine exactly where the coordinate of the image differences (x , y).
- iii. Propose and recommend best and efficient algorithms among SSIM, ORB and SIFT.

1.6 Report Organization

Chapter 1 : Introduction

This chapter covers and discuss about the project introduction and project background. It also includes project's problem statement, project question, project objective, project scope, project contribution, report organization and the conclusion of the project introduction.

Chapter 2 : Literature Review

This chapter covers and explains about the previous research or studies that have been done by any other researches across the world that similar or related to this project. In this chapter, it includes introduction about the literature review, related or previous works that have been done before. It also includes the critical review of the current problems and the justification for the problem. Furthermore, proposed solution also has been included in this chapter and the conclusion of the chapter 2.

Chapter 3 : Project Methodology

This chapter discuss about the flow of the project will be developed. Prototypes, diagrams and milestones of every stages in this project will be discussed and shown in this chapter.

Chapter 4 : Analysis and Design

This chapter includes the design of the project such as logical and physical design, the system architecture and all the designs that related to this project will presented and explained in this chapter.

Chapter 5 : Implementation

This chapter discuss about the steps and activities that involved during the implementation phase. Expected output is also included in this chapter. The analysis of the source codes are also included in this chapter.

Chapter 6 : Testing and Analysis

This chapter discuss about method and steps to test the program. The expected outputs are included in this chapter as well.

Chapter 7 : Project Conclusion

This chapter covers the summarization of the entire project.

1.7 Conclusion

As for the conclusion for chapter 1, this project is mainly focuses on the project background which describes about the problem statement, research questions and research objectives, project scopes and project contributions. This project is developed to help the image forensic department to identify the differences between original and manipulated images. The identified differences will help them generate their report on image forgery cases.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter mainly focuses on information, solutions and studies that already existing in the world that related to the scope of this project. Furthermore, the studies and proposed solutions by other researchers have been reviewed for project study purposes. It is to have a better understanding on the scope of this project to achieve the project objectives. All the previous research has been compared and reviewed as study materials.

The main element of this project is on developing an image forgery system using SSIM Approach, ORB and SIFT using a Python programming system. This includes a software development for the detection technique. Previously, many researchers have done their research on image forgery detection techniques. Some of the techniques are being used in worldwide now to detect the image differences. Most of the image detection technique are unable to identify accurately the manipulated location in the forged image. The main concept of this project is to identify the differences between original and manipulated images and mark the differences to make the identification process easy and fast.