West Visayas State University
COLLEGE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
La Paz, Iloilo City, Philippines

GRAPHICS' AXIS: PLATFORM FOR GRAPHIC DESIGNERS WITH ROBUST IMAGE WATERMARKING TECHNIQUE FOR COPYRIGHT PROTECTION

An Undergraduate Thesis

Presented to the Faculty of the

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La Paz, Iloilo City

In Partial Fulfillment

Of the Requirements for the Degree

Bachelor of Science in Information Technology

By

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JUNE 2022

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Approval Sheet

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Abstract

Graphic designs are becoming more well-known in today's world as a result of increased business and personal interests, resulting in a sudden increase in the number of aspiring and experienced graphic designers, and adversities are expected to arise in a variety of ways. Since posting online has become a popular way to promote and share one's talent, copyright issues have become a major concern. This study focused on copyright protection and how it can benefit graphic designers by providing a platform for them with a robust image watermarking technique to ensure that all images posted are copyright protected. To maintain the original image's quality, the platform's watermark will be embedded invisibly to the original image. The Discrete Cosine Transform and the Discrete Wavelet Transform are two image watermarking techniques presented and evaluated under three considerations: imperceptibility, capacity, and robustness or

security, to see which one is more robust based on its performance. After comparing the robustness of the algorithms of two watermarking techniques, DCT was shown to be the most reliable. The Image Reader System is integrated or connected in the web platform to facilitate the uploading of images and embedding of watermark using robust image watermarking technique. Exploring digital watermarking techniques and contributing on how to maximize the use of this kind of robust watermarking to images will be impactful to this area of research. Lastly, this study or the system implemented will be very beneficial to graphic designers because they will be able to secure their images, which costs them skill, time, and ideas to create.

Table of Contents

List of Tables

Table

List of Figures

CHAPTER 1 INTRODUCTION TO THE STUDY

Background of the Study

Graphic design is one of the aspects of expression and communication of today's world. It communicates concepts, defines objects, navigates individuals, and imparts physically recognizable forms of information. Knowing where people look at and click on the visuals will reveal how the designs are perceived as well as where the most relevant content is located (Bylinskii et al., 2017). Graphic designs are becoming known due to the rising demands in businesses and personal interests that result in the abrupt increase in the number of aspiring and expert graphic artists nowadays and adversities are inevitable in many ways.

One of the major problems encountered by graphic designers especially when they are posting their works online is the copyright issue. Because of the rapid advancement of computer science, issues with piracy and copyright over digital goods are becoming more serious; therefore, it is an urgent duty to find solutions to these issues (Liu, et.al, 2017). The key challenges associated with the sharing of any digital images are copyright and evidence for rightful

ownership. A tool for preserving the ownership of digital multimedia is the watermarking technique. A strong degree of imperceptibility, robustness, and security is obtained by most current watermarking techniques (Ernawan & Kabir, 2019). Digital watermarking is a likely solution for owners of digital content who provide digital content protection. Digital watermarking has played a critical role in offering the reverse solution in recent years and several studies have been performed (Kannan & Gobi, 2015).

The usage of digital media and content is growing every day. The digital record must therefore be protected from both the unauthorized and authorized users. A digital document needs to be protected from registered users who are attempting to unlawfully redistribute it. Digital watermarking techniques, same with cryptography, are enough ways to assure acceptable digital media security. In the modern world, the security of digital data transfer is also a major concern, since there is a significant possibility of security breaches (Kumar, 2019). The most popular solution for making the transfer of data protected from unauthorized interference is the digital image watermarking technique. Digital image watermarking is a method by which signature or data is

embedded and extracted from the watermarked digital content into the digital content. The embedded data or message is usually undetectable but can be identified or retrieved later to verify digital information's ownership. Digital image watermarking is a very significant and vital area of study through its real-world applications (Verma et al., 2015).

Theoretical Framework

Digital watermarking technique is being used to make sure that digital media is protected and secured, and to facilitate data authentication especially copyright protection. Since the exchange of digital information is increasing in the form of different multimedia formats like images, audio, and videos, digital watermarking is now considered as the most important technology on preventing illegal copying or redistribution of these digital mediums (Rashid, 2016).

There are a lot of watermarking techniques being adopted to ensure copyright ownership, and the Discrete Cosine Transform (DCT) is considered as one of the most used watermarking techniques for storing digital images and watermarking. By using the DCT method, the breakdown of images

to coefficients plays a vital role in strengthening the said technique (Sahin & Güler, 2021). The DCT technique proves its imperceptibility to preserve the image quality and robustness against JPEG compression, filtering and noise attacks (Ahmed & Yousif, 2019). A study on Discrete Wavelet Transform (DWT) based image watermarking technique conducted by Najafi (2017) proposed that the technique produces an efficient output with an acceptable peak signal- to- noise ratio (PSNR) value in relation to the size of the watermark and its invisibility on the watermarked image. The technique is resistant against any geometrical attacks and also implies that Discrete Wavelet Transform is also secure and appropriate in application on copyright protection.

In evaluating the watermarked image and extracted watermarks, it is necessary to analyze watermark's performance with the use of several statistical metrics and deterioration to test its robustness (Dixit & Dixit, 2017). Digital watermarking is now considered an important research area in solving the challenges caused by rapid growth of digital mediums (Rashid, 2016).

Conceptual Framework

A platform with copyright protection for graphic artists is proposed utilizing a digital image watermarking technique implemented in an image reader system. The conceptual framework shows the structuring of the system.

As shown in Figure 1, input requires the users to type in their data such as name, birthdate, gender, username, email, and password as well as the images to be uploaded for the system to work its tasks. The user data will be used for logging in to the platform while the image selected will be embedded by a watermark before it gets uploaded. Once the data is processed, the user's data will be displayed in his profile and a watermarked image will be uploaded in the portfolio. Figure 1 shows the conceptual framework of the system.

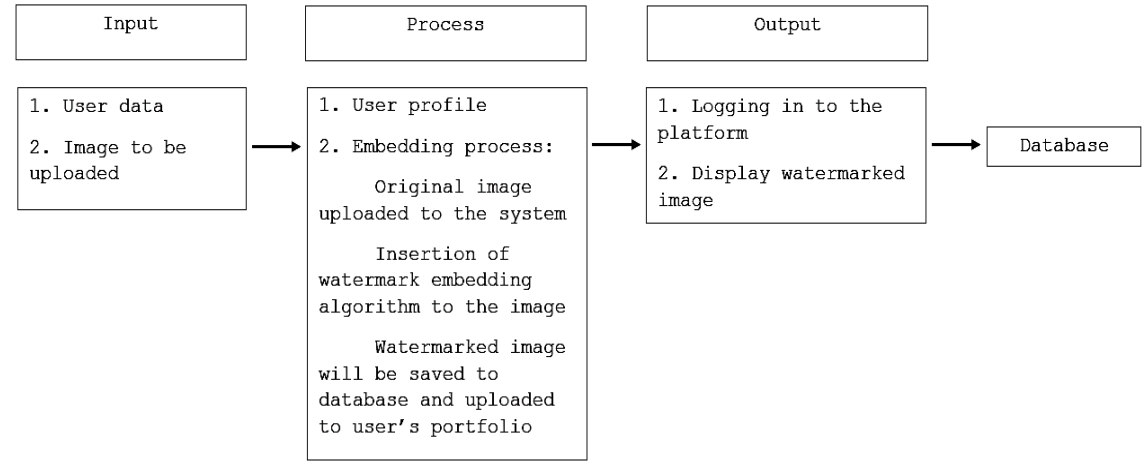


Figure 1: Conceptual Framework of the System

Objectives of the Study

This study aims to resolve the copyright issues experienced by graphic designers by developing a platform with copyright protection using a robust image watermarking technique focusing on the following specific objectives:

1. to develop an image reader system for embedding and extraction of the watermark using two techniques, Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT);

2. to evaluate the imperceptibility, capacity, and robustness or security of the two techniques; and

3. to implement the selected robust image watermarking technique to the image reader system and integrate it into the platform.

Significance of the Study

Several watermarking techniques were created to ease the concerns about copyright ownership of an image. However, it is not easy to attain such a watermarking system that is secure and robust at the same time. Studying and applying a watermarking technique that is robust and suitable to create a platform that secures ownership of an image are significant. The following sectors will benefit from the study:

The Graphic Designers. The direct recipients of this study are the graphic designers. It will give them awareness on how a digital watermarking can help protect their images from copyright issues without ruining their quality when posted on the platform developed. More graphic designers will be encouraged to create and upload more artworks online as a purpose of this research, as they will be confident that their work will be kept secure.

Software Developers. This research will help software developers understand how to implement a robust watermarking technique into their future projects to ensure copyright protection in the field that they are interested in.

College of ICT. The researchers believe that this research will help broaden the scope of previously published researches by providing new ideas and results that will benefit students, faculty, and the college as a whole.

Future Researchers. This study will serve as a basis for the future researchers in exploring more about robust digital watermarking to further explain, understand, and also contribute to improving the research gaps on this topic.

Definition of Terms

For a better understanding of terms and concepts used in this study, the following terms were defined conceptually and operationally.

Capacity. Capacity is the maximum amount or number that can be contained or accommodated (Merriam- Webster, 2022).

In this study, capacity is the number of bits in a watermark image a host image can contain.

Copyright Protection. When work is considered important, copyright protection is automatically applied. The symbol "©" is present when a product is copyright protected (Duening, et al., 2021).

In the study, copyright protection pertains to graphic designers' rights to their artworks, which is the primary concern for working on the platform's development.

Digital Image Watermarking. Digital image watermarking is the process of hiding information into a digital signal by embedding. It is usually invisible and requires a detector to extract the hidden information (Kumar, 2016).

In the study, digital image watermarking will protect the artworks to be posted on the platform through embedding the watermark in the images without affecting its quality.

Discrete Cosine Transform (DCT). The Discrete Cosine Transform (DCT) is a technique allowing the conversion of a signal into frequency components (Licciardi, 2020). It divides the image into sub-bands of different levels considering the image's quality (Marshall, 2001).

In the study, DCT is one of the techniques that will be used for comparison and to be applied for the watermarking of the images.

Discrete Wavelet Transform (DWT). A Discrete Wavelet Transform (DWT) is in a transform domain that decomposes a given signal into a set of wavelets, where the coefficients correspond to the time series of the signal in the frequency band (Hosseinzadeh, 2020).

In the study, the Discrete Wavelet Transform (DWT) is another technique that will be used for comparison and to be applied for the watermarking of the images.

Embedding. It means by grouping similar semantically identical inputs in the subspace, an embedding capture some of the input's semantics (Jiang, 2021).

In the study, embedding refers to inserting the watermarks in the images using the image reader system to be posted within the platform for copyright protection.

Extraction. Extraction is a method of removing something from a solution or substance. (The Free Dictionary, 2011).

In the study, extraction refers to the removal of the watermark in the images using the image reader system to detect the embedded watermark.

Graphic. A design or visual picture exhibited on several media, such as paper, signage, or a digital screen, is known as a graphic. They are usually used for information, amusement, or advertising (Computer Hope, 2018).

In the study, graphic refers to visual designs and works.

Graphic Designer. Graphic designer uses digital tools or by his or her hands to produce visual designs that attract, enlighten, and engage the audiences (Bls.Gov, 2021).

In the study, a graphic designer is someone who makes designs using new typographies, graphics, and other elements. He or she will be using the platform built by the researchers.

Imperceptibility. Imperceptibility means impossible or difficult to perceive by the mind or senses (The Free Dictionary, 2011).

In the study, imperceptibility refers to the similarity degree of two images when compared using the PSNR formula and one of the requirements of the watermarking technique.

Mean Squared Error (MSE). Mean Squared Error refers to the average of the square of the difference between estimated and actual values (Deval, 2020).

In the study, mean square error refers to the tool to be used in evaluating the imperceptibility of the two watermarking techniques.

Normalized Cross-Correlation (NCC). Normalized Cross-Correlation refers to a metric used to assess the degree of similarity between two images (Rao, et al., 2014).

In the study, Normalized Cross-Correlation refers to the tool to be used in evaluating the robustness or security of the watermarking techniques.

Peak Signal-to-Noise Ratio (PSNR). The peak signal-to-noise ratio is the proportion of a signal's maximum possible

value to the power of distorting noise that alters the quality (NI (White Paper), 2020).

In the study, peak signal- to- noise ratio refers to the tool to be used in evaluating the imperceptibility and capacity of the watermarking techniques.

Platform Development. Platform development refers to the development of essential software that allows hardware to function and serves as a platform for developing applications (Aarno & Engblom, 2015).

In the study, platform development refers to creating a website wherein graphic designers can upload their artworks.

Robustness. Robustness refers to a network's ability to withstand failures or attacks (Liu, et al., 2017).

In the study, robustness refers to how secure the technique is in protecting the artists' artwork images. It is one of the requirements to consider when evaluating the robustness of two watermarking techniques' algorithms.

Robust Watermarking. Robust watermarking is a watermarking algorithm that can withstand not just general operations like compression, noise addition, and tampering,

but also tampering attempts. It is often used in ownership protection (IGI Global, 2008).

In the study, robust watermarking refers to a watermarking technique wherein embedded watermarks on images are not easily tampered or destroyed.

Secret Key. Secret key is the piece of information used to encrypt and decrypt messages (Techopedia, 2022).

In this study, a secret key will be used to insert and retrieve watermarks to ensure security.

Security. *It* means safety, or measures taken to be safe or protected (Vocabulary.com, 2022).

In the study, security refers to how firm and secured the embedded watermarking in protecting the images. It is one of the requirements to be considered in evaluating the robustness of the algorithm of two watermarking techniques.

Delimitation of the Study

This study aims to focus on digital image watermarking using robust image watermarking techniques. The two common types of robust digital watermarking techniques, which are the Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT), are compared in a way to know which of the two is more robust and more reliable for copyright protection. The two techniques are compared by their abilities to apply three design requirements of a watermarking system which are imperceptibility, capacity, and robustness or security. The embedding and extraction of the watermarks are managed by an image reader system which will be applied on the platform once a certain technique is selected. In relation to the platform, the functions included in the development are the user profile and the uploading of artworks. Before an image can be uploaded to the user's profile, a watermark will be embedded for copyright protection. In particular, images in JPG and PNG formats are allowed and will be processed by the image reader system.

CHAPTER 2 REVIEW OF RELATED STUDIES

Review of Existing and Related Studies

Graphic Designers, Their Work, and Role in the Society

Graphic designers have long been associated with assisting social innovators by expertly organizing valuable data or rebranding a non-profit organization. Yet, as "makers" and "producers" of socially valuable products, graphic designers are finding new ways to be even more proactive (Heller and Vienne, 2015). There has to be a reason why their work is valuable and important to society. A single statement from them has the potential to influence a significant number of individuals and their opinions.

Graphic designers' work is evolving in terms of scope and content. Historically, graphic designers have been thought to be primarily concerned with symbolic and visual communication (Buchanan, 2001) when it comes to the creation of messages and videos. Graphic designers have long been considered to be responsible for expressing ideas through visual elements such as typography, colors, and pictures in both print and digital media. However, as industry and technology have progressed, the scope of graphic designers'

work has become increasingly uncertain and complicated (Dziobczenski and Person, 2017).

Graphic designers play an important role in society. A small word from them may have an impact on someone until the majority of people are able to discern their work, which is why they must be cautious about what they promote and develop. This article shows how difficult it is to be a graphic designer and to develop a specific piece of work, emphasizing the importance of creating a platform where people can safely express their love of design through their work.

Sickman, the author of the study entitled "Tools vs. Templates: A Commentary on Modern Graphic Design Ethics and Advancing Technologies", emphasizes her deep concern about the profession's reliance on technology, the misunderstandings it fosters about graphic designers' actual tasks, and the exploitation of professionals by non-designers and/or clients that this approach encourages (Sickman, 2015). Sickman's research is relevant to this study since it addresses how graphic artists rely too heavily on technology when creating their designs, as well as how technology may potentially harm their work, both of which will be addressed in this study.

In the same study mentioned above, technology has a major role in using digital assets to ensure easy access to design manipulation. With just a few clicks, everything on the canvas has shifted. These resources are widely and universally available to be used. No requirements are needed to access graphic design tools. Also, it is open to all aspiring designers. What Sickman wants to present in her study is that with the rapid advance of technology, many graphic designers will be taken for granted and their designs will be under serious threat too. Considering the fact that there are many people whose hobby is to download the works of graphic designers, manipulate them and repost them to take all the credits on the design, there is indeed a need to have a platform for graphic designers wherein their designs are safe and free from any malicious attacks.

Copyright Protection

Copyright is a right granted to individuals who have made distinct works (Kaplan, 2016). The rights give authors' work protection while also allowing them to benefit from what they've created. After creating a piece, an author has the right to reproduce, distribute copies, present the work

publicly, and create works that are variations of the actual work.

Copyright protection enables the owner or the author to profit using the copyright content by the third parties and maintains the work's authorship. In some cases, if the copyrighted work was created during the employment and is indicated in the employment agreement, the employer owns the copyright. This is also significant since the owner of the copyrights is responsible for implementing the rights, which can result in significant expenses in the event of copyright infringement (Caplanova, 2020).

In the context of this study, if a copyright holder feels that the image has indeed been enticed for modification or unauthorized use, he or she could request for watermark extraction. Securing copyright for property owners ensures a fair level playing field and rewards their effort and time in creating something valuable.

Copyrighted work can be made accessible without disregarding the owner's rights. Even if the definition of fair use varies by country, the phrase generally refers to circumstances that promote societal welfare (Caplanova, 2020). The goal of this research is to develop a system that

will help in limiting or eliminating copyright issues on the internet. Considering how terrible it is to steal someone's digital photo and repost it as your own. It moves slowly, but it moves effectively.

Digital Image Copyright Protection. Content authentication using digital watermarking has made it easier to share copyright documents, photographs, audios, and videos on the Internet. Content security, copyright control, and tamper detection are some of the other areas where it can be used. Manipulation and replication of audio, photographs, and videos are much simpler with the use of advanced signal/image processing algorithms. As a result, content authentication via encryption, as well as resistance to general attacks like noise, compression, and geometric, has become a pressing concern (Ambadekar, et al., 2019). Researchers want to focus on overcoming graphic designers' concerns about having copyright protection for the graphics they will publish online for this study. Copyright concerns can be avoided and lowered in this manner until all types of materials are copyright protected.

Because the Internet as a whole does not use secure links, data in transit may also be vulnerable to disruption. The importance of minimizing the probability of information being detected during transmission is becoming increasingly apparent in the real world (Perwej et al., 2012). Digital data and media can now be readily shared due to rapid growth in the use of personal computers, the internet, and digital multimedia technology. The availability of various image processing tools, on the other hand, makes unauthorized use of such data easier. Unauthorized users or assailants have easy access to digital data and they can easily copy, delete, or alter it. This issue of illegal modification or reproduction of digital data prompts the development of new methods to protect digital data or media intellectual property rights (Arora & Poonam, 2018). This study aimed to grant copyright protection to the photographs because graphic designers poured their talents and knowledge into these particular artworks, because someone else could simply grab them and claim them as his or her own. This is to ensure that graphic designers' efforts are not wasted and that they are properly credited.

Digital Image Watermarking

Watermarking techniques for digital media are being used to ensure and facilitate data authenticity, security, and copyright protection (Rashid, 2016). Digital watermarking is the process of maintaining privacy within digital media. It is extensively used to safeguard digital images from copyright violation. This technique embeds information into a host that will be hard to detect and has no effect on data usage. There are numerous applications that utilize visible digital watermarking to indicate that an image or video was modified or posted in that application. The major goal of developing a platform that can integrate a watermark is to address copyright concerns that graphic designers have in order to preserve their ownership and expertise (Ou. L. et al., 2016).

The focus of this research is on digital image watermarking. Two robust watermarking techniques will be compared to three requirements: imperceptibility, robustness, and security. This type of image watermarking is embedded, which means that the watermarking is embedded into the pixels of the original image and is not visible on the surface.

Unlike the traditional method of putting a visible watermark to a document.

Integrating digital watermarking into many applications is essential for copyright protection. With this, owners will be able to protect their creative efforts from copyright difficulties. The use of digital watermarks on photos can protect their safekeeping and help others to recognize that they have acquired someone's work.

Based on the watermark's resistance to attacks, digital watermarking techniques are categorized into three categories. These techniques are robust, fragile, or semi-fragile. Robust watermarks are best when applied in copyright protection and owner identification since they withstand the most image-processing actions. There are two domains: pixel domain and transform domain, in which watermarks are usually embedded (Loan, et al., 2018).

Robust Image Watermarking. A robust watermark protects the watermark data from multiple image attacks, as well as geometric and non-geometric attacks. Even after some attacks, the watermark stays the same, and detection of the watermark provides permission. Before the image owner may extract the

embedded watermark, image extraction was requested and confirmed by the system. No one can remove the watermark because doing so would compromise the image's copyright protection. This is one of the solutions that the developers considered in order to minimize and reduce any copyright issues. Copyright security, broadcast tracking, copy control, and fingerprinting are all fields where this watermark is used.

For copyright security and tamper detection, a fragile and durable watermark image was inserted into the host image as a guide. The owner’s logo was incorporated as a robust watermark into the host image for copyright protection. An attacker, on the other hand, might try to remove the difficult watermark. The proposed method was able to remove the tough watermark even when half of the picture was cropped, according to the results of the experiments. The watermark is inserted into the magnitude range of the middle frequencies of the DFT of the original medical image using the proposed procedure. Medical images cannot be distorted or detached from the corresponding electronic patient record (EPR) records. It was shown that the device is resistant to signal processing and geometric distortions (Begum & Uddin, 2020).

Robust watermarking using the transform domain will be utilized in this study because it was stated that it is the best for copyright protection and ownership verification, and this is what the platform should contain to guarantee the safety of graphic artists' images.

Discrete Cosine Transform. Discrete Cosine Transform (DCT) is the most common technique used from the frequency domain. DCT distributes carrier signals into three frequency bands namely low, middle, and high-frequency bands. The algorithms that use DCT as a watermarking technique are proven to be more robust than the spatial domain watermarking techniques. This is persistent against simple image manipulations like sharpening, contrast, toning, and blurring. This is one of the transforms that will be compared to see which is more robust and can be applied to the platform that will be developed. However, they are difficult to implement and are technically much more expensive. Also, it is weak against geometric attacks like cropping, rotation, and scaling. The Discrete Cosine Transform is one of the widely used techniques in watermarking and storing digital images. By using the DCT method, the breakdown of images to

coefficients plays a vital role in strengthening the said technique (Sahin & Güler, 2021). The DCT technique proves its imperceptibility to preserve the image quality and robustness against JPEG compression, filtering, and noise attacks (Ahmed & Yousif, 2019).

DCT-based digital watermarking has been the subject of extensive research in the past few years. The study of Liu et.al (2017) stated several methods and experimental studies. Shivani et al. (2013) proposed a DCT-based block intelligent fragile digital watermarking system for detecting and recovering altered photos. Divecha and Jani (2013) applied the DCT, DWT, and SVD to watermark digital colored images. They tested and studied their procedure to ensure their efficacy. This research focuses on the usage of watermarks to digital images. These are the graphic designers' artworks that will be displayed on the site, and an integrated watermark will be added to the original image to ensure its security and authenticity.

In the DCT domain, several researches on digital image watermarking methods have already been conducted. Block-based DCT image watermarking is one of them. It works by splitting the host image into different image blocks and then applying

the DCT transform to each of them. The method then uses an algorithm to insert the watermark into the block and DCT-based host image. The watermarked image is then generated using the inverse discrete cosine transform (IDCT). Figure 2 better describes the above-mentioned DCT methods for watermark embedding. It is worth noting that watermark extraction can also be performed the other way around (Begum & Uddin, 2020).

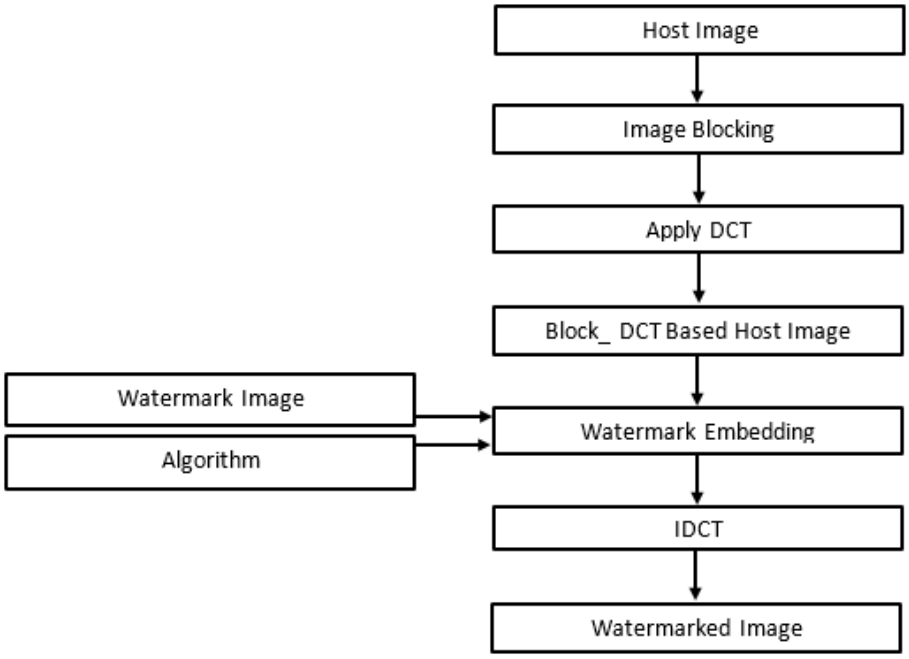


Figure 2: Watermark Embedding in a Block- based DCT Domain. From "Digital Image Watermarking Techniques: A Review"

Figure 2 is discussed from the study of M. Begum and M. S. Uddin, 2020. After dividing an image into blocks, Kitanovski et al. (2005) proposes using quantization index modulation to perform a block-based DCT transform in each of the blocks and embed a watermark created using an image hash as a key. Each DCT block in QIM contains only one watermark bit. In image authentication, their proposed method proved to be more reliable.

In aspects of robustness or security, Patra (2010) has proposed a Chinese Remainder Theorem (CRT)-based watermarking scheme in the DCT that works more efficient than a CRT scheme based on spatial domain methods and persistent against brightening, sharpening adjustments, and JPEG compression attacks. DCT techniques take a substantial amount of computation, and are complex to implement and are vulnerable to geometric attacks.

Discrete Wavelet Transform. As described in the study of Barnouti, et al. (2018), DWT is a two-dimensional image divided into four sub-bands, the LL, LH, HL, and HH. At level 1, where the first letter uses low-pass or a high-pass frequency in rows and second letter refers to the columns.

Each sub-band is divided until the required number of levels is reached. The human visual system (HVS) is very sensitive to the LL subband which is the low frequency. The digital watermarking technique embeds the watermark into subbands where the image has a high quality. Discrete Wavelet Transform is the other transform that will be used in comparison in this study. A two-dimensional image after one-level, two-level, and three-level DWT decomposition is shown in Figure 3 below.

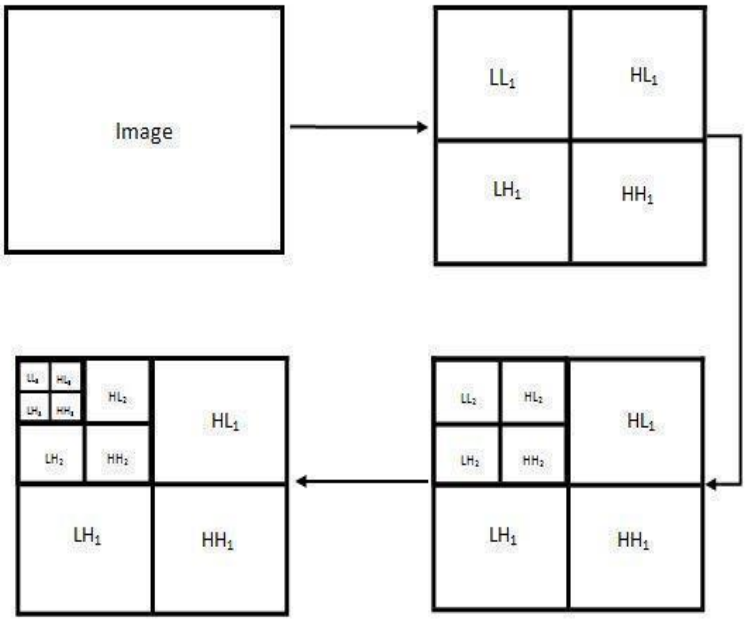


Figure 3: Three Levels of DWT Decomposition adapted from "Digital Watermarking Based on DWT (Discrete Wavelet Transform) and DCT (Discrete Cosine Transform)".

Figure 3 is present in the study of N. H. Barnouti, et al., 2020. The system uses an algorithm to insert the watermark into the host image after applying the DWT, and then uses the inverted DWT (IDWT) to obtain the watermarked image. The DWT is applied at the same level to the watermarked image in the watermark extraction process. Finally, the IDWT is used to create the watermark image. Figure 4 illustrates the whole procedure (Begum & Uddin, 2020).

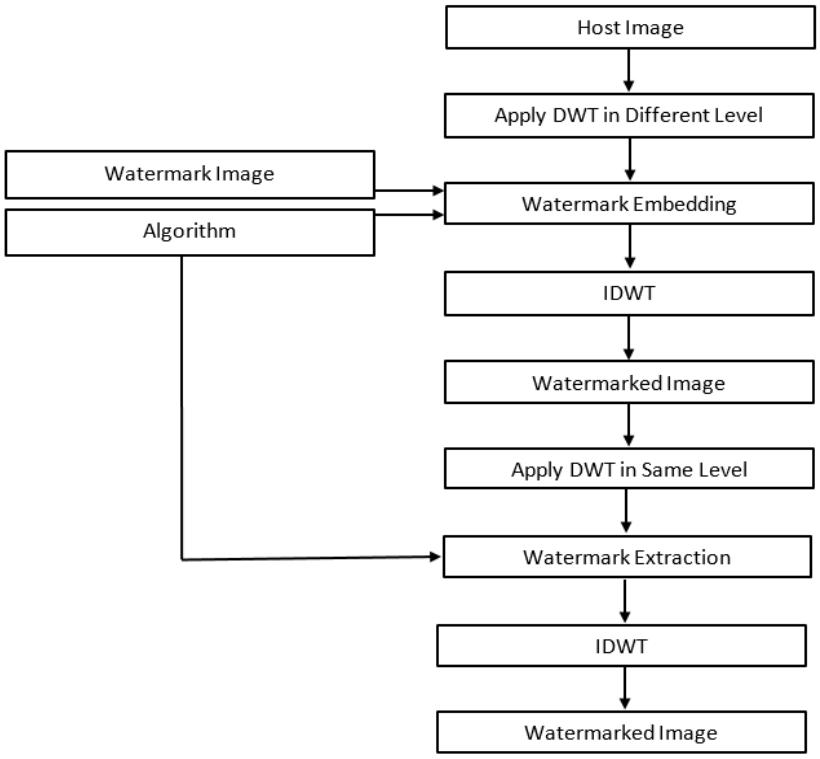


Figure 4: Watermark Embedding and Extraction in Discrete Wavelet Transform Domain from "Digital Image Watermarking Techniques: A Review"

The authentication of images in the DWT domain has been the subject of numerous studies. Chen, et al. (2015) proposed a digital image watermarking algorithm that was based on wavelet threshold classification. The technique defines the complexity of an image to measure the resistance to attacks and its visual quality. The DWT algorithm was separated into different blocks for embedding and the signals were inserted at blocks where lower frequencies are present by derived optimal sub-bands. The findings demonstrated that the proposed algorithm is robust and imperceptible to some attacks.

Ambadekar, et al. (2019) suggested a study that protects the copyright by embedding a watermark in the DWT domain and extracting the watermark using watermark encryption. This approach was extremely resistant to noise, geometric, and compression attacks. The transform domain has been considered a more appealing research field because spatial domain dependent image watermarking cannot withstand geometric attacks. The system's robustness is ensured by this algorithm, which protects it from attacks including lossy compression and Gaussian noise. It was used to ensure the protection of images.

The digital image watermarking using Discrete Wavelet Transform (DWT) has an excellent spatio-frequency localization property that has been experimented to locate a space in the host image where noises cannot be easily detected or seen. This does not require a separate copy of the original image for watermark extraction. Thus, it is most likely used in compression and noise removal (Lala, 2017).

The study of Susanto et al. (2018) has proven that in the terms of image quality and robustness, combining the DCT and DWT technique is reliable. The use of two DWT levels proved to improve the imperceptibility aspect compared to the one DWT level. The method of extraction also works well where the results of the extraction without attack get the value 1. The algorithm has shown high results of persistence against JPEG compression attack.

Another study on DWT based image watermarking technique by Najafi (2017) proposed that the technique produces an efficient output with an acceptable PSNR value in relation to the size of the watermark and its invisibility on the watermarked image. The technique is resistant against any geometrical attacks and also implies that DWT is also secure and appropriate in the application for copyright protection.

Online Platforms Development

The term "online platform" was coined by the OECD (2019) to define a wider variety of Internet-based services, such as marketplaces, SEO, media platforms, digital content, mobile applications, network infrastructure, banking systems, and services in the economy and more. It's also referred to as a digital service that promotes connections among multiple but interrelated groups of people that communicate via the Internet.

Online platforms have a contribution to the fast change and rapid development of the sharing, learning and spread of ideas. Some of these are using images to search, making tutorial videos on YouTube, TikTok, and Facebook. These online platforms make people feel more connected to each other. Also, for developers, there are now platforms where they could openly access sources and packages like software development kits and application interfaces. Digital platforms are a complex research subject because of their distributed architecture with organizations, businesses, and innovations. This challenge emerges as a result of the rapidly growing progression of platform development, the increasing complexity of system architectures, and the expansion of

digital platforms across a variety of markets.

Basole, et al. (2019) studied that digital networks offer new strategies for cross contacts via a range of dispersed border tools, enabling distributed network and systematic management of operations at consolidated level. Instead of monolithic structures, the design of technology itself can be carried out to a greater extent through applications, micro-services, and other modular components, but still unclear on how to design its architecture.

The implementation of platforms will play a role in replacing some companies and industries with modern digital technology, as well as challenging the role of some areas of work with others. The distribution and adoption of digital platforms that operate across markets are fast rising. Though economics information systems and other approaches provide a valuable ground in studying such platforms, there are some key differences that must be considered.

CHAPTER 3 RESEARCH DESIGN AND METHODOLOGY

Description of the Proposed Study

Author's legal rights to their original artworks, published or unpublished, are considered to be copyright. Today's existing issues about copyright, especially those on graphic design, present that a certain work is not credited to its rightful owner and sometimes claimed or stolen by others. That is why this proposed study focuses on dealing with copyright protection and how it would benefit the graphic designers. This study aims to provide a platform for graphic designers with robust image watermarking techniques for copyright protection to make sure that all uploaded works inside the platform are safe and protected. To maintain the quality of the uploaded images, the inserted watermark will be embedded to the original image since using a visible watermark can ruin the image's quality. Two techniques of image watermarking will be presented: the Discrete Cosine Transform and Discrete Wavelet Transform and compare which of the two techniques will suit best for the platform. The image reader will be created within the platform for embedding of watermark to the images and also for the comparison of the

two techniques. By evaluating the algorithm of the DCT and DWT, a more robust technique will be determined. This will be done through extracting the embedded watermark in an image. Mainly, this study focuses on applying robust watermarking techniques to images that will be uploaded on the platform to secure the copyright works of the graphics designer.

Assumptions and Preconditions

The study's expected output is a platform with an image reader system that embeds a watermark to images for copyright protection. One of the two watermarking techniques, either the Discrete Cosine Transform (DCT) or Discrete Wavelet Transform (DWT), will be chosen for implementation in the platform, as this type of robust watermarking technique offers a better and more reliable end result in maintaining image quality and security. The platform will include an image reader system that will be in charge of embedding the watermark for each image. This stands for copyright purposes. Users must thoroughly read the terms and conditions before using the platform for them to understand how the image reader system works. By using this platform, users will be able to ensure that their artworks posted online are safe from copyright issues.

Methods and Proposed Enhancements

Digital image watermarking techniques add a watermark into multimedia data to ensure authenticity and to protect a copyright holder from the unauthorized manipulation of their data. Hence, it is necessary to define the requirements or characteristics of a watermarking system. The two watermarking techniques, Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) will be used in comparison to measure the robustness of their algorithm (Begum & Uddin, 2020).

Watermark Embedding Process

A specific watermark provided by the system will be embedded to the original image during the process. This embedded watermark includes a secret key that will serve as a protection to ownership of the artists. In this study, the embedding process includes the insertion of the platform's watermark to the images to be uploaded to secure and protect one's ownership. A comparison between the two techniques was performed to determine which between DCT and DWT is more robust. For the website, the user will click the open modal

button and upload his or her image. The algorithm of the chosen technique will be processed to the image for the insertion of the watermark. Once the process is completed, the image with the watermark will be uploaded to the user's profile and saved to the database. In uploading an image, JPG or PNG file format can be accepted but the watermarked image will be in PNG file format since it provides a better result.

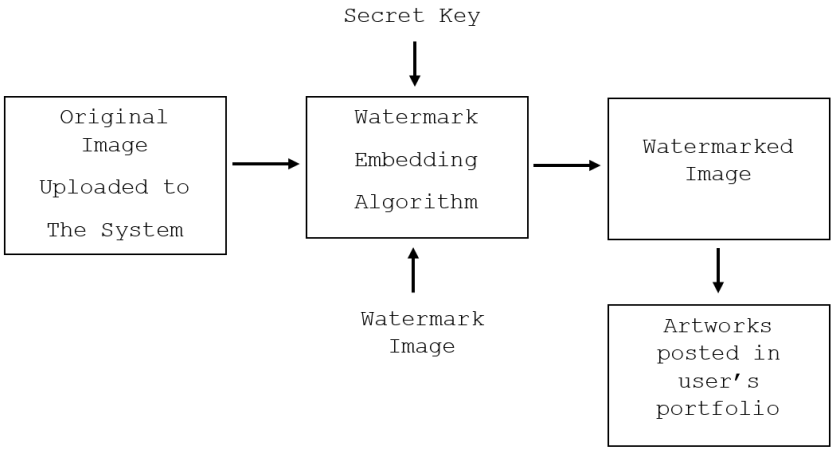


Figure 5: Digital Watermarking Embedding Process Diagram

Watermark Extraction Process

The watermark is extracted from the original image used in the embedding process during this step. This would ensure that the watermarking technique is effective and useful in detecting attacks. Extraction of the watermark will only be

accessible in the comparison of the two techniques to detect the embedded watermark. In terms of the extraction process, the user will click the open modal button and select the extraction process, upload the watermarked image and choose the technique between DCT or DWT. As for this process, PNG will still be used for the resulting image format for the extracted logo, same as for the watermarked image since it shows better results.

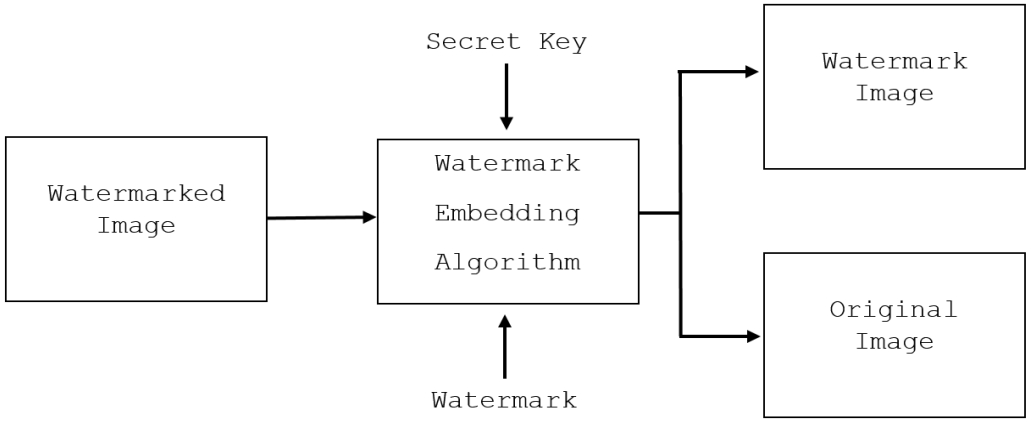


Figure 6: Digital Watermarking Extraction Process Diagram

Discrete Cosine Transform (DCT)

The DCT divides an image into various frequency bands, making it much simpler to embed watermarking information in

the middle frequency bands (Barnouti, et.al, 2018).

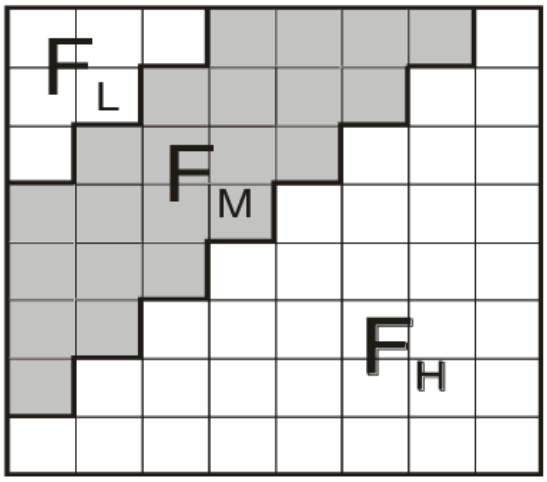


Figure 7: DCT Frequency Blocks Division adapted from "Digital Image Watermarking Techniques and Biometrics Data Security: A Review" by Adamović, S. and Tašić, J., 2017, International Scientific Conference on Information Technology and Data Related Research, p. 58. Copyright 2017 by Sinteza.

In Figure 7, the original image will be divided into 8x8 frequency blocks. The FL denotes the low frequency region of the image. FM refers to the middle frequency, and FH is for the high frequency. The embedding will likely take place in the middle frequency because this area resists attacks, and keeps the visual quality of the original image when a watermark is inserted (Ko et al, 2020).

DCT Watermarking Algorithm: Watermark Embedding Process

1. The input image is converted from RGB to Grayscale.

2. To transform from spatial to frequency domain, the image will be divided into non-overlapping blocks of 8x8 that will be changed using the Discrete cosine transform.

3. Forward DCT is applied to every block.

4. Block selection criteria is applied.

5. Select subset parameters of coefficients and embed watermark bits into the blocks in the host image.

6. To get the watermarked image, use reversed DCT on each block.

DCT Watermarking Algorithm: Watermark Extraction Process

The extraction process of DCT is the inverse application of the embedded watermarking algorithm.

1. The watermarked image is converted to grayscale and decomposed into the size of 8x8 blocks;

2. DCT transform is applied for each of the block;

3. The inverse DCT technique is used to retrieve each block's watermark; and

4. The inverse DCT transform is applied, and the watermark

image is extracted.

Discrete Wavelet Transform (DWT)

As described in the study of Barnouti, et. al. (2018), the two-dimensional image is divided into four sub-bands, which include: LL, LH, HL, and HH. The human visual system is way more sensitive to the LL sub-band which represents low frequency components and the digital watermarking is commonly embedded in one or more of the other three sub-bands which have better visual quality.

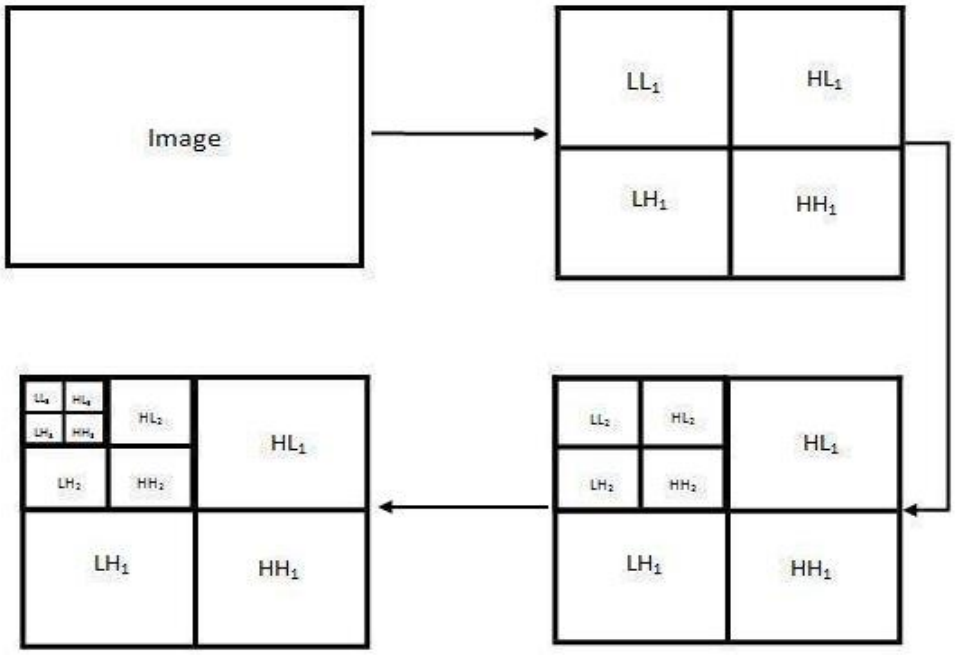


Figure 8: Three-Level Subband Decomposition of DWT adapted from "Secure and Fragile Watermarking of Medical Images with Fingerprint Based Biometric Data Using Matlab" a study by Geetha Priya, S., 2021

DWT Watermarking Algorithm: Watermark Embedding Process

1. Convert the image from RGB to grayscale.

2. Compute and identify the DWT coefficient value of the image with the use of three level sub band decomposition.

3. Determine a sub band's distribution, followed by the DWT coefficients.

4. Compute the parameters of the distribution which will be

used as a key.

5. Rearrange the parameters generated from image in three different ways which use embedding in LH3, HH3, HL3, LH2, HH2, and HL2.

6. Insert numbers randomly to DWT coefficients of a particular sub band.

7. Use the inverse DWT transform to produce a watermarked image.

DWT Watermarking Algorithm: Watermark Extracting Process

1. Using 3 level subband decomposition, calculate the DWT coefficients of a watermarked image.

2. Using the key as a parameter, generate random integers with the same distribution.

3. Subtract random integers from DWT coefficients to a particular subband of the watermarked image.

4. Use the Inverse Discrete Wavelet Transform to get the original image and the watermark image.

Statistical Tools

To provide meaning and interpretation to the data needed to conclude this study, researchers used different methods

and tools to make sure that results are precise by performing tests through the image reader system to evaluate the two watermarking techniques, DCT and DWT using the following metrics/tools:

Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR)

The PSNR and MSE are used to measure the quality (imperceptibility) of an image using the two techniques. For the evaluation of degree of similarity between the original image and watermarked used to or embedded to images, the Mean Square Error or MSE and the Peak Signal-to-Noise Ratio or PSNR are used. The equation presented below is how to get the similarity degree. If the PSNR is high, the similarity degree between the watermark and original image is considered high.

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(I_m(i) - I_w(i))^2 \qquad \mathrm{PSNR} = 10\log_{10}\frac{255^2}{\mathrm{MSE}}$$

where I_m and I_w are the original and watermarked images, and the value 255 represents the maximum possible pixel value of an image and uses 8 bits per sample.

Normalize Cross-Correlation

The robustness and security of the digital image watermarking technique is evaluated by analyzing the strength

under commonly used image manipulations. The key used in embedding is the same key that will be used in extracting the watermark. The Normalized Cross Correlation (NCC) will be used to estimate the watermark robustness by calculating the similarity degree between the original watermark (element w(i,j)) and the extracted watermark (w′(i,j)). If the normalized correlation value is 1, the extracted watermark is exactly the same as the original one. The value decreases as the difference between the two watermarks increases. This is defined by the equation below:

$$NCC = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} w(i,j)\, x\, w\prime(i,j)}{\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n} w(i,j)}\sqrt{\sum_{i=1}^{m}\sum_{j=1}^{n} w\prime(i,j)}}$$

where:

(i,j) = pixel value from the original watermark image

$w'(i,j)$ = pixel value from extracted watermark image

Components and Design

Software Architecture

Figure 9 below shows the software needed in order to create the system. For the front-end or the interface of the system, developers are going to use HTML, CSS, and JavaScript while Python with Flask is used for the backend. Sublime for its IDE, MySQL for the database for storing data, and Xampp for its localhost. As for the image reader system, Spyder 5.0 IDE will be used with Python 3.8 and Flask for its backend. Also shown in the illustration are the features of the platform which are the user profile, portfolio, and users can post images.

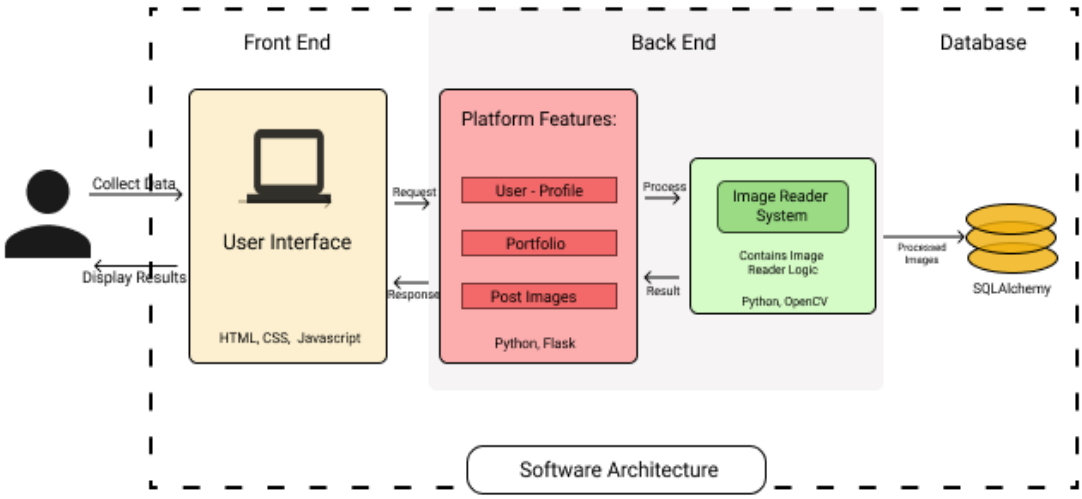


Figure 9: Software Architecture of the System

System Architecture

Figure 10 illustrates the components of the architectural design of the system providing the overall view of its physical deployment. Users must have a device connected to the internet to access and log in to the web platform. After registering/logging in to the platform, users' data will be saved to the database. Users will be able to upload their artworks/images in the portfolio using the Image Reader System (IRS). The IRS will be responsible for the embedding of watermark to the original image using a robust watermarking technique. The watermarked image will then be uploaded/posted to the web platform and the image's results and uploads will be saved on the database server of the system.

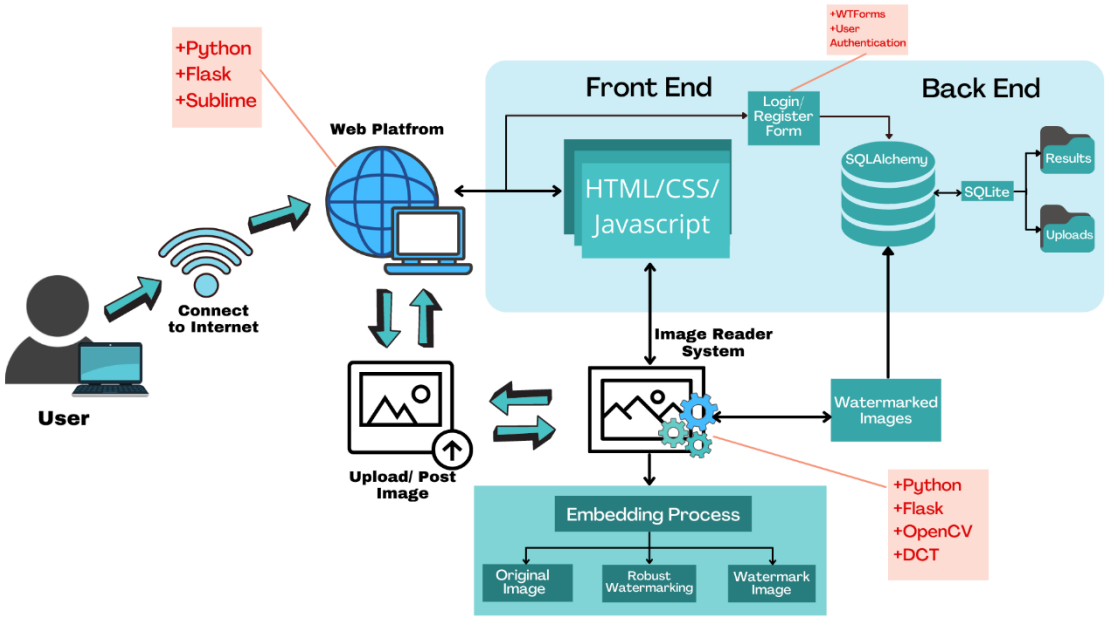


Figure 10: System Architecture of the System including the Embedding Process

Figure 11 below presents the system architecture of the extraction process of the watermarked image. This process only works if the watermarked image is suspected to have been attacked or tampered by any imaging processes (filtering, noise, scaling, etc.). An inverse method of robust watermarking is applied to the image in order to extract the original image from the watermark using a secret key.

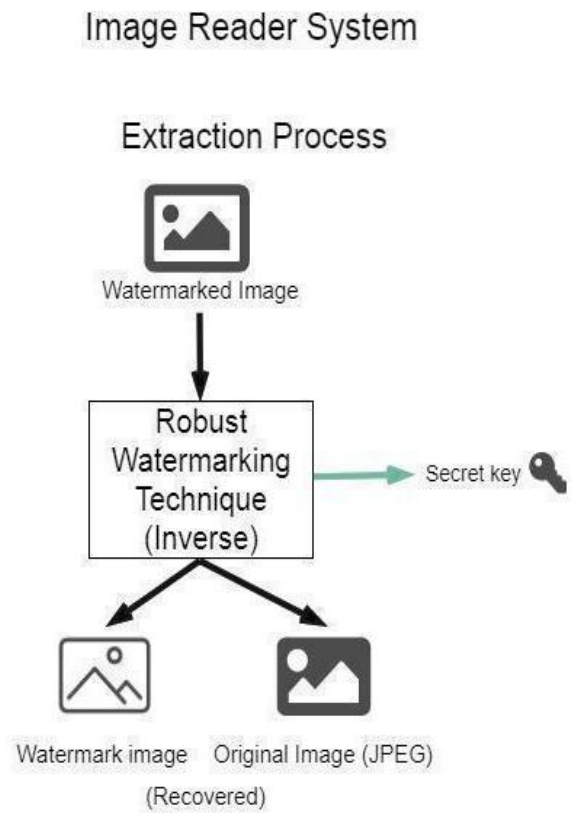


Figure 11: Extraction Process of the Watermarking System

Database Design

The database design of this study illustrates the table used in the actual database of the system.

The normalization of the database is presented in the following tables as shown in Figure 12 to help explain the flow of the system. Web platform table contains the user table, login, user profile, portfolio and an image reader

system. User table includes the personal information of the user such as first name, last name, username, email address, password, gender and birth date which will be used for login and displayed in the user profile. Login table will use the user table ID in order to verify the user who tries to login. User profile will display personal information of the user from the user table such as first name, last name, username and birthdate. Portfolio contains a watermarked image and a caption. This is where the watermarked image is saved after embedding a watermark from the image reader system. The image reader system table has the following: original image, watermarked image, and watermarking technique. This watermarking technique will contain either of the DCT or DWT with the embedding and extraction formula and a secret or unique key.

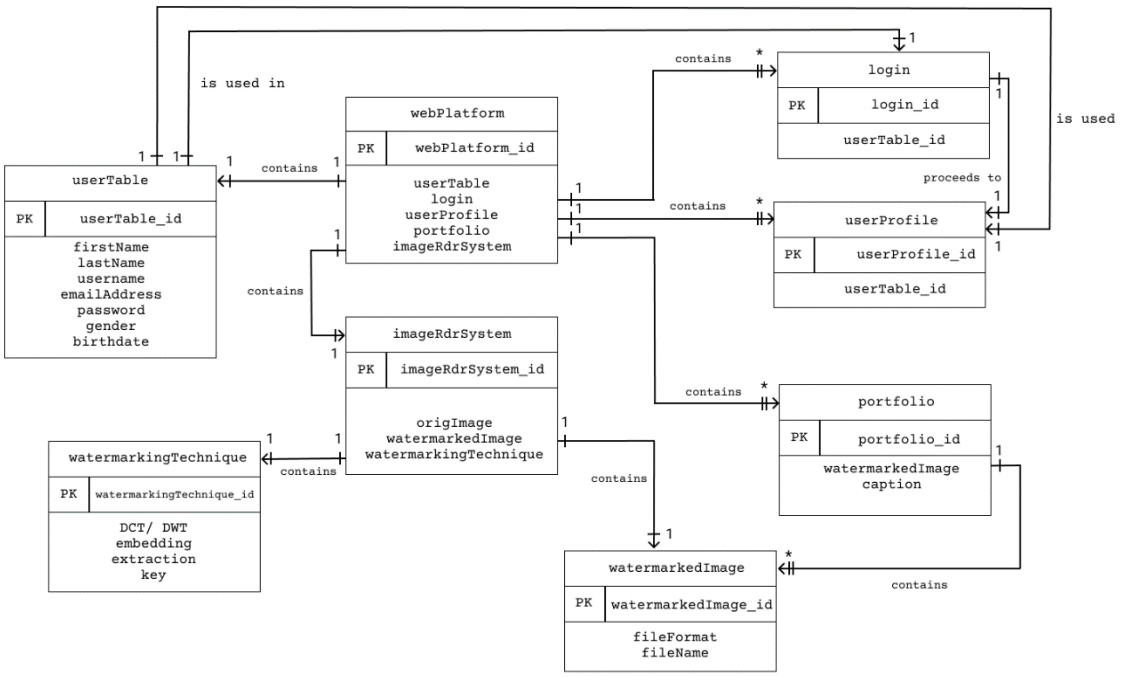


Figure 12: Database Design of the System

Procedural Design

Figure 13 shows the procedural design that visualizes the process on how the system will perform when a certain activity is done. It also shows some features of the system, in our case, the user-profile, portfolio, uploading of images,and extracting of watermark if necessary and requested. A user must sign in first in order to log in if he or she has an account and if not, he or she must sign up. After signing in, he or she will be directed to the web platform and lead to the user profile. Within that user

profile page, there is a portfolio where he can upload his artworks. The uploaded original image will be embedded with the platform's watermark to ensure security of the image and the image will be posted in the portfolio. The user can go back to profile or directly sign out.

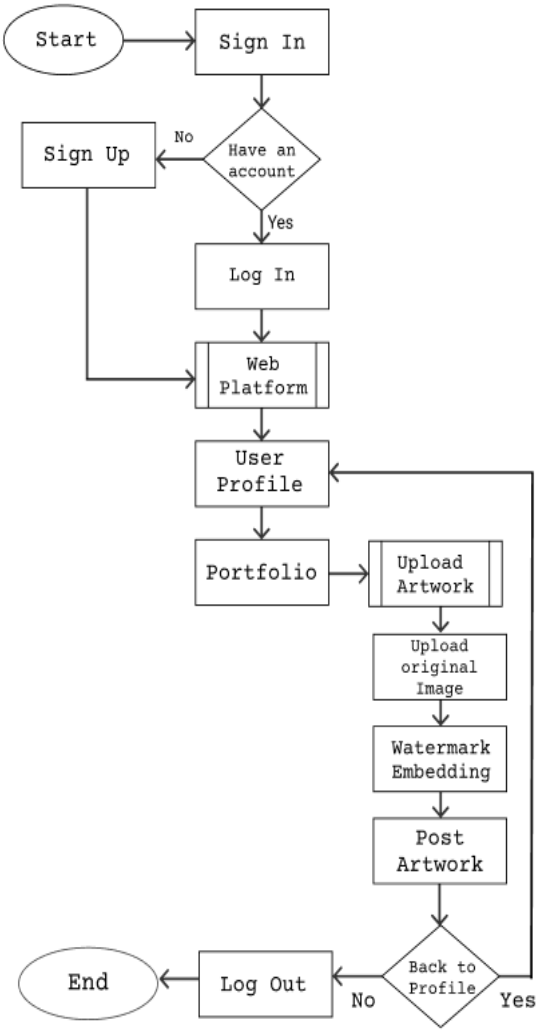


Figure 13: Procedural Design of the System

The Figure 14 below is the procedural design of the embedding process within the platform. A user must select an image of his or her artwork to be uploaded to the image reader system and the embedding process starts. The watermark image will be embedded or inserted to the original image and once the process is done, the watermarked image will be posted to the portfolio. The user then could return back to his or her profile or directly log out.

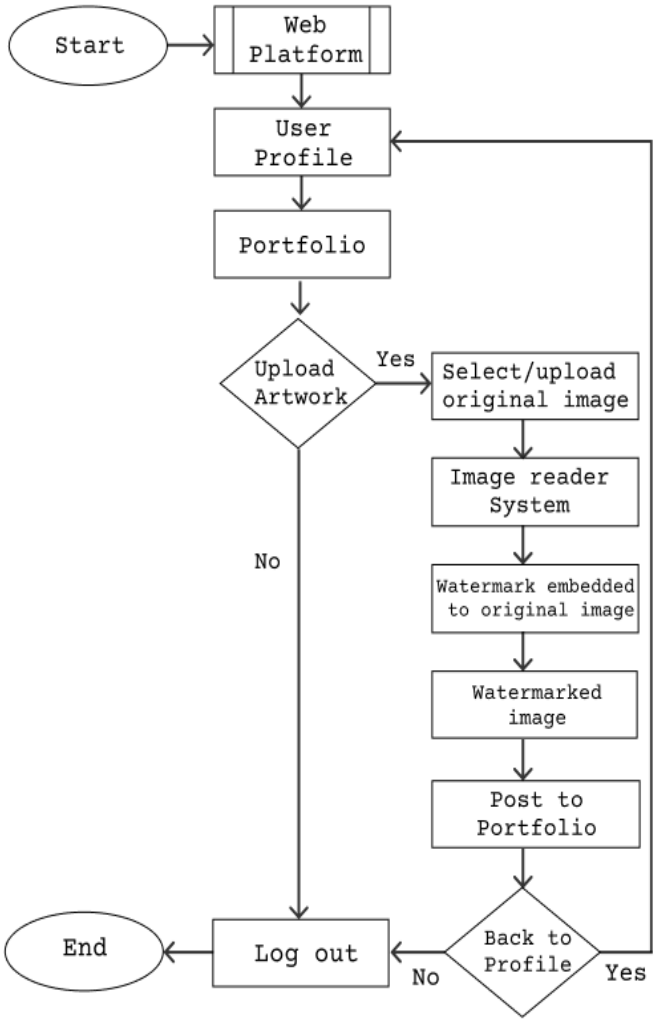


Figure 14: Procedural Design Embedding Process

Object- Oriented Design

Figure 15 presents the UML class diagram of the object-oriented design of the overall system. Flask Forms is used for different forms needed in the website platform and a database for the user account. The watermarking technique was

integrated into the platform and only the embedding process will be included.

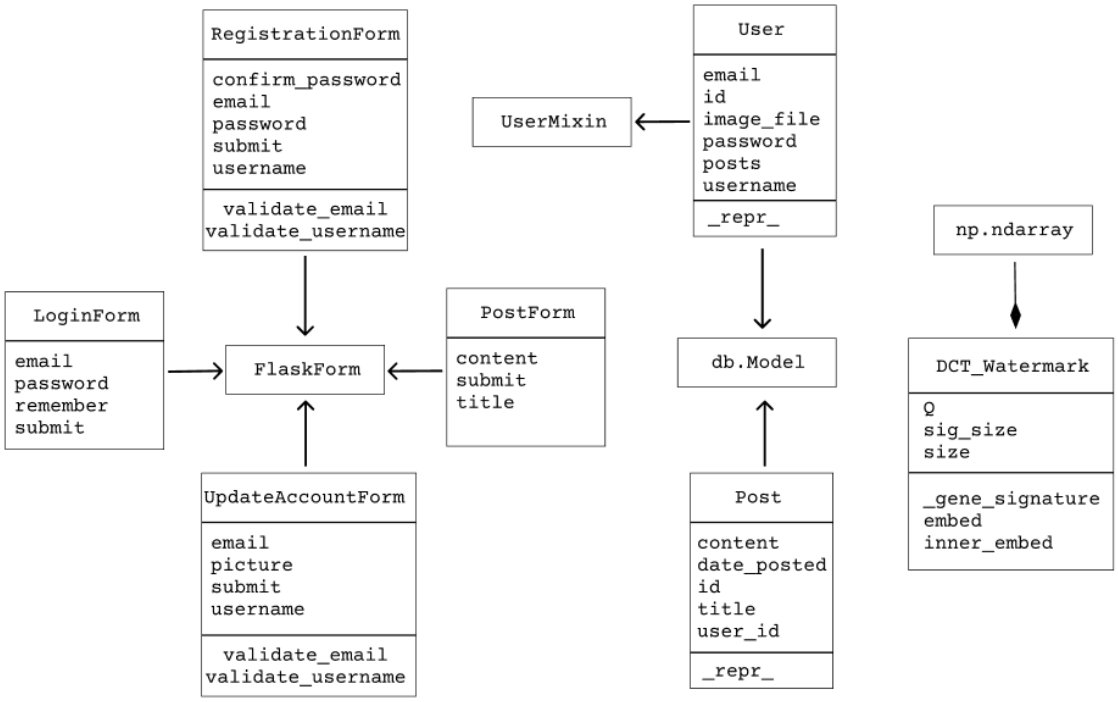


Figure 15: UML Class Diagram of the Overall System

Figure 16 below displays the UML class diagram of the Image Reader System for the comparison process. The DCT and DWT calls the Watermark class as it processes the embedding and extraction of a watermark.

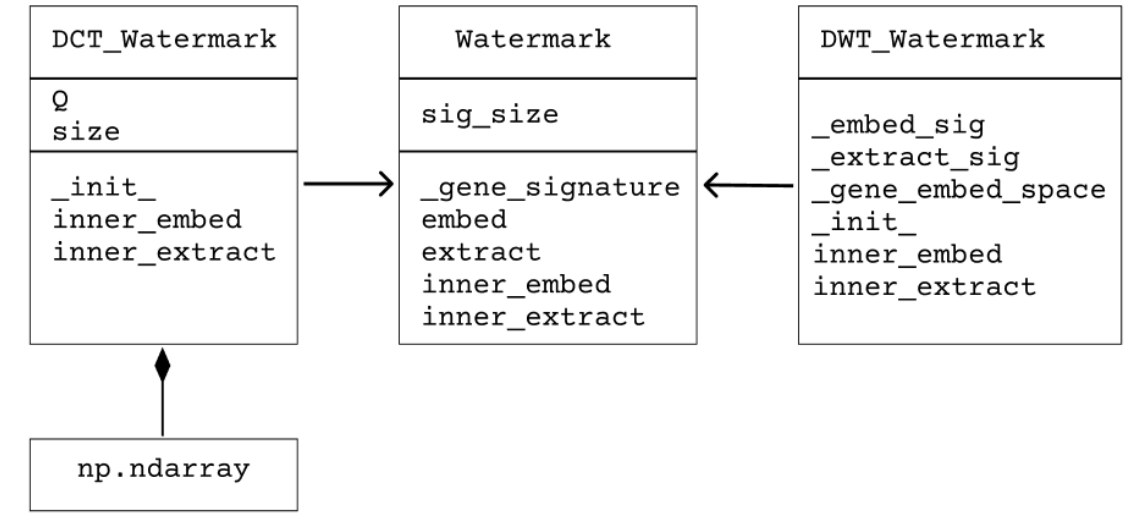


Figure 16: UML Class Diagram of the Image Reader System for Comparison of DWT and DCT watermarking technique

Activity Design

Figure 17 shows the activity design regarding of the actions and activities of each entity. A user must log in or register before proceeding to its profile. The user can edit his or her profile and access his or her portfolio. In editing profile, the user can update its profile picture or update its data such as email and displayed name and save changes. In accessing the portfolio, a user can add an image. Terms and conditions will be shown, and the user needs to agree in order to proceed in choosing an image by clicking the confirm

button. Then, the system will process the embedding of a watermark. Afterwards, the portfolio will be updated and the new image that was uploaded is displayed. The user can log out once done.

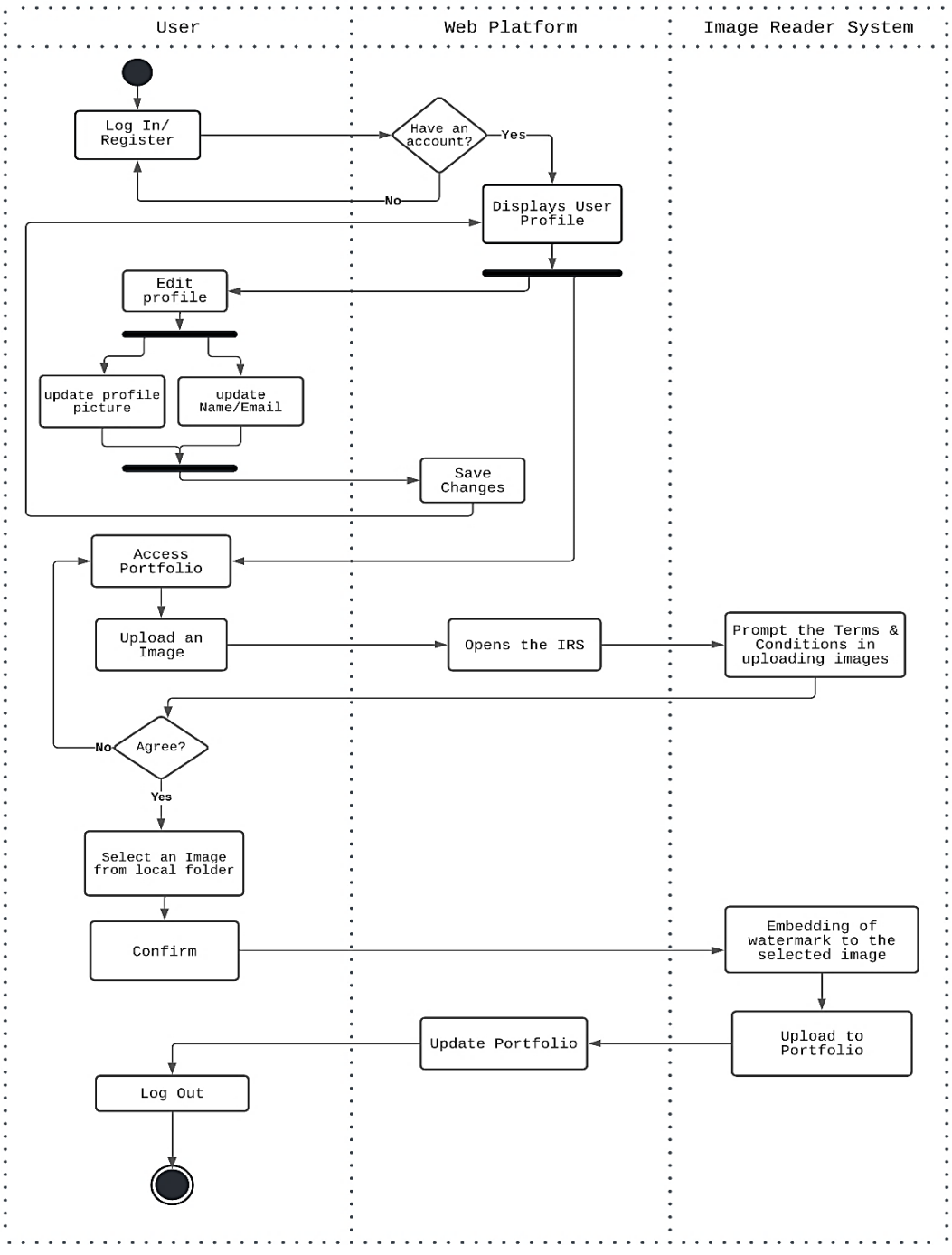


Figure 17: Activity Design of the System

System Development Life Cycle

The Agile development model was utilized in the system development. The process is conducted iteratively until the specific goals are achieved. The method is adaptive to any changes as it goes through several phases. This also involves system evaluation by the developers to make sure that the system is working properly. Sprint method, a two- week period wherein developers are given time to finish their specific task, will be implemented. Scrum process will also be applied where developers commit for the code they will deliver of current sprints.

The overall system was broken down to smaller tasks. First, the platform that includes a user profile and uploading of pictures was developed. Second is the image reader system, followed by comparison and evaluation of the two techniques (DCT and DWT). The last step consists of the insertion and application of watermarks using the Image Reader System and its integration to the platform. Every task is developed iteratively until it is completed for at least two weeks. Then, it proceeds to the next task by using the same method. The proposed robust watermarking technique must achieve the following requirements: (1) imperceptibility or quality of

the image must not be affected after manipulations; (2) robustness or security against different attacks; and (3) capacity of the watermarking technique to accept information.

The first stage is the planning process. In this stage, problems and specific needs and resources are identified. The researchers conducted studies on how to develop the image reader system to facilitate the evaluation process of the two watermarking techniques. Specific needs and data gathered are analyzed to come up with a system design and develop the user interface and back end of the system using existing resources. The testing stage is where the system will be tested by the developers for its effectiveness, documented for its development, and assured of its quality until it passes the requirements for production. The two stages of the development process are the application of the selected robust watermarking technique and its actual integration into the platform. The application of robust watermarking technique was the selected watermarking technique based on the evaluation conducted. The last stage is to integrate the image reader system into the platform for it to be used to embed digital watermark into images.

Once the system is good and completed, the overall performance of the system will be compiled and evaluated again by different metrics to ensure that the technique is robust and protects the copyright of the rightful owner. Simulation and tests were also performed by the research panel to ensure the usability and effectiveness of the system.

CHAPTER 4 RESULTS AND DISCUSSION

Implementation

The first phase in platform development is to design the website's interface, providing that users can access the platform's functions without difficulty. Users were given access to a user profile where they can post and display their work after signing up. The developers use the following software and hardware specifications for the development of the web platform.

The frontend consists of HTML, CSS, and JavaScript while Python with the use of Flask is for web development. The IDE was the Sublime Text, and Flask SQLAlchemy was for the user database. Its IDE was the Spyder 5.0 using the Python 3.8 language. Adobe Photoshop was also used for the image manipulation. Hardware specifications include 64-bit Windows 11 OS, an Intel Celeron processor running at 1.10GHz using 4GB of RAM, and a GPU of Intel(R) HD Graphics 600. For the users to operate the application, Chrome browser is recommended to be used and must be connected to the internet to access the website platform.

Within the platform, the image reader system will be

implemented with the same frontend and backend with the platform development. Basically, the developers will create a system within a system.

Image Reader System

The image reader system was built separately using python programming language to facilitate the evaluation of the two watermarking techniques. This watermarking system was built with a simple user interface with the use of HTML, CSS, and JavaScript. It can accept images in JPG and PNG format which will serve as datasets to be used for the embedding and extraction process inside the system. With this procedure, the researchers are able to gather data needed for comparison to make sure that the digital watermarking technique implemented is more robust. Lastly, this image reader system was attached or connected within the platform developed for graphics designers and was responsible for embedding or insertion of watermark.

Embedding and Extraction Processes

Embedding process includes the insertion of the digital watermark to an image and is invisible without destroying the image's quality. By using this process, it can help secure

and protect one's ownership when uploaded on the platform developed which is the Graphics' Axis. As for the extraction process, this separates the embedded watermark from the original image. This shows how the extracted watermark looks after applying several attacks and proves the ownership of the artist assuming that someone might use or alter the image without permission.

Performance Metrics

By using the Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) formula, results will be produced in determining the visual quality (imperceptibility) of the watermarked image when compared to the original image. The same process was applied for the capacity requirement of the watermarking technique, whether it can accept more bits of information when embedded to the original image. The Normalized Cross Correlation (NCC) was used to evaluate the robustness of the two techniques against various attacks that are applied to the datasets used.

Website

Graphics' Axis, a website intended for graphics designers, was developed with the image reader system connected to it.

The two systems were connected with the use of flask in the python programming language, this platform will serve as a representation of a platform where they can upload their artworks. The implementation of the image reader system within the platform is for the researchers to prove that it is possible for a digital watermarking system to facilitate an embedding of a digital watermark to an image which is more robust compared to watermarking techniques used by other platforms online.

Image Reader System

Figure 18 is the interface of the image reader system alone. It has two processes. One is the embed watermark which is to perform the embedding of watermark and the other one is extract watermark to perform the extraction process.

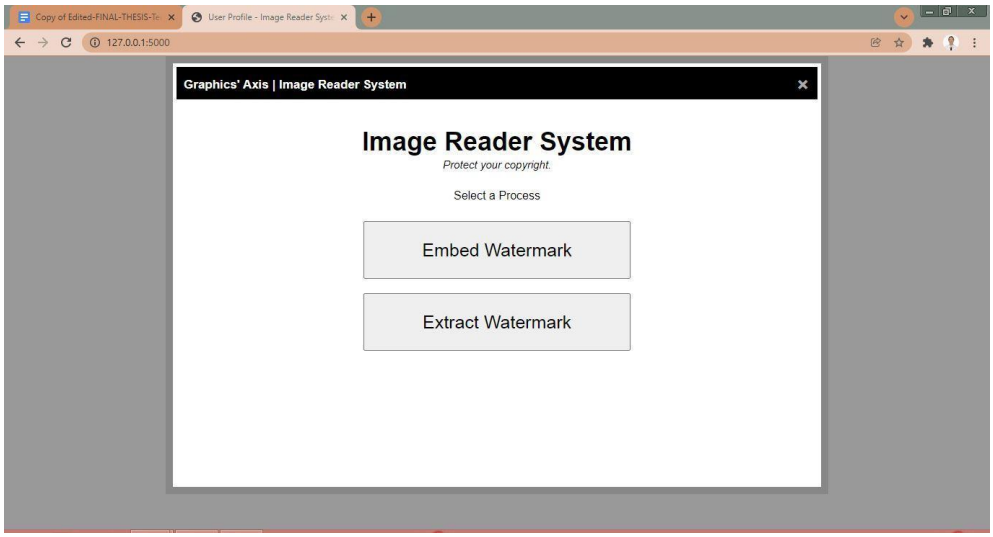


Figure 18: Image Reader System Interface

The application displays the screen as shown in Figure 19 if the embed watermark button is clicked. Users can select an image to be used for embedding from the local folder. The screen also shows the watermark to be embedded into the image selected.

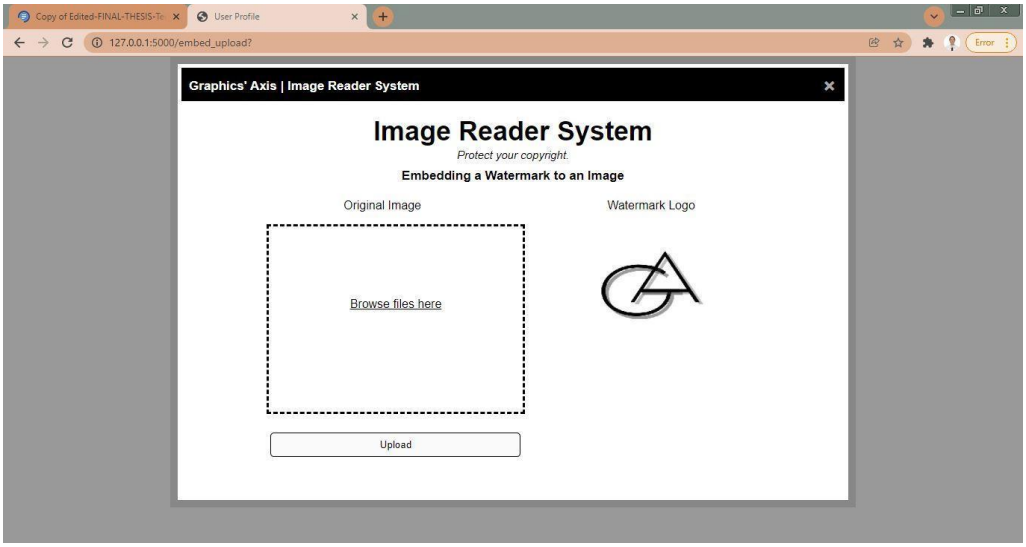


Figure 19: Upload an image to be embedded

After the selection of the image, it appears on the screen together with the watermark to be embedded as seen in Figure 20 below. On the lower right corner of the screen are the two buttons. One is the "Embed using DCT" button to perform the watermark embedding using the Discrete Cosine Transform (DCT) watermarking technique. The other one is the "Embed using DWT" button to perform embedding of the watermark using Discrete Wavelet Transform (DWT) watermarking technique.

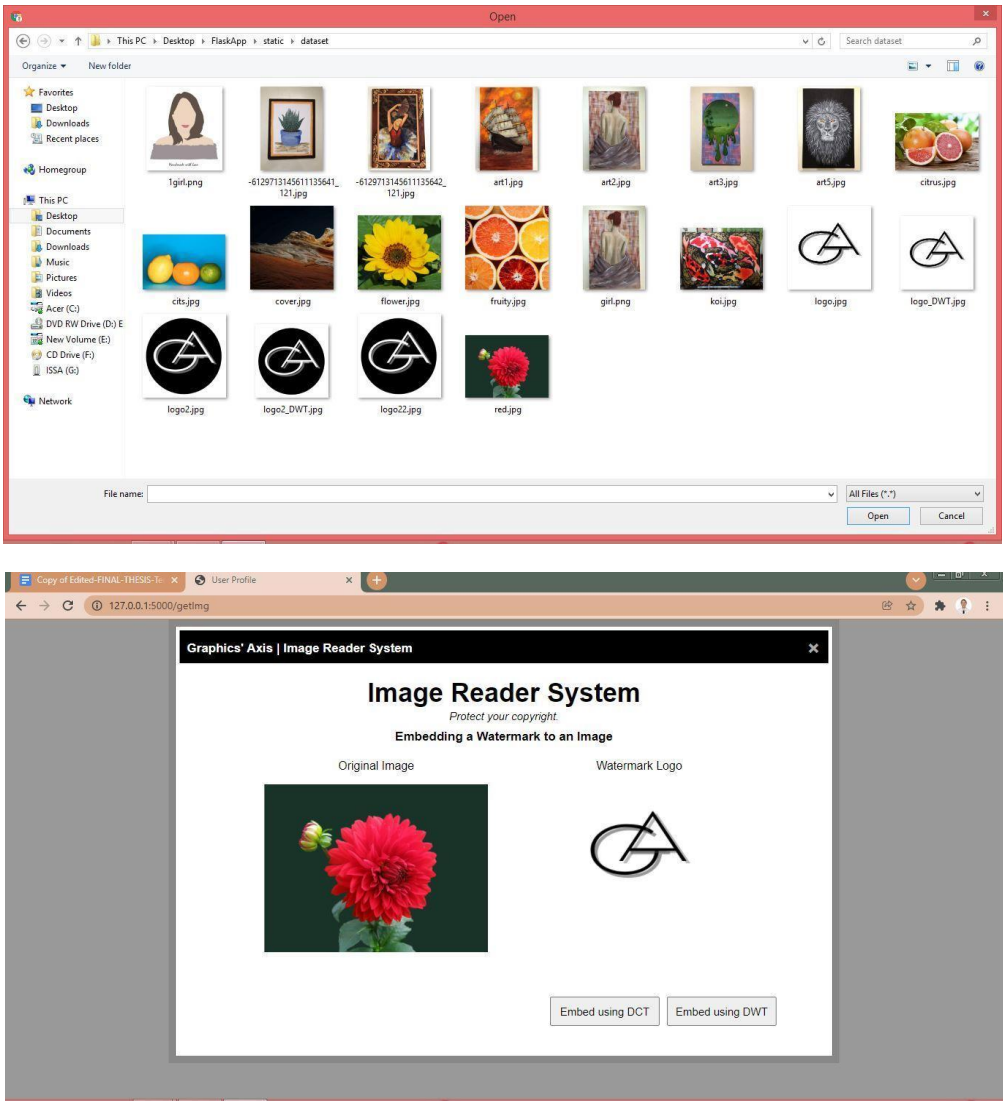


Figure 20: Select an image and choose watermarking technique.

Figure 21 shows that after clicking a specific button on what watermarking technique to be used, the image with

embedded watermark, or referred to as watermarked image, is reflected on the screen.

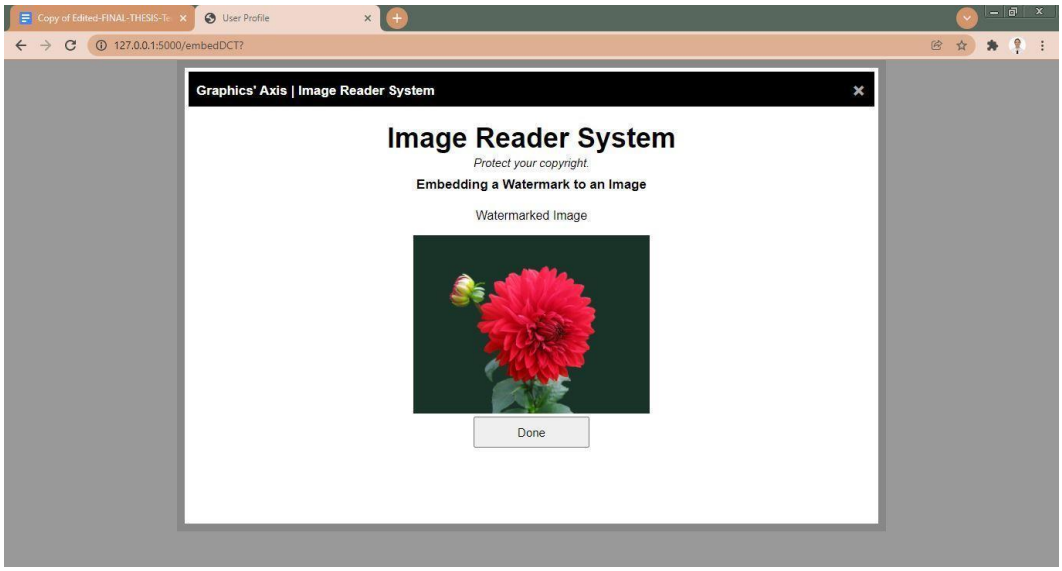


Figure 21: Embedding process is complete.

Figure 22 displays the extraction process in the image reader system wherein the user could upload a watermarked image from the local folder.

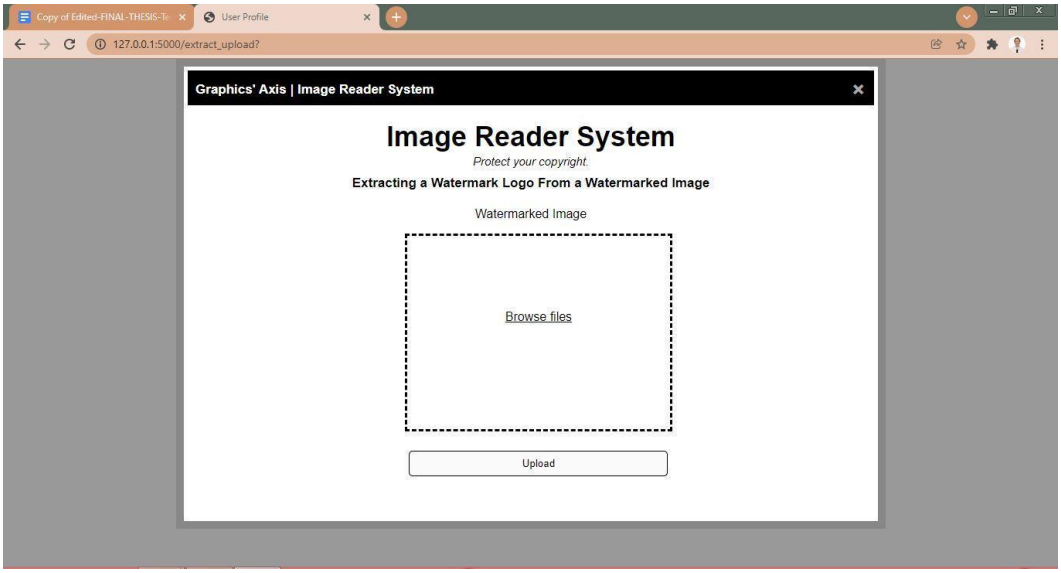


Figure 22: Extraction process in image reader system.

After selection of a watermarked image, it would then be reflected on the image reader system screen, as seen on Figure 23. Again, on the lower right corner of the screen are two buttons. One is the "Extract using DCT" button to extract the embedded watermark image from the original image using the Discrete Cosine Transform (DCT) watermarking technique. The other button is "Extract using DWT" which is to extract the watermark image from the original image using the Discrete Wavelet Transform (DWT) watermarking technique.

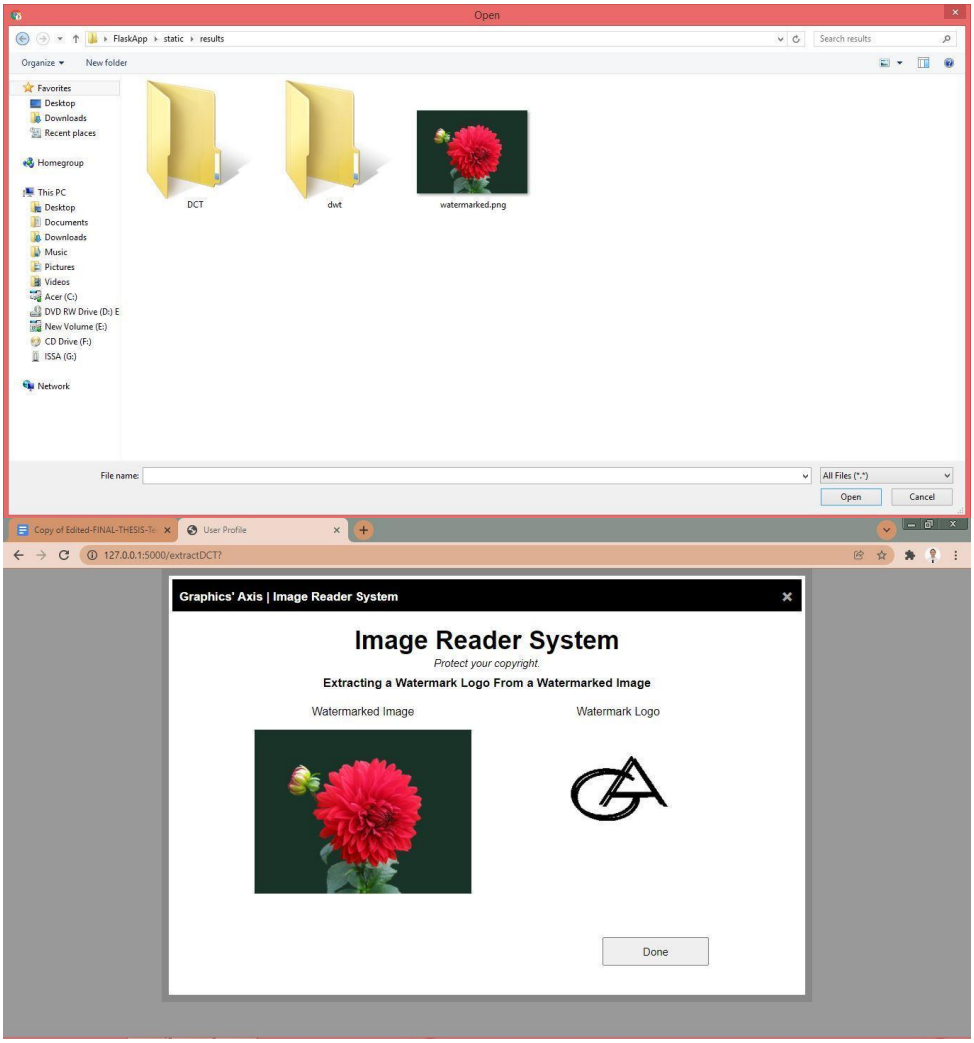


Figure 23: Select a watermarked image to be extracted.

In Figure 24, the extracted watermark image (logo) was extracted from a watermarked image using the selected watermarking technique. The original (no watermark) image and the extracted watermark image (logo) are directly stored in the local folder.

These images saved from the embedding and extraction process inside the image reader system were used as datasets for the evaluation of the two watermarking techniques.

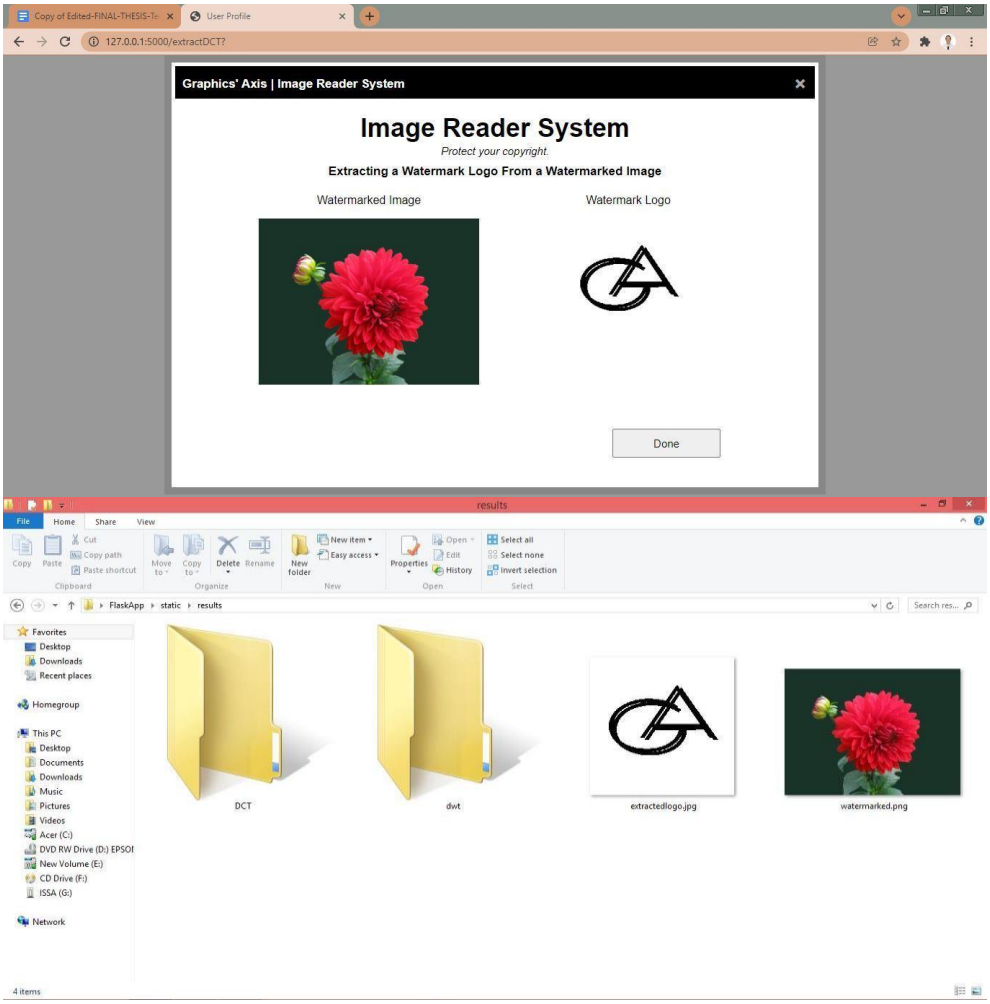


Figure 24: Extraction process is complete.

Overall System

Figure 25 is the first screen to appear after opening the website which is the Login and Register page. On the register, the user needs to input needed information and click the "signup" button and it will redirect him or her to the login where the user needs to input the information, he or she provided on the registration form in order to access the website.

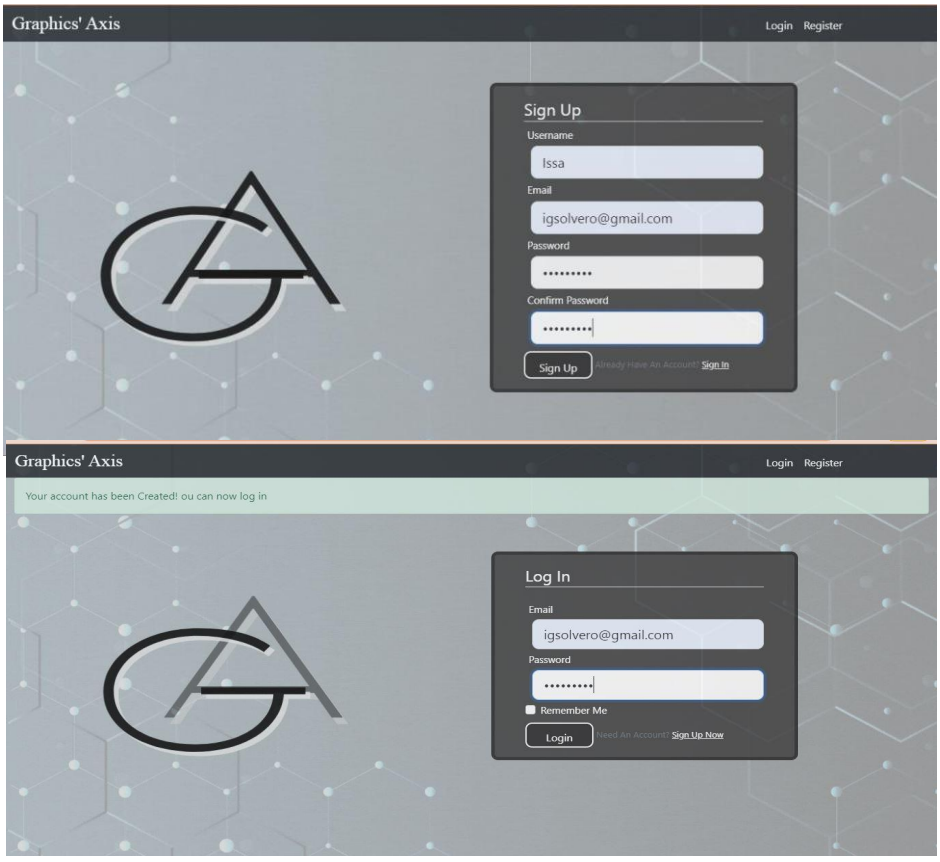


Figure 25: User Register/Log in

After logging in, it will redirect the user to the user-account page as shown in Figure 26. In this page, users can edit their profile information by clicking the "update" button and "choose file" button to change profile picture.

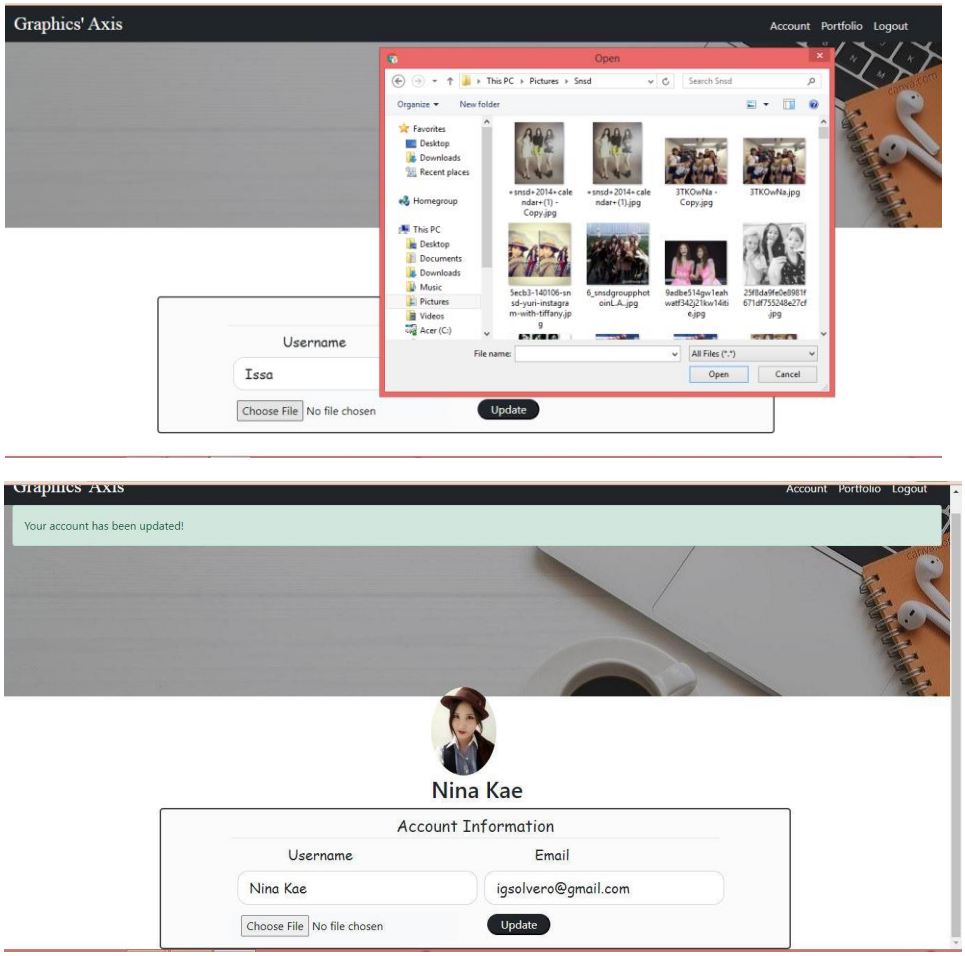


Figure 26: User Account

Figure 27 is the user portfolio page of the website and where the image reader system is integrated which can be

accessed by clicking the "portfolio" on the upper right part of the page. The image reader system pops up when the add button is clicked and displays the terms and conditions of the image watermarking application.

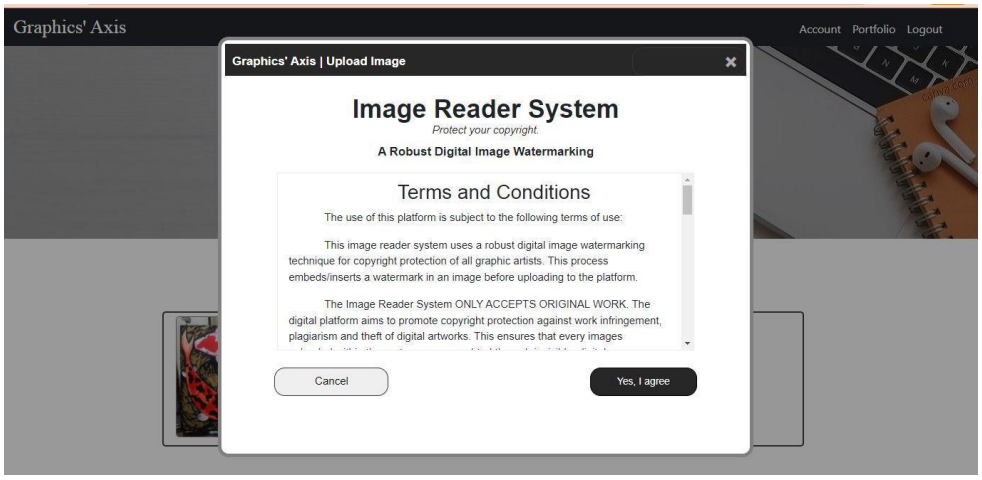


Figure 27: User's Portfolio with IRS for uploading of images.

Figure 28 is where users can browse for images to be uploaded. The logo is also shown on the right side which will serve as the watermark image to be embedded in the original image selected by the user. The "upload" button uploads the image on the portfolio page after the embedding process of the watermark within the watermarking system.

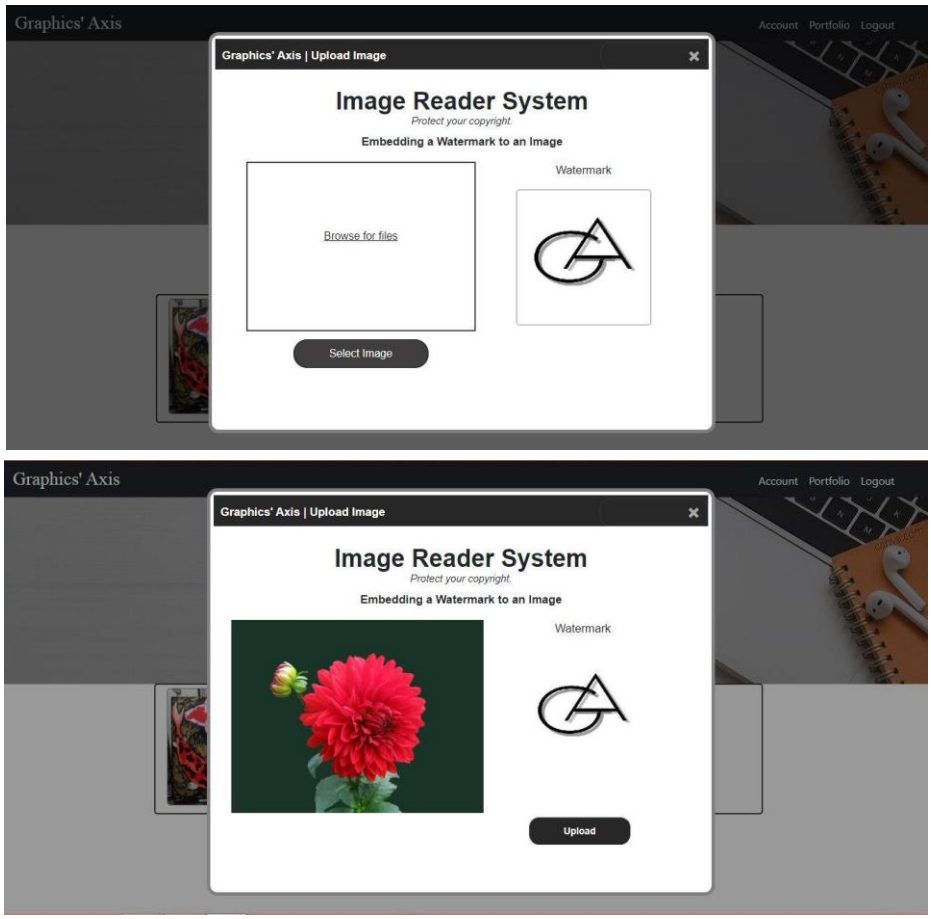


Figure 28: Uploading of image with embedded watermark using the selected watermarking technique

Figure 29 shows the image displayed on the user's portfolio after uploading. This image is embedded with the watermark image that was previously shown. The user can log out from his or her account and he or she will be redirected to the main page of the website.

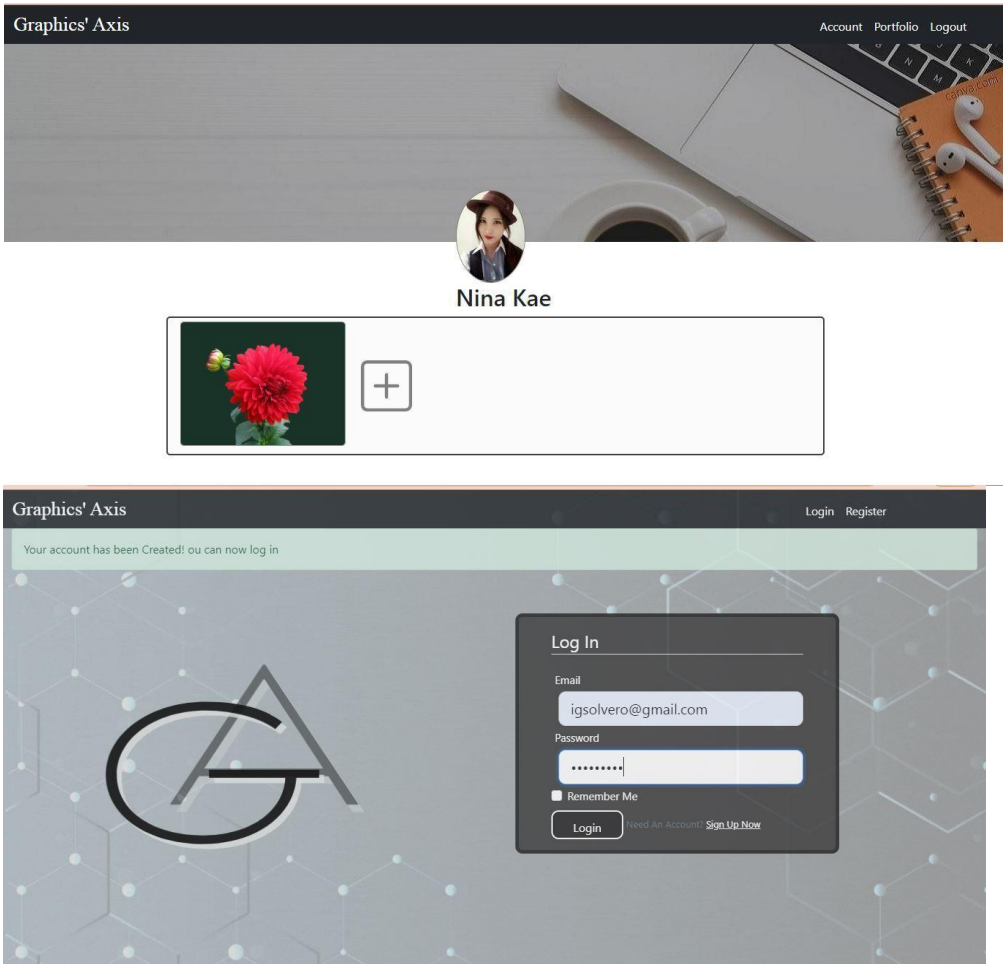


Figure 29: Image uploaded to the platform and the main page of the system.

Results Interpretation and Analysis

To evaluate the two techniques, the Discrete Cosine Transform and Discrete Wavelet Transform, the researchers used three requirements; imperceptibility, capacity, and robustness or security. One of the two watermarking techniques should satisfy these four requirements below:

1. Imperceptibility

When analyzing the performance of a watermarking system, imperceptibility is crucial. Invisibility and constancy are representations of it. The watermarked image must look identical to the original image in this situation. As a result, the image quality must not be altered.

2. Capacity

Based on the amount of the original data, watermarking capacity determines how much data or information can be embedded in a host image. The capacity is defined by the number of bits that are carried by each host image once the watermark image is inserted. However, inserting extra watermark information is a complex process that requires a

prerequisite based on practical applications. To put it another way, the capacity dictates the watermarking information's restrictions while also ensuring watermarking robustness and imperceptibility.

3. Robustness

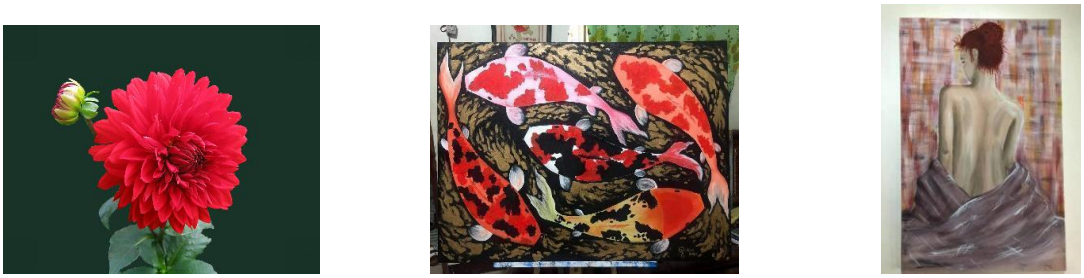
The requirement of robustness in digital image watermarking systems is that a watermark should still be detected after several image manipulations or modifications have been applied. There are several basic ways to achieve high robustness, including redundant embedding, spread spectrum, and embedding watermarks to name a few. As a result, an effective digital image watermarking system needs to be resistant to a variety of attacks, ensuring that watermark data cannot be removed or excluded by unauthorized users.

4. Security

Unsecure watermarking algorithms cannot safeguard copyright, fingerprinting, data authentication, or tracking of media content. As a result, in digital picture watermarking approaches, security is a major concern. Various encryption methods can be used to confirm security, with the key

determining the level of protection. Telemedicine, digital imaging, telecommunications, multimedia data, and other fields can all benefit from the security needs.

Datasets are relevant in order to acquire the data needed for comparison. The researchers used a JPG and PNG image format to further evaluate the watermarking techniques given different datasets used. Figure 30 shows the datasets used for comparison of the two watermarking techniques. These images were used all throughout the comparison and evaluation process.



a.) redflower.jpg b.) koi.jpg c.) girl.png

Figure 30: Datasets Used for Comparison

Figure 31 below shows the two watermarks that were used for this evaluation- the original watermark of the platform, and the other one is used to test the capacity of the watermarking techniques, both with a size of 200x200. The Capacity will be explained further on Table 2.

a.) Original Watermark b.) Used to measure capacity

Figure 31: Watermarks Used for comparison

Embedding and Extraction

Table 1 shows the watermarked images after they were embedded and their corresponding extracted watermarks after the extraction process in the image reader system using the two techniques; the Discrete Cosine Transform and Discrete Wavelet Transform.

Table 1. Watermarked images after embedding and the watermarks after extraction using the DCT and DWT techniques.

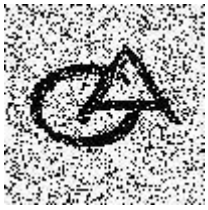
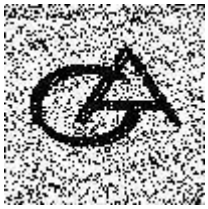
DCT Watermarking Technique		DWT Watermarking Technique	
Watermarked Image	Extracted Watermark	Watermarked Image	Extracted Watermark
			
			
			

Table 1 shows that the watermarked images using the two techniques produce a good visual output with a blind and invisible watermark. The extracted watermark after the

extraction process is identifiable and clear, especially on the DCT. On the DWT, the extracted watermark produces random noises both on the images of koi and girl. The image red flower has a clean output of its extracted watermark due to a high resolution of the original image used.

Imperceptibility

Imperceptibility is crucial when analyzing the performance of a watermarking system. The watermarked image must look similar to the original one and its quality must not decrease after embedding a watermark. MSE and PSNR are used to measure the imperceptibility or similarity degree between original image and watermarked image. A high PSNR value indicates good imperceptibility. The least acceptable value for PSNR is about 38 dB.

Table 2. Original PSNR Values of Watermarked Images for Imperceptibility

Original Images (No Watermark)	DCT Watermarked Images With PSNR Values	DWT Watermarked Images with PSNR Values
 redflower.jpg	 41.4056	 43.196
 koi.jpg	 39.1734	 43.1614
 girl.png	 36.8278	 43.2476

As shown on Table 2 above, the PSNR values of watermarked images under DWT are higher than the DCT. The DCT technique embedded a watermark with a size 200x200. The DCT has an instance that its quality may be affected during the embedding process as it compresses two JPG images. This causes a lossy

quality output, thus affecting the PSNR value of the watermarked images. The *girl.png* displays a lower value because PNG image formats support transparency/lossless compression, and the watermark used was in JPG format. When embedded, the similarity between the original image and watermarked was degraded.

The DWT technique embedded a size of 100x100 watermark, resized from 200x200 pixels, in order to meet the requirements of the algorithm. Several studies regarding the use of DWT in digital watermarking (Najafi, 2017) uses a grayscale image as a host to easily decompose to each subband. This creates a noise when the watermark is extracted, as the original image used in the DWT algorithm is in the RGB scheme. The *girl.png* also shows the same level of quality with the JPG images. In terms of imperceptibility, results show that the PSNR values of DWT were acceptable and retained their quality closer to the original image.

The two techniques, the Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT), indicated a good performance in evaluating their imperceptibility. During the comparison process, the higher resolution the original image has, the better PSNR output. The original images and

watermarked images visually show no difference to each other, which means that the two watermarking techniques satisfy the imperceptibility requirement on this evaluation. Both digital watermarking techniques retain the quality of the images after the embedding process.

Capacity

Watermarking capacity determines how much information can be inserted into the host image. For this requirement, the researchers tested another watermark with more bits to measure the capacity of the watermarking techniques. Peak Signal- to- Noise Ratio was used to evaluate the capacity of a watermarking technique.

Table 3. PSNR Values of Watermarked Images for Capacity

Watermarked Image Datasets	DCT PNG Watermarked Image PSNR Values (Capacity)	DWT PNG Watermarked Image PSNR Values (Capacity)
 redflower.jpg	 44.2137	 45.3954
 koi.jpg	 42.1976	 44.5186
 girl.png	 39.9256	 45.2659

Table 3 shows the PSNR values of watermarked images embedded with a watermark that is modified to higher bits (see Figure 31). Compared to the original PSNR values presented on Table 1, there is a significant increase of values in using the DWT than the DWT technique. Results show

that the complexity of an image is proportional to the visual quality of the output in embedding a watermark to the image. The higher amount of information embedded in the original image, the more imperceptible and undetectable the watermarking technique is. The DCT can take in more information capacity than DWT technique without degrading the quality of the watermarked image.

Robustness or Security

The watermark should be detected even after the extraction. An effective digital image watermarking system should be resistant to a variety of attacks, ensuring that watermark data cannot be removed or excluded by unauthorized users. Various encryption methods and signal processing modification operations can be applied to measure the security and robustness of digital image watermarking techniques. The Normalized Cross Correlation was utilized to determine the watermark robustness. This measures the extent of similarity between the original and extracted watermarks. If the normalized correlation value is 1, the extracted watermark is identical to the original.

To test the robustness and security of the watermarking techniques, which is the most important of all the requirements mentioned, images were tampered by applying commonly used image manipulation like adding contrast, Gaussian noise, sharpening, cropping and overlay texts. After the attacks, the NCC value of the extracted watermark must be close to 1. The lower the value difference to 1, the more secure and robust a watermarking technique is.

The following tables present the Normalized Cross Correlation (NCC) values and appearance of extracted watermarks from two watermarking techniques DCT and DWT in every image used after applying various attacks.

Table 4. Contrast (+25) Attack and Extracted watermarks' NCC Values

Contrast +25	DCT	DWT
 redflower.jpg	 0.9003	 0.8062
 koi.jpg	 0.9003	 0.3286
 girl.png	 0.9003	 0.2396

Table 4 shows the images that have been tampered by adding contrast to them as well as the Normalized Cross Correlation (NCC) values of their extracted watermarks using the two watermarking techniques DCT and DWT.

Table 5. Gaussian Noise Attack and Extracted Watermarks' NCC Values

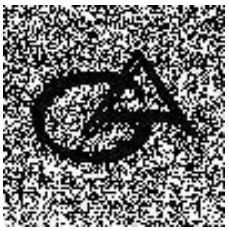
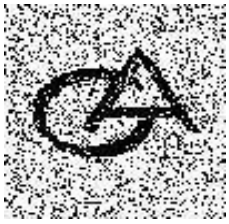
Gaussian Noise 0.5	DCT	DWT
 redflower.jpg	 0.9003	 0.2863
 koi.jpg	 0.9003	 0.4390
 girl.png	 0.9003	 0.2656

Table 5 shows the images that have been tampered by performing Gaussian noise attack to them as well as the Normalized Cross Correlation (NCC) values of their extracted watermarks using the two watermarking techniques DCT and DWT.

Table 6. Sharpening Attack and Extracted Watermarks' NCC Values

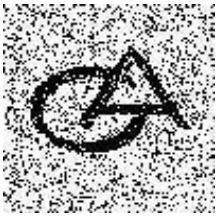
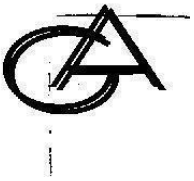
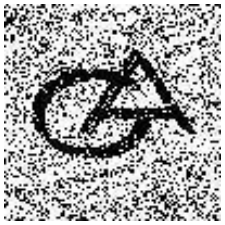
Sharpen +8	DCT	DWT
 redflower.jpg	 0.9003	 0.74939364
 koi.jpg	 0.7591	 0.4479
 girl.png	 0.8699	 0.3993

Table 6 shows the images after applying the sharpening attack to them as well as the Normalized Cross Correlation (NCC) values of their extracted watermarks using the two watermarking techniques DCT and DWT.

Table 7. Cropping Attack to Images and Extracted Watermarks' NCC Values

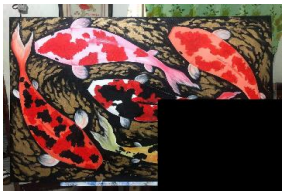
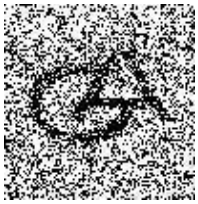
Cropping	DCT	DWT
 redflower.jpg	 0.9003	 0.8062
 koi.jpg	 0.9003	 0.2667
 girl.png	 0.9003	 0.3825

Table 7 presents the images after cropping certain parts of them. Also, the Normalized Cross Correlation (NCC) values of their extracted watermarks using the two watermarking techniques DCT and DWT are shown.

Table 8. Overlay Text Attack to Images and Extracted Watermarks' NCC values

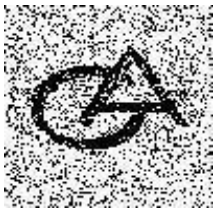
Overlay Text	DCT	DWT
 redflower.jpg	 0.8479	 0.7709
 koi.jpg	 0.8127	 0.4367
 girl.png	 0.8571	 0.2696

Table 8 shows the images after putting overlay texts and the Normalized Cross Correlation (NCC) values of their extracted watermarks using the two watermarking techniques DCT and DWT are presented.

As seen on tables above, the NCC values of both techniques have a wide gap after attacks were applied. Under the same circumstances, the extracted watermarks have produced different results.

In Table 4, the DCT has shown resistance to the contrast attack. The extracted watermark values on DWT acquired random noises and the watermark is still identifiable. The Gaussian noise attack in Table 5 has similar results with the contrast attack on Table 4. The DCT values remain persistent when contrast and Gaussian noise are applied while the DWT produces lower values. The values of DCT on Table 6 show a slight decrease, and the NCC values on DWT show vulnerability to sharpening. On Tables 7 and 8, cropping and overlay text were applied to watermarked images and extracted watermarks show that the techniques were slightly affected by these kinds of attacks.

The NCC values on DCT based on previous tables remain from 0.7 to 0.9 which is still acceptable. It is a good indication that the watermarking technique is robust and is resistant to common image manipulations. The watermarks using DCT could be extracted without losing its quality. Based on the comparisons and analysis, it is concluded that the DCT

watermarking algorithm shows more robustness against various signal processing attacks than the DWT technique.

CHAPTER 5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of the Proposed Study Design and Implementation

The researchers proposed a study entitled Graphics' Axis: Platform for Graphic Designers with Robust Image Watermarking Technique for Copyright Protection. This focuses on dealing with copyright protection by creating a platform with an image reader system that is responsible for embedding a digital watermark into an image since one of the concerns nowadays is that any forms of media, especially images are easily stolen and not being credited to their rightful owner.

First, researchers developed an image reader system that accepts images to embed and extract a watermark image into it. The embedding and extraction process inside the image reader system were used to evaluate the two watermarking techniques to test their robustness by satisfying the three digital watermarking requirements. After the evaluation process, the image reader system with the chosen watermarking technique applied to it was integrated in a platform. This was the last implementation in our study where users are able to upload images into a platform with robust watermarking.

This study developed a platform for graphic designers that includes robust image watermarking techniques for copyright protection, ensuring that all uploaded works are safe and secure. To achieve the objectives of this study, the agile development model was utilized in the system development. Iteratively, the process is carried out until the particular objectives are met. As it progresses through numerous phases, the approach adapts to any changes. The platform has an image reader system that manages the embedding of the digital watermark to the images to be uploaded.

Summary of Findings

This research aimed to develop a platform with an image reader system that can embed a watermark invisibly to avoid destroying the quality of an image and secure one's ownership. The researchers developed an image reader system to gather data needed for the comparison of the two techniques, the Discrete Cosine Transform and Discrete Wavelet Transform. Datasets are used to test the two techniques to satisfy three requirements; the imperceptibility, capacity, and robustness or security. After all the needed procedures, the values gathered attest which of the two techniques is more robust when applied to the platform. Studies from different sources such as online books, PDFs, related studies and methods were also considered and applied for the development of the study.

Getting the results for imperceptibility, DWT has higher PSNR value. Under capacity, DCT can take in more information. For robustness or security, among the five attacks presented, DCT has a more identical extracted watermark to the original watermark embedded which means that this technique is resistant to those attacks applied. Lastly, the image reader system with robust watermarking technique was successfully

implemented into the website and smoothly performs its role which is to embed watermark into images before finally posting it into the developed platform. Researchers found a way on how this image reader system will not only be for evaluation but to have another purpose which is the process of connecting it into an actual platform that can have more benefit and effects to this area of research. The system will be efficient to the graphic designers for they will be able to secure their images which costs them skill, time and ideas to bring something into existence.

Conclusions

A lot of digital watermarking techniques exist that are known for their own kind of robustness having some limitations after performing image manipulations and undergone different testing but are not applied to platforms that can truly benefit others. In this study, researchers identify which of the two watermarking techniques namely: Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) is more robust in terms of imperceptibility, robustness or security, and capacity. The platform includes an image reader system that is responsible for embedding and extraction of the watermark to images. Researchers are able to gather datasets as a basis for evaluation. Based on the evaluation conducted, the Discrete Cosine Transform (DCT) performs better in terms of robustness or security.

The image reader system developed is a standalone system which means that it can function independently and can be integrated to other systems to maximize its usability and to further contribute to this area of research and for the benefit of other fields of studies as well.

Lastly, the copyright issue encountered by people,

especially those in the graphic design industry, is addressed through the development of a platform that includes an image reader that is able to embed a digital watermark to secure the graphics designer's copyright ownership.

Recommendations

Two watermarking techniques were used and evaluated to test its robustness when it comes to embedding a watermark into images and based on the findings and conclusions drawn, the following recommendations were made:

1. Improve the reliability and robustness of the digital watermarking by adding other techniques to combine with the DCT.

2. Include back search images to allow the system to look for identical images on the Internet to strengthen copyright protection.

References

Aarno, D., & Engblom, J. (2015). Chapter 1 - Introduction. In Software and System Development using Virtual Platforms (pp. 1–19). Morgan Kaufmann. https://doi.org/10.1016/B978-0-12-800725-9.00001-9.

Abdullah, M. A., Dlay, S. S., & Woo, W. L. (2015). Securing iris images with a robust watermarking algorithm based on discrete cosine transform. In International Conference on Computer Vision Theory and Applications (Vol. 2, pp. 108-114). Scitepress.

Adamović, S. & Tašić, J. (2017). Digital Image Watermarking Techniques and Biometrics Data Security: A Review. In Sinteza 2017-International Scientific Conference on Information Technology and Data Related Research (pp. 55-62). Singidunum University. doi:10.15308/Sinteza-2017-55-62

Ahmed, G. & Yousif, A. (2019). A Digital Image Watermarking Scheme based on Discrete Cosine Transform. Journal of Engineering and Applied Sciences. 14. 5762-5768. 10.36478/jeasci.2019.5762.5768. Retrieved from

https://www.researchgate.net/publication/335857364_A_Digital_Image_Watermarking_Scheme_based_on_Discrete_Cosine_Transform

Ali, Z., & Bhaskar, S. B. (2016). Basic statistical tools in research and data analysis. Indian journal of anaesthesia, 60(9), 662–669. https://doi.org/10.4103/0019-5049.190623

Alouneh, S., Biørn-Hansen, A., Grønli, T.M., & Ghinea, G. (2019). An Empirical Study of Cross-Platform Mobile Development in Industry. Wireless Communications and Mobile Computing, vol. 2019. https://doi.org/10.1155/2019/5743892

Ambadekar, S.P., Jain, J., & Khanapuri, J. (2019). Digital Image Watermarking Through Encryption and DWT for Copyright Protection. In: Bhattacharyya S., Mukherjee A., Bhaumik H., Das S., Yoshida K. (eds) Recent Trends in Signal and Image Processing. Advances in Intelligent Systems and Computing, vol 727. Springer, Singapore. https://doi.org/10.1007/978-981-10-8863-6_19

Arora, S., & Poonam (2018). A DWT-SVD based Robust Digital Watermarking for Digital Images. Published by Elsevier Ltd. p. 1. Retrieved from

https://www.sciencedirect.com/science/article/pii/S1877050918308081

Barnouti, N.H., Sabri, Z.S., & Hameed, K.L. (2018). Digital Watermarking Based on DWT (Discrete Wavelet Transform) and DCT (Discrete Cosine Transform). International Journal of Engineering & Technology, 7 (4) (2018) 4825-4829.

Basole, R., Sorensen, C., & de Reuver, M. (2017). The Digital Platform: A Research Agenda. Journal of Information Technology. 33. 10.1057/s41265-016-0033-3.

Begum, M., & Uddin, M. S. (2020). Digital Image Watermarking Techniques: A Review. Information, 11(2), 110. Retrieved from https://www.mdpi.com/2078-2489/11/2/110/htm

Bylinskii, Z., Kim, N.W., O'Donovan, P., Alsheikh, S., Madan, S., Pfister, H., Durand, F., Russell, B., & Hertzmann, A. (2017). Learning Visual Importance of Graphic Designs and Data Visualization. In Proceedings of the 30th Annual ACM Symposium on User Interface Software and Technology (UIST '17). Association for Computing Machinery, New York, NY, USA, 57–69. Retrieved from https://vcg.seas.harvard.edu/publications/learning-visual-

importance-for-graphic-designs-and-data-visualizations/paper

Caplanova, A. (2020). Start-Up Creation (Second Edition). Woodhead Publishing Series in Civil and Structural Engineering. https://doi.org/10.1016/B978-0-12-819946-6.00005-9

Chen, Z., Chen, Y., Hu, W., & Qian, D. (2015). Wavelet domain digital watermarking algorithm based on threshold classification. In the International Conference in Swarm Intelligence (pp. 129-136). Springer, Cham.

Deval, S. (2020). Mean Squared Error – Explained | What is Mean Square Error?. Great Learning. (2021). Retrieved from https://www.mygreatlearning.com/blog/mean-square-error-explained/#respond

Divecha, N., & Jani, N.N. (2013). Implementation and performance analysis of DCT DWT-SVD based watermarking algorithms for color images. Intelligent Systems and Signal Processing (ISSP), 2013 Int. Conf. on. IEEE, 2013, pp. 204-208

Dixit, A., & Dixit, R. (2017). A Review on Digital Image Watermarking Techniques. International Journal of Image, Graphics and Signal Processing. 9. 56-66. 10.5815/ijigsp.2017.04.07.

Duening, T. N., Hisrich, R. A., & Lechter, M. A. (2021). Protecting Your Intellectual Property. In Technology Entrepreneurship (Third Edition) (pp. 81–124). Elsevier Gezondheidszorg. https://doi.org/10.1016/B978-0-12-822203-4.00006-6

Dziobczenski, P. & Person, O. (2017). Graphic Designer Wanted: A Document Analysis of the Described Skill Set of Graphic Designers in Job Advertisements from the United Kingdom. International Journal of Design; Vol 11, No 2 (2017). 11. 41-55. Retrieved from https://www.researchgate.net/profile/Paulo-Dziobczenski/publication/319417914_Graphic_Designer_Wanted_A_Document_Analysis_of_the_Described_Skill_Set_of_Graphic_Designers_in_Job_Advertisements_from_the_United_Kingdom/links/59a943dea6fdcc2398415054/Graphic-Designer-Wanted-A-Document-Analysis-of-the-Described-Skill-Set-of-Graphic-

Designers-in-Job-Advertisements-from-the-United-Kingdom.pdf

Ernawan, F. & Kabir, M.N. (2019). An Improved Watermarking Technique for Copyright Protection Based on Tchebichef Moments. IEEE Access Volume 7. Retrieved from https://ieeexplore.ieee.org/abstract/document/8873527

extraction. (n.d.) WordNet 3.0, Farlex clipart collection. (2003-2008). Retrieved from https://www.thefreedictionary.com/extraction

Geetha Priya, S. (2021). Secure And Fragile Watermarking Of Medical Images With Fingerprint Based Biometric Data Using Matlab. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12(13), 1855-1862.

Grobbelaar, S., Herman, H., & Pistorius, C. (2020). The design and development of technology platforms in a developing country healthcare context from an ecosystem perspective. BMC Medical Informatics and Decision Making. 20. 10.1186/s12911-020-1028-0. Retrieved from https://www.researchgate.net/publication/339894347_The_des

ign_and_development_of_technology_platforms_in_a_developing_country_healthcare_context_from_an_ecosystem_perspective

Heller, S. & Vienne, V. (2015). Becoming a Graphic & Digital Designer. John Wiley & Sons, Inc., Hoboken, New Jersey. p. 148. Retrieved from https://books.google.com.ph/books?hl=en&lr=&id=u1R_BwAAQBAJ&oi=fnd&pg=PA148&dq=graphic+designer&ots=wNmHdmB0Z3&sig=pNlpPCtMO_7jeALUepANu88aZ54&redir_esc=y#v=onepage&q&f=false

Hosseinzadeh, M. (2020). Control Applications for Biomedical Engineering Systems. ScienceDirect. Retrieved from https://www.sciencedirect.com/topics/mathematics/discrete-wavelet-transform
http://ijcatr.com/archives/volume5/issue3/ijcatr05031006.pdf

imperceptibility. (n.d.) American Heritage® Dictionary of the English Language, Fifth Edition. (2011). Retrieved from https://www.thefreedictionary.com/imperceptibility

Jiang J. (2021). What is Embedding and What You Do With It. Retrieved from https://towardsdatascience.com/what-is-embedding-and-what-can-you-do-with-it-61ba7c05efd8

Kannan, D. & Gobi, M. (2015). An Extensive Research on Robust Digital Image Watermarking Techniques: A Review. InderScience Online. Retrieved from https://www.inderscienceonline.com/doi/abs/10.1504/IJSISE.2015.067047

Kaplan, I. (2016). Art Copyright, Explained. Art Market, Artsy. Retrieved from https://www.artsy.net/article/artsy-editorial-art-copyright-explained

Kitanovski, V., Taskovski, D. & Bogdanova, S. (2005). Watermark Generation using Image Dependent Key for Image Authentication. In proceedings of the International Conference on "Computer as a Tool", Belgrade, Serbia, 21–24 November 2005, 947–950. 78.

Ko, H. J., Huang, C. T., Horng, G., & Shiuh-Jeng, W. A. N. G. (2020). Robust and Blind Image Watermarking in DCT Domain using Inter-block Coefficient Correlation. Information Sciences, 517, 128-147.

Kumar, A. (2019). Design of Secure Image Fusion Technique Using Cloud for Privacy-Preserving and Copyright Protection. IGI Global Publisher of Timely Knowledge.

Retrieved from https://www.igi-global.com/article/design-of-secure-image-fusion-technique-using-cloud-for-privacy-preserving-and-copyright-protection/228914

Kumar H. B. B. (2016). Digital Image Watermarking – An Overview. Orient. J. Comp. Sci. and Technol;9(1). Retrieved from http://www.computerscijournal.org/?p=3564

Lala, H. (2017). Digital Image Watermarking Using Discrete Wavelet Transform. International Research Journal of Engineering and Technology, 4(1), 1682-1685.

Licciardi, G. (2020). Data Handling in Science and Technology. ScienceDirect. Retrieved from https://www.sciencedirect.com/topics/computer-science/discrete-cosine-transform

Liu, J. Zhou, M., Wang, S. & Liu, P. (2017). A comparative study of network robustness measures. Front. Comput. Sci. 11, 568–584 (2017). Retrieved from https://doi.org/10.1007/s11704-016-6108-z

Liu, S., Pan, Z., & Song, H. (2017). Digital image watermarking method based on DCT and fractal encoding. IET

Image Process Special Issue: Advances in Big Data Methods for Image Processing, 2017, Vol. 11 Iss. 10, pp. 815-821

Loan, N., et. al. (2018). Secure and Robust Digital Image Watermarking Using Coefficient Differencing and Chaotic Encryption. IEEE Access. PP. 1-1. 10.1109/ACCESS.2018.2808172.

Marshall, D. (2001). The Discrete Cosine Transform (DCT). Retrieved from https://users.cs.cf.ac.uk/Dave.Marshall/Multimedia/node231.html

Najafi, E. (2017). A robust embedding and blind extraction of image watermarking based on discrete wavelet transform. Math Sci 11, 307–318. https://doi.org/10.1007/s40096-017-0233-1. Retrieved from https://link.springer.com/article/10.1007/s40096-017-0233-1#Sec2

OECD (2019), Introduction to Online Platforms and Their Role to Digital Transformation, OECD Publishing, Paris, https://doi.org/10.1787/53e5f593-en.

Ou, L., Qin, Z., Yin, H., & Li, K. (2016). Security and

Privacy in Big Data. In Big data (pp. 285-308). Morgan Kaufmann.

Patra, J.C., Phua, J.E., & Rajan, D. (2010). DCT Domain Watermarking scheme Using Chinese Remainder Theorem for Image Authentication. In Proceedings of the International Conference on Multimedia and Expo, Suntec, Singapore, 19–23 July 2010; pp. 111–116. 80.

Perwej, Y., Parwej, F., & Perwej, A. (2012). An Adaptive Watermarking Technique for the copyright of digital images and Digital Image Protection. Retrieved from https://arxiv.org/abs/1205.2800

Rabie M. (2016). Meaning of Development. In: A Theory of Sustainable Sociocultural and Economic Development. 10.1007/978-1-137-57952-2.

Rao, A., Prathapani, N., & Nagabhooshanam, E.(2014). Application Of Normalized Cross Correlation To Image Registration. IJRET: International Journal of Research in Engineering and Technology. Volume 3. Retrieved from https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.675.1379&rep=rep1&type=pdf

Rashid, A. (2016). Digital Watermarking Applications and Techniques: A Brief Review. Retrieved from http://ijcatr.com/archives/volume5/issue3/ijcatr05031006.pdf

Sahin, A. B., & Güler, I. (2021). A Survey of Digital Image Watermarking Techniques Based on Discrete Cosine Transform. International Journal of Information Security Science. , Vol.10, No.3, pp.99-110

Shivani, S., Singh, D., & Agarwal, S. (2013). DCT based approach for tampered image detection and recovery using block wise fragile watermarking scheme. In Iberian Conference on Pattern Recognition and Image Analysis (pp. 640-647). Springer, Berlin, Heidelberg.

Sickman, K., (2015). Tools vs. Templates A Commentary on Modern graphic Design Ethics and Advancing Technologies. Retrieved from http://wagner.radford.edu/213/2/Sickman%20Thesis%20-%20Final.pdf

Susanto, A., Rachmawanto, E. H., & Sari, C. A. (2018). A robust non-blind image watermarking method using 2-level

HWT-DCT. In 2018 International Seminar on Application for Technology of Information and Communication (pp. 304-308). IEEE.

Tsai, S.E., Liu, K.C., & Yang, S.M. (2017). An Efficient Image Watermarking Method Based on Fast Discrete Cosine Transform Algorithm. Hindawi. Mathematical Problems in Engineering. Volume 2017, Article ID 3509258, 10 pages. https://doi.org/10.1155/2017/3509258

Verma, V. & Jha, R. K. (2015). An Overview of Robust Digital Image Watermarking. Research Gate. Retrieved from https://www.researchgate.net/publication/278303339_An_Overview_of_Robust_Digital_Image_Watermarking

Wang, J., Du, Z. (2019). A Method of Processing Color Image Watermarking Based on the Haar Wavelet. J. Vis. Commun. Image Represent. 2019, 64, 1–8.

https://www.computerhope.com/jargon/g/graphic.htm

https://www.researchgate.net/publication/339348660_Digital_Image_Watermarking_Techniques_A_Review

https://www.youtube.com/watch?v=1iccpf2eN1Q

https://en.wikipedia.org/wiki/Spyder_(software)

https://www.researchgate.net/publication/228985405_AN_OVERVIEW_OF_TRANSFORM_DOMAIN_ROBUST_DIGITAL_IMAGE_WATERMARKING_ALGORITHMS

https://d1wqtxts1xzle7.cloudfront.net/39564449/AmyDritz_thesis_2014.pdf?1446252798=&response-content-disposition=inline%3B+filename%3DClosing_the_Sustainability_Gap_The_Emerg.pdf&Expires=1624202110&Signature=KUY49zDP9OpUjKJ9okMTKDfSpMxK8L2NyCHG7qRj9UDtou0-mFZnpA5x4xok6JmjBC5L5mNkYmsGiH8Iz28nDCdb-j3XAP9YDbtNl2V-5dn59jeQ2nZimaTN~9B8pXvXsO3RMEx2yZMjqJg~TEQVI~G8M-0PK1rYl~Oe1GDqfiHxTLOLO6XNKxE8HZWIPBDfShlqWPbZeTacpwHNhJ~Nah6MJDtwnNDCSuwlhz~6oEbB6SsCiFQco-urOipVUrGeaq9TS-5DRjYlKJaem-5dwbP7OSxj-zZnEE16GRCLIVf9A1M8yC3vqCBCulp-uU2hniNxUbsrBNGYskUg0knkoQ__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

https://www.bls.gov/ooh/arts-and-design/graphic-designers.htm

https://www.merriam-webster.com/dictionary/capacity

https://techterms.com/definition/copyright#:~:text=Copyright%20is%20a%20legal%20means,the%20consent%20of%20the%20author.

https://www.igi-global.com/dictionary/multimedia-encryption-watermarking-wireless-environment/25480

https://www.techopedia.com/definition/24865/secret-key#:~:text=A%20secret%20key%20is%20the,known%20as%20a%20private%20key.

https://www.ni.com/en-ph/innovations/white-papers/11/peak-signal-to-noise-ratio-as-an-image-quality-metric.html

https://www.vocabulary.com/dictionary/security

Appendices

Appendix A

Letter to the Adviser

Attachment 3

	INVITATION LETTER FOR ADVISER	Document No.	WVSU-ICT-SOI-03-F03
		Issue No.	1
		Revision No.	0
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	April 27, 2018
		Issued by:	CICT
		Page No.	Page 1 of 1

March 2, 2021

CYRENE S. DOFITAS JR.
Associate Professor I
College of Information and Communications Technology - West Visayas State University
La Paz, Iloilo City

Dear Prof. Dofitas,

The undersigned are BS Information Technology Research 1/Thesis 1 students of CICT, this university. Our thesis/capstone project title is "*Graphics' Axis: Platform for Graphic Designers With Robust Watermarking Technique for Copyright Protection* ".

Knowing of your expertise in research and on the subject matter, we would like to request you to be our **ADVISER**.

We are positively hoping for your acceptance. Kindly check the corresponding box and affix your signature in the space provided. Thank you very much.

Respectfully yours,

1. Hermenia Y. Bucana,
2. Niña Kae L. Sumaculub,
3. Juisa Grace R. Solvero,

PS:

Advisers, are task to work with the students in providing direction and assistance as needed in their thesis/capstone project. They shall meet with the students weekly or as needed to provide direction, check on progress and assist in resolving problems until such a time that the students passed their defenses and submit their final requirements, as well as, preparing their evaluations and grades.

Action Taken:
● I Accept.
❍ Sorry. I don't accept.

CYRENE S. DOFITAS JR.
Signature over printed name of the Adviser

CC:

CICT Dean
Research Coordinator
Group
**To be accomplished in 4 copies*

Appendix B

Letter to the Editor

	ADVISER'S ENDORSEMENT FORM (For Thesis Manuscript)	Document No.	**WVSU-ICT-SOI-03-F10**
		Issue No.	**1**
		Revision No.	**0**
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	**April 27, 2018**
		Issued by:	**CICT**
		Page No.	**Page 1 of 1**

Respectfully endorsed to the **Technical Editor**, the attached manuscript of the thesis entitled:

GRAPHICS' AXIS: PLATFORM FOR GRAPHIC DESIGNERS WITH ROBUST IMAGE WATERMARKING TECHNIQUE FOR COPYRIGHT PROTECTION

Said manuscript has been presented to me for preliminary evaluation and guidance, and after a series of corrections/directions given which was implemented by the proponents whose names are listed hereunder and their thorough research, we have come to its completion.

Now therefore, I hereby **ENDORSE** the said thesis manuscript to the Technical Editor for **TECHNICAL EDITING**.

PROF. CYRENEO DOFITAS JR.
Adviser's Name & Signature

Date: January 10, 2022

Group Members:
1. Bucana, Hermenia Y.
2. Gegrimal, Denise Marie T.
3. Solvero, Juisa Grace R.
4. Sumaculub Niña Kae L.

Note: *This form should be accomplished and signed if the corrections and changes made by the adviser have been implemented and a new copy of the document have been printed for checking and submission to the next editor*

Appendix B

Letter to the Editor

	THESIS FORMAT EDITOR'S ENDORSEMENT FORM (For Thesis Manuscript)	Document No.	**WVSU-ICT-SOI-03-F11**
		Issue No.	**1**
		Revision No.	**0**
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	**April 27, 2018**
		Issued by:	**CICT**
		Page No.	**Page 1 of 1**

Respectfully endorsed to the **English Editor**, the attached manuscript of the thesis entitled:

GRAPHICS' AXIS: PLATFORM FOR GRAPHIC DESIGNERS WITH ROBUST IMAGE WATERMARKING TECHNIQUE FOR COPYRIGHT PROTECTION

Said manuscript was presented to me and was reviewed and edited in terms of technical specifications, correctness of diagrams and other technical matters. The corrections and suggestions was carried and implemented by the proponents whose names are listed hereunder.

Now therefore, I hereby **ENDORSE** the said thesis manuscript to the English Editor/Grammarian for **English Grammar Editing.**

DR. REGIN A. CABACAS
Technical Editor's Name & Signature

Date: March 4, 2022

Group Members:
1. Bucana, Hermenia Y.
2. Gegrimal, Denise Marie T.
3. Solvero, Juisa Grace R.
4. Sumaculub Niña Kae L.

Note: *This form should be accomplished and signed if the corrections and changes made by the Technical Editor have been implemented and a new copy of the document have been printed for checking and submission to the next editor.*

Appendix B

Letter to the Editor

	ENGLISH EDITOR/GRAMMARIAN'S ENDORSEMENT FORM (For Thesis Manuscript)	Document No.	**WVSU-ICT-SOI-03-F12**
		Issue No.	**1**
		Revision No.	**0**
	WEST VISAYAS STATE UNIVERSITY	Date of Effectivity:	**April 27, 2018**
		Issued by:	**CICT**
		Page No.	**Page 1 of 1**

Respectfully endorsed to the **Thesis Format Editor**, the attached manuscript of the thesis entitled:

GRAPHICS' AXIS: PLATFORM FOR GRAPHIC DESIGNERS WITH ROBUST IMAGE WATERMARKING TECHNIQUE FOR COPYRIGHT PROTECTION

Said manuscript was presented to me for English grammar editing. Corrections have been made and the proponents whose names are listed hereunder implemented said corrections and changes in the revised manuscript.

Now therefore, I hereby **ENDORSE** the said thesis manuscript for **Thesis Format Editing**.

ESPERVAL CEZHAR H. CADIAO
English Editor/Grammarian's Name and Signature

Date: March 18, 2022

Group Members:
1. Bucana, Hermenia Y.
2. Gegrimal, Denise Marie T.
3. Solvero, Juisa Grace R.
4. Sumaculub Niña Kae L.

Note: *This form should be accomplished and signed if the corrections and changes made by the English Editor have been implemented and a new copy of the document have been printed for checking and submission to the next editor.*

Appendix C

Gantt Chart

TASK	Start	End	Year 2020	Year 2021											
			Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
			Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week	Week
			1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Preparation for concept proposal paper	Dec.27	Feb.5													
Concept proposal Presentation	Feb.8	Feb.9													
Chapter 1	Apr.5	May. 5													
Chapter 2 (RRL gathering)	Apr.5	May. 5													
Chapter 3 (Methods)	May.10	May.25													
20% Presentation	Jun.10	Jun.11													
Manuscript Revisions	Jun.13	Jul.1													
Prototyping and Video Demo editing for 50%	Jul. 1	Jul.14													
50% Presentation	Jul.15	Jul.16													
Web Platform dvelopment	Aug.16	Sep.30													
Image reader system development	Aug.16	Oct.5													
Comparison of two techniques	Oct.11	Oct.27													
Implementation of IRS to the platform	Nov.4	Nov.22													
Chapter 1-3 Revisions	Nov.4	Nov.7													
Chapter 4 & 5	Nov.4	Nov.25													
Video demos (IRS, comparison, platform, results)	Nov. 4	Nov.11													
Forms/letters requirements for submission	Nov. 4	Nov.6													
Final Thesis Defense	Dec.02	Dec.3													
Appendices	Dec.8	Dec.13													

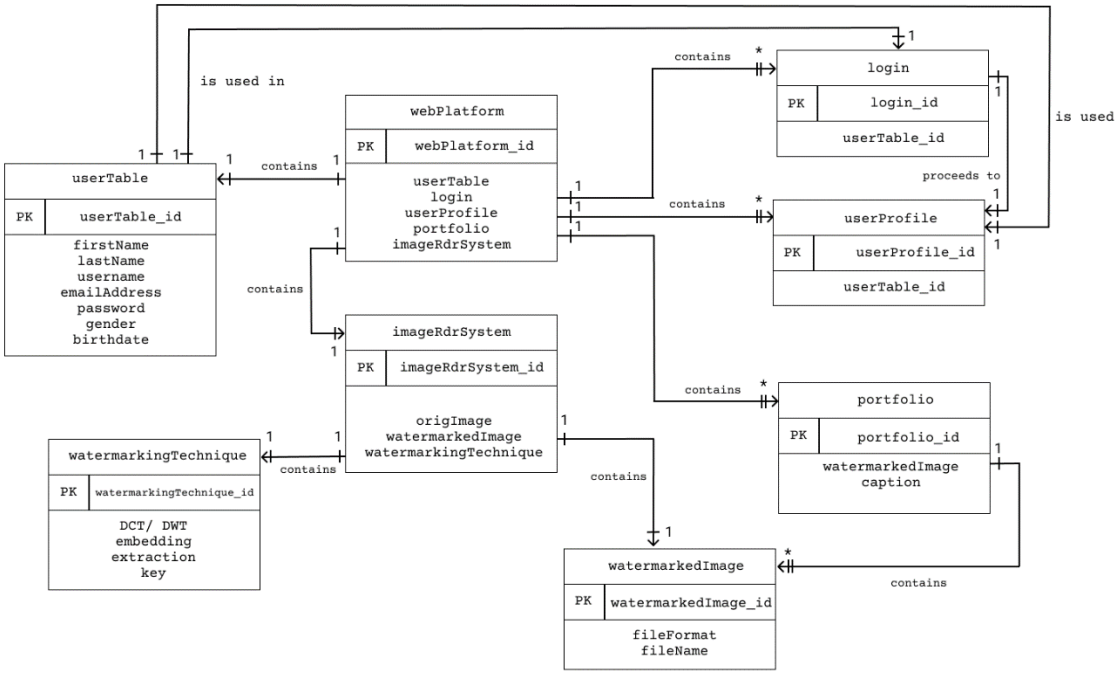
Appendix D

Data Dictionary

Field Name	Data Type	Field Size	Constraint	Description	Example	Required?
userid	int	10	primary key	Unique user id, auto generated	1	Y
Username	string	20	not null	username of the users	useraccount1	Y
email	string	120	not null	any email id	useracc1@gmail.com	Y
password	string	60	not null	login password of the user	wvsU_$1T	Y
image file	string	20	not required	filename of an image	profilepic.jpg	N

Appendix E

Entity- Relationship Diagram



Appendix F

Sample Program Codes

dct watermark.py

```
import cv2
import numpy as np

class DCT_Watermark:
    @staticmethod
    def __gene_signature(wm, size):
        wm = cv2.resize(wm, (size, size))
        wm = np.where(wm < np.mean(wm),0 , 1)
        return wm

    def embed(self, cover, wm):
        sig_size =200
        B = None
        img = None
        signature = None
        if len(cover.shape) > 2:
            img = cv2.cvtColor(cover, cv2.COLOR_BGR2YUV)
            signature = self.__gene_signature(wm,
sig_size).flatten()
            B = img[:, :, 0]

        if len(cover.shape) > 2:
            img[:, :, 0] = self.inner_embed(B, signature)
            cover = cv2.cvtColor(img, cv2.COLOR_YUV2BGR)
        else:
            cover = B
        return cover
```

dwt watermark.py

```
class DWT_Watermark(Watermark):
    def __init__(self):
```

Appendix F

Sample Program Codes

```
def inner_extract(self, B):
        w, h = B.shape[:2]

        LL, (HL, LH, HH) = pywt.dwt2(
            B[:32 * (w // 32), :32 * (h // 32)], 'haar')
        LL_1, (HL_1, LH_1, HH_1) = pywt.dwt2(LL, 'haar')
        LL_2, (HL_2, LH_2, HH_2) = pywt.dwt2(LL_1, 'haar')
        LL_3, (HL_3, LH_3, HH_3) = pywt.dwt2(LL_2, 'haar')
        LL_4, (HL_4, LH_4, HH_4) = pywt.dwt2(LL_3, 'haar')

        _, _, _, ori_sig = self.__gene_embed_space(HH_3)
        sig = self.__extract_sig(ori_sig, self.sig_size**2)
        return sig
```

models.py

```
def load_user(user_id):
     return User.query.get(int(user_id))

class User(db.Model, UserMixin):
     id = db.Column(db.Integer, primary_key=True)
     username = db.Column(db.String(20), unique=True,
nullable=False)
email = db.Column(db.String(120), unique=True,
nullable=False)
          image_file = db.Column(db.String(20),
nullable=False, default='default.png')
     password = db.Column(db.String(60), nullable=False)

     def __repr__(self):
          return f"User('{self.username}',
'{self.email}','{self.image_file}', "
```

Appendix F

Sample Program Codes

forms.py

```
class RegistrationForm(FlaskForm):
     username = StringField('Username',
validators=[DataRequired(), Length(min=2, max=20)])
     email = StringField('Email',
validators=[DataRequired(), Email()])
     password = PasswordField('Password',
validators=[DataRequired()])
     confirm_password = PasswordField('Confirm Password',
validators=[DataRequired(), EqualTo('password')])
     submit = SubmitField('Sign Up')

     def validate_username(self, username):
          user =
User.query.filter_by(username=username.data).first()
          if user:
               raise ValidationError('That username is
taken, please choose a different one')
def validate_email(self, email):
          user =
User.query.filter_by(email=email.data).first()
```

routes.py

```
@app.route('/getImg', methods=['POST'])
def upload_image():
    if 'file' not in request.files:
        flash('No file part')
        return redirect(request.url)
    file = request.files['file']
```

Appendix F

Sample Program Codes

```
 if file.filename == '':
        flash('No image selected for uploading')
        return redirect(request.url)
    if file and allowed_file(file.filename):
        file.filename = "original.jpg"
        # filename = secure_filename(file.filename)
        path = os.path.join(app.root_path,'static/uploads',
file.filename)
        file.save(path)
        return render_template('portfolio.html',
show_predictions_modal=True, filename=file.filename, )
        # return redirect(url_for ('static',
filename='uploads/' + file.filename,
show_predictions_modal=True), code=301)
```

portfolio.html

```
<div class="content-section">
    <div class="media">
      <img class="rounded-circle account-img" src="{{
image_file }}" style="size: 120px;">
      <div class="media-body">
        <h2 class="account-heading">
{{current_user.username}} </h2><!-- USERNAME -->
      </div>
    </div>
  </div>
  <div class="upload-box">
    <div class="upload-content">
<div class="container">
       <img id="imgId" onload="reload()" src="{{
url_for('static',  filename='results/watermarked.png') }}"
style=" height: 170px;" >
```

Appendix F

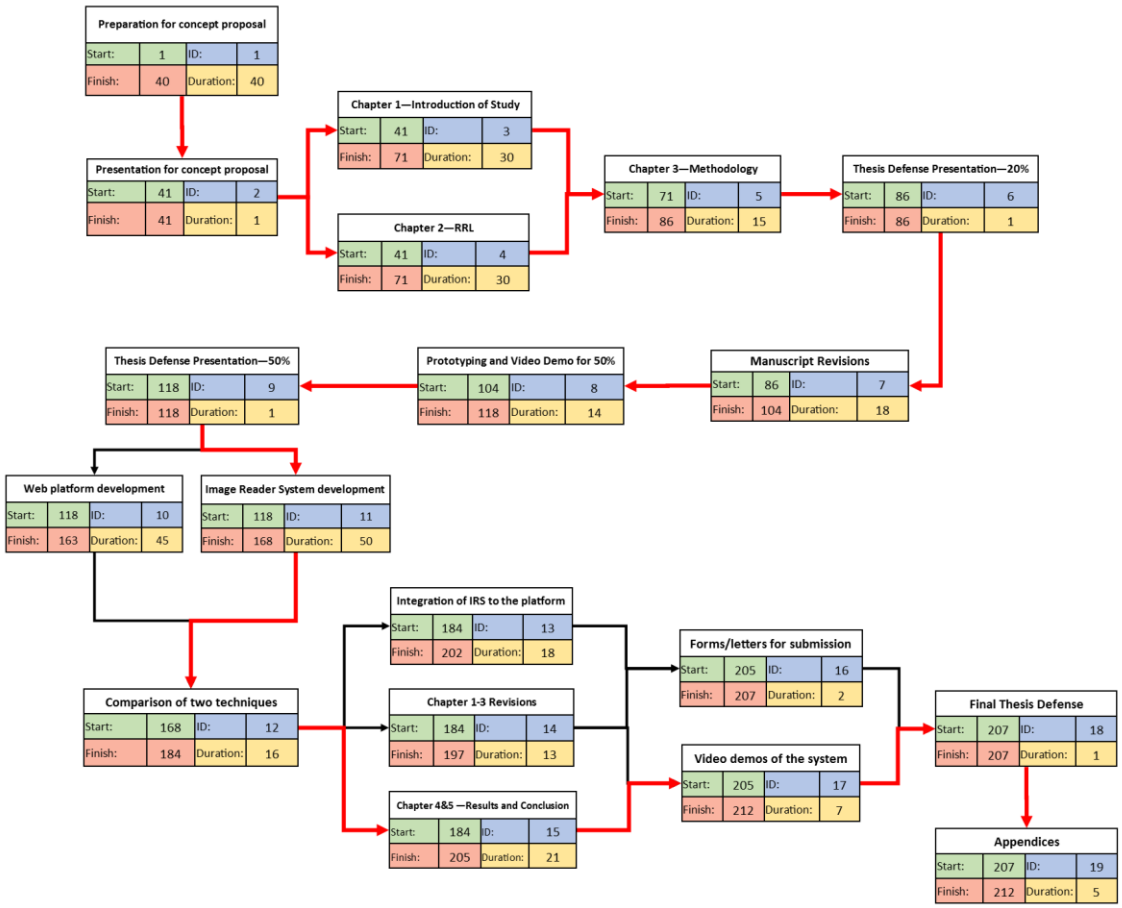
Sample Program Codes

```
     <div class="popup-img">
      <span>&times;</span>
       <img id="imgId" onload="reload()" src="{{
url_for('static',  filename='results/watermarked.png') }}"
alt="" >
     </div>
    </div>
```

Appendix G

PERT- CPM

PERT-CPM Chart



Critical Path: 220 days

Critical Path (ID): 1, 2, 3 & 4, 5, 6, 7, 8, 9,11, 12, 13, 15, 17, 18, 19

Appendix H

Disclaimer

This software project and its corresponding documentation entitled "Graphics' Axis: Platform for Graphic Designers with Robust Image Watermarking Technique for Copyright Protection" is submitted to the College of Information and Communications Technology, West Visayas State University, in partial fulfillment of the requirements for the degree, Information Technology. It is the product of our own work, except where indicated text.

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