

An
Industry Oriented Mini Project Report On

IMAGE STEGANOGRAPHY PROGRAM USING LEAST SIGNIFICANT BIT(LSB)

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Submitted By

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CERTIFICATE

This is to certify that the project report titled“ **IMAGE STEGANOGRAPHY PROGRAM USING LEAST SIGNIFICANT BIT(LSB)**” is being submitted by **K. Someshwar (217Z1A05A4)** in Partial fulfilment for the award of **Bachelor of Technology in Computer Science And Engineering** is a record bonafide work carried out by them. The results embodied in this report have not been submitted to any other University for the award of any degree.

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I am K. Someshwar the student of **Bachelor of Technology in Computer Science and Engineering, Nalla Narasimha Reddy Education Society's Group Of Institutions**, Hyderabad, Telangana, hereby declare that the work presented in this project work entitled **IMAGE STEGANOGRAPHY PROGRAM USING LEAST SIGNIFICANT BIT(LSB)** is the outcome of our own bonafide work and is correct to the best of our knowledge and this work has been undertaken taking care of engineering ethics. It contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning.

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Signature:

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ABSTRACT

This project presents a practical implementation of an image steganography program using the Least Significant Bit (LSB) technique. The program allows users to encode a secret message into an image and subsequently decode the hidden message from the image. By manipulating the least significant bits of the image's pixel values, the program embeds the message in a way that is imperceptible to human vision. The encoding process converts the secret message into a binary format and modifies the pixel data of the image to embed this binary message. Conversely, the decoding process extracts the binary message from the pixel data and converts it back to the original text format. This implementation leverages the Python programming language and the Pillow library for image manipulation, providing a simple yet effective tool for secure communication. The program is designed to handle standard image formats and can be extended to accommodate larger messages and different steganographic techniques.

Keywords : Data hiding, Secure Communication, Carrier Image, Least Significant Bit (LSB).

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1. INTRODUCTION

1.1 MOTIVATION

The motivation behind integrating steganography with a secure key in ethical hacking stems from the increasing sophistication of cyber threats and the growing need for robust data protection mechanisms. With the rise of advanced persistent threats and the potential for covert data exfiltration, it is essential to understand and address the ways in which hidden information can be exploited or protected. By studying steganography techniques and their interplay with secure key mechanisms, ethical hackers can better identify and defend against hidden data vulnerabilities, ensuring more secure communication channels and reducing the risk of unauthorized data access..

1.2 PROBLEM STATEMENT

The primary problem addressed by this project is the challenge of securing hidden information within digital images using steganography techniques, while also ensuring that the information remains protected from unauthorized access. Current steganographic methods may be susceptible to detection and unauthorized decoding, especially if the embedded data is not sufficiently protected by a secure key. This vulnerability poses a risk in scenarios where sensitive information is concealed and needs to remain confidential. Therefore, there is a need to explore and implement enhanced steganographic methods that incorporate secure key mechanisms to fortify data protection.

1.3 PURPOSE

The purpose of this project is to develop and document an image steganography technique using Least Significant Bit (LSB) embedding, enhanced with a secure key to ensure that hidden data remains confidential and protected from unauthorized access. By implementing this technique, the project aims to provide a comprehensive solution for covert data transmission while maintaining high security standards. Additionally, this documentation will serve as a guide for ethical hackers to understand and apply advanced steganographic methods in their security assessments.

1.4 SCOPE

This project involves learning how to hide data in images using the Least Significant Bit (LSB) method. It also includes adding a secure key to protect the hidden data from unauthorized access. The project will show how these techniques can be used in ethical hacking to find hidden data vulnerabilities and will provide straightforward documentation on how to use these methods.

1.5 PROJECT OBJECTIVE

The project aims to improve ethical hacking and data security by developing a method to hide secret data in images using the Least Significant Bit (LSB) technique, with minimal changes to the image. It will also include a secure key to encrypt and decrypt the hidden data, enhancing its protection. The technique will be tested for security to ensure it can resist attacks and unauthorized access. Additionally, the project will provide practical advice for ethical hackers on how to use and evaluate these methods and will produce clear documentation on implementing and using the technique effectively. These goals are focused on advancing tools for securing hidden information and improving data protection.

1.6 LIMITATIONS

The project has a few limitations. The Least Significant Bit (LSB) technique can only hide a small amount of data before affecting the image's quality, which might become noticeable. Security depends on the strength of the key and encryption, which could be vulnerable to advanced attacks. Additionally, sophisticated detection methods might find hidden data if the technique isn't strong enough. Combining secure key management with LSB can be complex, and there may be ethical and legal issues if misused. Compatibility with various image formats can also pose challenges.

2. LITERATURE SURVEY

2.1 INTRODUCTION

Image steganography, a method used to conceal secret information within digital images, is a pivotal technology in the realm of data security and covert communications. This technique is designed to hide sensitive data in a manner that is not easily detectable by human observers or conventional security tools. Among the various steganographic methods, the Least Significant Bit (LSB) technique stands out due to its simplicity and efficiency. By modifying the least significant bits of pixel values, LSB steganography can embed hidden data while making minimal changes to the image's appearance, thereby preserving its visual integrity.

However, while LSB steganography is effective for certain applications, its basic implementation may leave hidden data vulnerable to unauthorized access and detection. To address these vulnerabilities, researchers have explored integrating secure key mechanisms with LSB steganography. The addition of a secure key enhances the confidentiality and protection of the embedded data, making it significantly more challenging for unauthorized parties to access or decode the hidden information. This integration of encryption and steganography creates a more robust system for protecting sensitive data.

This review aims to provide a thorough examination of research and advancements related to image steganography that employs the LSB technique in conjunction with secure key mechanisms. It begins by exploring foundational studies that outline the principles and applications of LSB steganography. Key contributions by researchers such as Anderson and Petitcolas (1998) and Katzenbeisser and Petitcolas (2000) are discussed to establish a baseline understanding of how LSB works and its strengths and weaknesses.

The review then explores how the integration of secure keys enhances the security of steganographic methods. Notable research by Stallings (2017) and Pfitzmann and Köhntopp (2001) is highlighted to show how encryption can be effectively combined with LSB to protect hidden data from unauthorized access and enhance overall data security.

Furthermore, the review addresses the challenges and limitations associated with LSB

steganography, such as data capacity constraints and image quality degradation. Research by Fridrich and Goljan (2002) is included to illustrate the trade-offs between embedding capacity and maintaining the visual fidelity of the image. The effectiveness of various detection methods, as explored by Westfeld and Pfitzmann (2000), is also discussed to emphasize the need for advanced techniques to prevent data detection.

The ethical and legal implications of using steganography are considered, with insights from Simmons and Hartenstein (2002) on responsible use and potential legal issues. Finally, the review highlights recent advancements in the field, including new techniques and improvements to LSB steganography, based on research by Zhang et al. (2018). These advancements reflect ongoing efforts to address the limitations of traditional methods and enhance the security and effectiveness of steganographic practices.

2.2 EXISTING SYSTEM

Basic LSB steganography tools are used to hide and find data in images using the Least Significant Bit (LSB) technique. Steghide is a popular, easy-to-use tool for embedding and extracting data in image formats like BMP and JPEG. OpenStego also lets you hide and extract text and images, making it useful for testing LSB techniques. S-Tools hides messages in images using LSB and includes simple password protection. SilentEye also uses LSB but adds basic encryption to secure hidden data. For detecting hidden data, StegExpose helps find LSB-encoded data in images, while StegSecret uncovers hidden information and evaluates LSB methods. These tools are helpful for learning about and working with LSB steganography.

2.3 PROPOSED SYSTEM

The message is encrypted with cryptography and hidden in the image. This extra step keeps the message safe, making it unreadable without the key, even if someone finds the hidden data.

3. SYSTEM ANALYSIS

3.1 FUNCTIONAL REQUIREMENTS

3.1.1 Image Embedding

Users can input an image file (BMP, PNG, or JPEG) and a secret message (plain text or binary). The program embeds the message into the image using the LSB technique, making the changes barely noticeable. The result is a new image file with the hidden message.

3.1.2 Message Extraction

The program extracts the hidden message from a stego image file. To do this, users must provide the correct encryption key, ensuring only authorized individuals can access the hidden message.

3.1.3 Encryption Key Management

The program generates a secure, random encryption key for encrypting the secret message before embedding it. This key is also needed to decrypt the message later. The key is handled and stored securely, using encryption methods like AES.

3.2 NON-FUNCTIONAL REQUIREMENTS

3.2.1 Performance

The program should work efficiently, handling various image sizes quickly during both embedding and extraction.

3.2.2 Security

The encryption key must be kept secure to prevent unauthorized access. The program must protect both the message and key throughout the process.

3.2.3 Usability

The user interface should be simple and provide clear instructions for embedding, extracting messages, and managing encryption keys.

3.2.4 Reliability

The system must be reliable, with effective error handling and recovery mechanisms in place. It should manage failures gracefully and provide informative messages or logs to assist in troubleshooting and preventing data loss.

3.2.5 Scalability

The system should be scalable to accommodate varying image sizes and the amount of secret data being embedded. It must effectively manage resources to support both small and high-resolution images, as well as varying data capacities.

3.2.6 Maintainability

A modular design and high-quality code are required to facilitate easy maintenance and updates. The system should adhere to best practices to ensure that changes can be implemented with minimal impact on existing functionality.

3.3 INTERFACE REQUIREMENTS

3.3.1 User Requirements

User Interface (UI),

Command-Line

Interface (CLI) (if applicable).

3.3.2 System Requirements:

Compatibility: The program must be compatible with a range of hardware configurations and software environments.

Dependencies: Ensure compatibility with required libraries and frameworks for image processing and encryption.

Integration: The program should integrate smoothly with other software tools or systems if required (e.g., for key management or additional security features).

3.3.2.1 Hardware Requirements:

Processor	: Intel Core i5 or equivalent.
Memory (RAM)	: Minimum 4GB.
Storage	: At least 100 MB free space.

3.3.2.2 Software Requirements:

Programming Languages: Support for languages used in development, such as Python, C++, or Java.

Libraries/Frameworks: Required libraries for image processing (e.g., OpenCV, PIL) and cryptographic operations (e.g., PyCrypto, OpenSSL).

3.3.3 Performance Requirements

The program must handle image embedding and extraction efficiently, ensuring minimal delay during these processes. It should be capable of effectively managing images up to a specified maximum resolution, such as 4000x3000 pixels, without experiencing significant performance issues. Both the embedding and extraction processes should be completed within a reasonable timeframe, ideally within a few seconds for average-sized images, to provide a smooth and responsive user experience.

4. SYSTEM DESIGN

4.1 UML DIAGRAMS

UML stands for Unified Modeling Language. UML is a standardized general- purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group. The goal is for UML to become a common language for creating models of object oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems. The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems. The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

Goals:

The Primary goals in the design of the UML are as follows: Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models. Provide extendibility and specialization mechanisms to extend the core concepts. Be independent of particular programming languages and development process. Provide a formal basis for understanding the modeling language. Encourage the growth of OO tools market. Support higher level development concepts such as collaborations, frameworks, patterns and components.

Data Flow Diagram

A data flow diagram (DFD) maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show steganography Image, secure key and stego text , the routes between each destination.

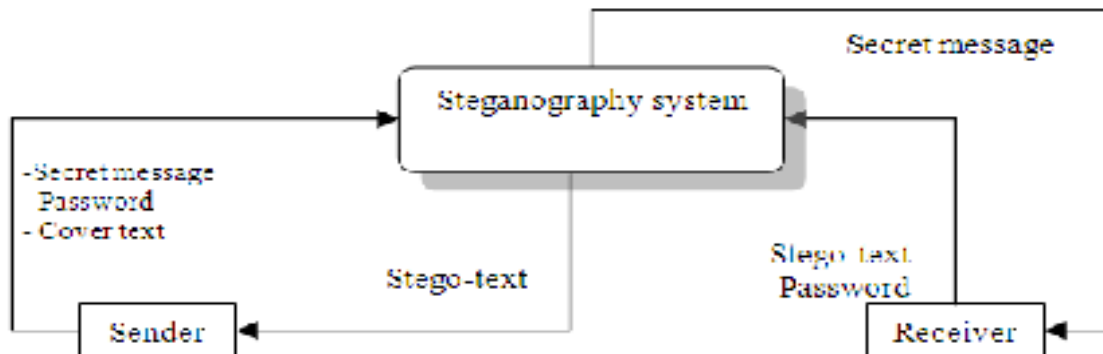


Fig 4.1 : Data Flow Diagram

Use Case Diagram:

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

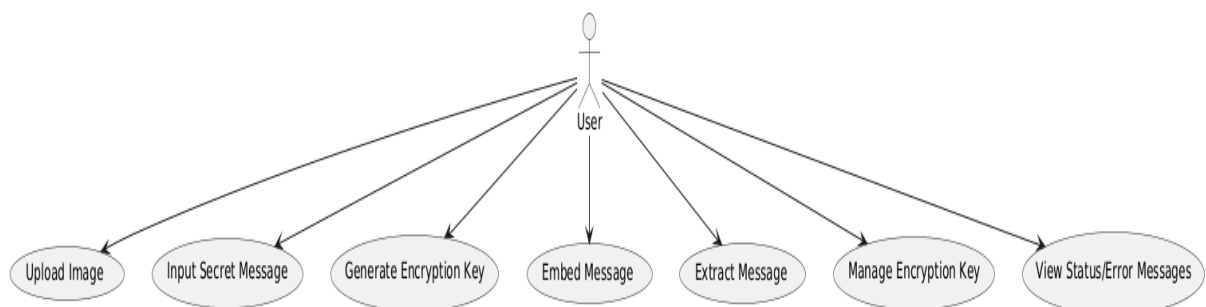


Fig 4.2 : Usecase Diagram

Class Diagram:

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.

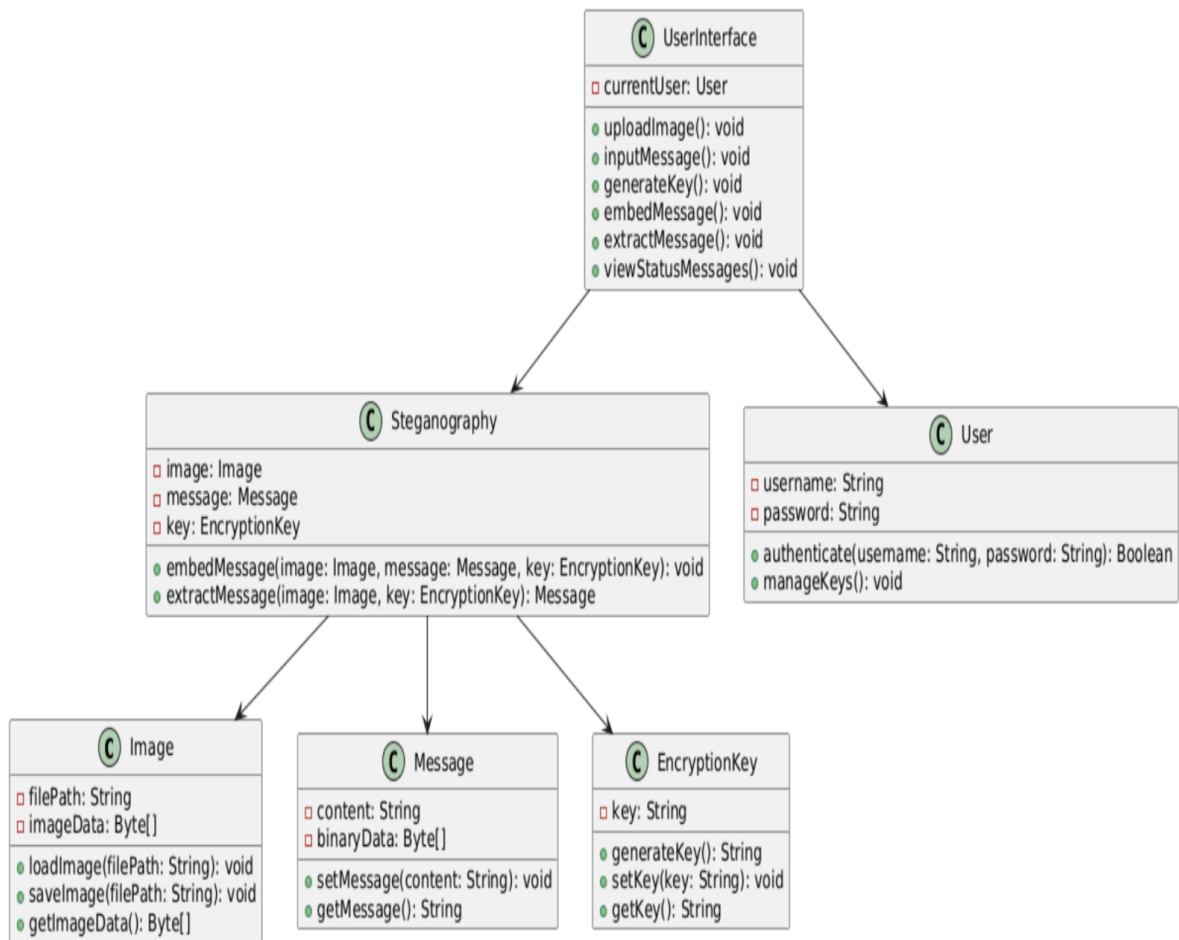


Fig 4.3 : Class Diagram

Sequence Diagram:

A sequence diagram in Unified Modelling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.

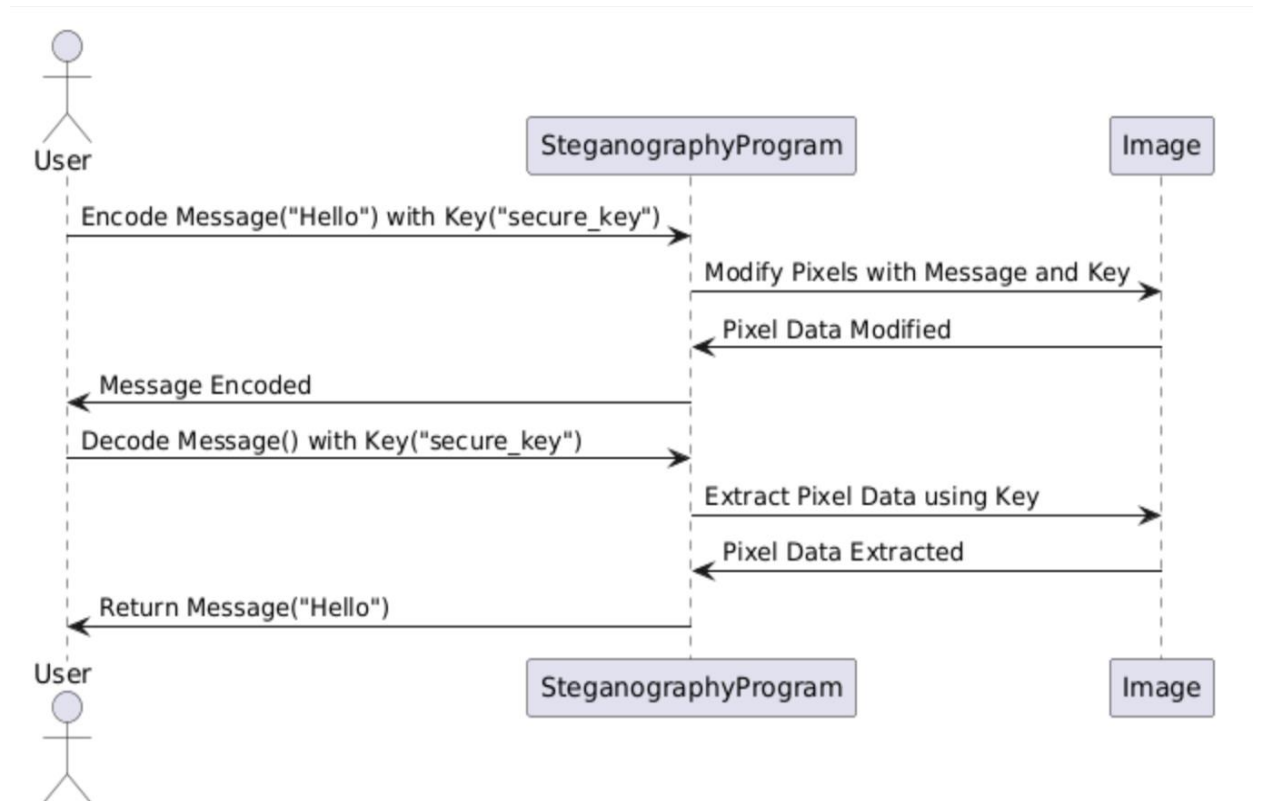


Fig 4.4 : Sequence Diagram

Activity Diagram:

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step- by-step workflows of components in a system. An activity diagram shows the overall flow of control.

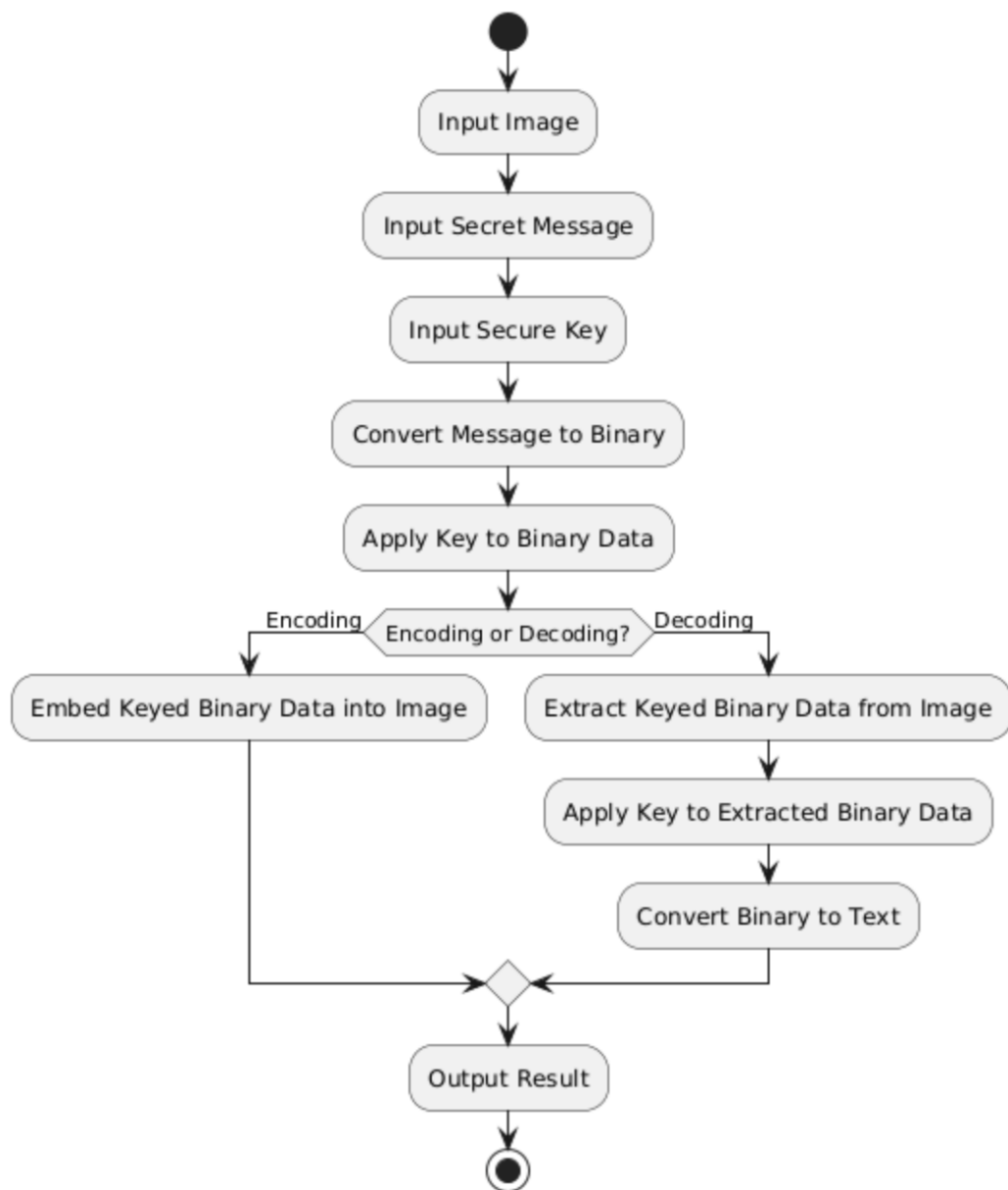


Fig 4.5 : Activity Diagram

4.2 MODULES:

4.2.1 Key Management Module

Purpose: Handles the generation, storage, and management of secure keys.

Functions:

- Generate a secure key.
- Store and retrieve keys.
- Ensure key integrity and confidentiality.

4.2.2 Image Processing Module

Purpose: Manages image loading, manipulation, and saving.

Functions:

- Load an image file.
- Modify pixel data (embedding and extracting data).
- Save the modified image.

4.2.3 Data Encoding Module

Purpose: Handles the conversion of the secret message into a binary format and embeds it into the image.

Functions:

- Convert message to binary.
- Apply key to the binary data.
- Embed binary data into the image.

4.2.4 Data Decoding Module

Purpose: Extracts and decodes the hidden message from the image using the secure key.

Functions:

- Extract binary data from the image.

- Apply the key to the extracted binary data.
- Convert binary data back to the text message.

4.2.5 User Interface Module

Purpose: Provides a means for users to interact with the system, such as inputting

Functions:

- Provide options for encoding and decoding.
- Handle user inputs and outputs.
- Display results to the user.

1.a.1 Deployment:

To deploy an image steganography system, start by testing the system and preparing documentation. For local deployment, set up a virtual environment, install necessary packages, and run the application to ensure it works. For cloud deployment, choose a cloud provider, set up a virtual machine or container, install the software, and deploy the application while configuring security. If deploying on a web server, convert the application to a web format if needed, set up the web server, and secure it with SSL/TLS. Make sure to configure settings properly and test the system thoroughly. Finally, maintain the system by monitoring it, applying updates, and offering user support. These steps help ensure the system is deployed effectively and securely.

1.a.2 End User Module

The End User Module is designed to provide a straightforward and intuitive interface for users to encode and decode messages within images. Users can upload images, input secret messages, and provide encryption keys to hide messages in images. They can also upload images containing hidden messages and input the corresponding keys to extract these messages. The module includes features for error handling, such as notifying users of invalid inputs or operational failures, and provides help resources for guidance. Overall, this module ensures users can easily and effectively interact with the steganography system.

5. IMPLEMENTATION AND RESULTS

5.1 METHOD OF IMPLEMENTATION

What is Python :-

Python is currently the most widely used multi-purpose, high-level programming language. Python allows programming in Object-Oriented and Procedural paradigms. Python programs generally are smaller than other programming languages like Java. Programmers have to type relatively less and indentation requirement of the language, makes them readable all the time.

Python language is being used by almost all tech-giant companies like – Google, Amazon, Facebook, Instagram, Dropbox, Uber... etc.

The biggest strength of Python is huge collection of standard library which can be used for the following –

Machine Learning

GUI Applications (like Kivy, Tkinter, PyQt etc.)

Web frameworks like Django (used by YouTube, Instagram, Dropbox) Image processing (like Opencv, Pillow)

Web scraping (like Scrapy, BeautifulSoup, Selenium) Test frameworks

Multimedia

Python

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural, and has a large and comprehensive standard library.

Python is Interpreted – Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP. **Python is Interactive** – you can actually sit at a Python prompt and interact with the interpreter directly to write your programs.

Python also acknowledges that speed of development is important. Readable and terse code is part of this, and so is access to powerful constructs that avoid tedious repetition of code. All its tools have been quick to implement, saved a lot of time, and several of them have later been patched and updated by people with no Python background - without breaking.

What is Ethical Hacking :-

Ethical hacking, also known as penetration testing or white-hat hacking, is a proactive approach to cybersecurity where skilled professionals assess computer systems, networks, or applications to identify and address security vulnerabilities before they can be exploited by malicious actors. Unlike malicious hackers, ethical hackers operate with explicit permission from the system owners, ensuring their activities are legal and aligned with organizational goals. The process of ethical hacking typically involves a variety of techniques and tools similar to those used by cybercriminals. This includes vulnerability scanning, network sniffing, and social engineering, among others. Ethical hackers simulate potential attacks to test how well a system can withstand various security threats. Their goal is to uncover weaknesses that could be exploited by unauthorized individuals, thereby providing insights into how to strengthen the system's defenses.

Modules Used in Project :-

User Interface Module:

The **User Interface Module** provides an easy-to-use platform for interacting with the steganography system. It includes features for **Image Upload**, allowing users to choose images for encoding or decoding. **Message Input** lets users type in the message they want to hide. **Key Input** collects the secure key needed for encryption and decryption. **Buttons** enable users to start the encoding or decoding process. Finally, the **Status Display** shows updates on progress, success, or any errors, keeping users informed throughout the process.

Encoding Module:

The **Encoding Module** is responsible for embedding a secret message into an image using the Least Significant Bit (LSB) technique. It processes the image file to modify its pixel data, converts the secret message into binary format, and alters the least significant bits of the

image's pixels to embed the binary message. This module also integrates a secure key to enhance encryption and ensure that only authorized users can decode the message. Finally, it saves the modified image with the hidden message.

Decoding Module:

The **Decoding Module** extracts and retrieves the hidden message from an image. It processes the image file to extract pixel data, retrieves and converts the binary data from the least significant bits of the pixels, and converts this binary data back into the original message format. It also verifies the secure key to ensure the message is correctly decrypted.

Key Management Module:

The **Key Management Module** handles the creation, storage, retrieval, and validation of encryption keys used for encoding and decoding. It generates secure keys, stores them to prevent unauthorized access, provides mechanisms for retrieving and validating keys, and ensures that the provided key matches the one used during encoding.

Security Module:

The **Security Module** ensures the overall security of the steganography system. It encrypts the secret message using secure algorithms before embedding it into the image and decrypts the hidden message using the secure key during the decoding process. This module also manages user permissions, restricts access to sensitive operations, and handles and logs errors related to security and operations.

File Handling Module:

The **File Handling Module** manages the input and output of image files and data. It handles file uploads and downloads, ensures that files are in the correct format and not corrupted, and organizes file paths, storage, and retrieval.

Logging and Monitoring Module:

The **Logging and Monitoring Module** tracks the system's operations to assist with troubleshooting and auditing. It logs user actions such as encoding and decoding operations, records errors and exceptions, and provides real-time monitoring of system performance and usage.

To install the Pillow library on both Windows and macOS, follow these steps:

Installing Pillow on Windows

1. **Open Command Prompt:** You can do this by searching for "cmd" in the Windows search bar and selecting "Command Prompt."
2. **Install Pillow:** Run the following command in the Command Prompt:

```
//pip install Pillow//
```

Make sure you have Python and pip installed. If you encounter any issues, ensure that Python is added to your system's PATH environment variable.

3. **Verify Installation:** To check if Pillow was installed successfully, you can run:

```
// python -m pip show Pillow//
```

This command will display information about the Pillow package if it's installed correctly.

Installing Pillow on macOS

1. **Open Terminal:** You can find Terminal in Applications > Utilities or search for it using Spotlight (Cmd + Space).
2. **Install Pillow:** Run the following command in the Terminal:

```
//pip install Pillow//
```

Ensure that you have Python and pip installed. macOS often comes with Python pre-installed, but you may need to install pip separately. You can also use Homebrew to install Python and pip if needed:

```
//brew install python//
```

3. **Verify Installation:** To confirm that Pillow was installed correctly, you can use:

```
//python3 -m pip show Pillow//
```

This will show information about the Pillow package if the installation was successful.

Python is Interpreted – Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.

Python is Interactive – you can actually sit at a Python prompt and interact with the interpreter directly to write your programs.

Python also acknowledges that speed of development is important. Readable and terse code is part of this, and so is access to powerful constructs that avoid tedious repetition of code. Maintainability also ties into this may be an all but useless metric, but it does say something about how much code you have to scan, read and/or understand to troubleshoot problems or tweak behaviors.

Install Python Step-by-Step in Windows and Mac :

Python a versatile programming language doesn't come pre-installed on your computer devices. Python was first released in the year 1991 and until today it is a very popular high-level programming language. Its style philosophy emphasizes code readability with its notable use of great whitespace. The object-oriented approach and language construct provided by Python enables programmers to write both clear and logical code for projects. This software does not come pre-packaged with Windows.

How to Install Python on Windows and Mac :

There have been several updates in the Python version over the years. The question is how to install Python? It might be confusing for the beginner who is willing to start learning Python but this tutorial will solve your query. The latest or the newest version of Python is version 3.7.4 or in other words, it is Python 3.

Note: The python version 3.7.4 cannot be used on Windows XP or earlier devices.

Before you start with the installation process of Python. First, you need to know about your **System Requirements**. Based on your system type i.e. operating system and based processor, you must download the python version. My system type is a **Windows 64-bit Operating system**.

So the steps below are to install python version 3.7.4 on Windows 7 device or to install Python 3. [Download the Python Cheatsheet here](#). The steps on how to install Python on Windows 10, 8 and 7 are **divided into 4 parts** to help understand better.

Step 1: Go to the official site to download and install python using Google Chrome or any other web browser. OR Click on the following link: **<https://www.python.org>**



Fig 5.1: Download Python

Now, check for the latest and the correct version for your operating system.

Step 2: Click on the Download Tab.



Fig 5.2: Python 3.7.4

Step 3: You can either select the Download Python for windows 3.7.4 button in Yellow Color or you can scroll further down and click on download with respective to their version. Here, we are downloading the most recent python version for windows 3.7.4

Looking for a specific release?

Python releases by version number:

Release version	Release date		Click for more
Python 3.7.4	July 8, 2019	Download	Release Notes
Python 3.6.9	July 2, 2019	Download	Release Notes
Python 3.7.3	March 25, 2019	Download	Release Notes
Python 3.4.10	March 18, 2019	Download	Release Notes
Python 3.5.7	March 18, 2019	Download	Release Notes
Python 3.7.16	March 4, 2019	Download	Release Notes
Python 3.7.2	Dec. 24, 2018	Download	Release Notes

Fig 5.3: Specific Release

Step 4: Scroll down the page until you find the Files option.

Step 5: Here you see a different version of python along with the operating system.

Files

Version	Operating System	Description	MD5 Sum	File Size	GPG
Gzipped source tarball	Source release		68111671e5b2db4aef7b9ab01b079be	23017663	S/G
XZ compressed source tarball	Source release		d33e4aa66097051c3eca45ee3604803	17131432	S/G
macOS 64-bit/32-bit installer	Mac OS X	for Mac OS X 10.6 and later	6428b4fa75a3da0f1a4c2c3a0ce00e6	34898436	S/G
macOS 64-bit installer	Mac OS X	for OS X 10.9 and later	5bd05c3d217a45773b5e4a036b2a3f	28802845	S/G
Windows heap file	Windows		063990573a2c06b2a58cade0b477a02	8131761	S/G
Windows x86-64 embeddable zip file	Windows	for AMD64/EM64T/x64	9809c3c7d1ee0f0a0e0315a4e0729a2	7504291	S/G
Windows x86-64 executable installer	Windows	for AMD64/EM64T/x64	a702b4b0ad76d6d63043a5d3e563e00	26882948	S/G
Windows x86-64 web-based installer	Windows	for AMD64/EM64T/x64	28c31c908b0d73a0e65a3b3c351b4bd2	1362904	S/G
Windows x86 embeddable zip file	Windows		9fab0bd18041879fda94120574139d0	6741626	S/G
Windows x86 executable installer	Windows		33c002942a5444a3d0451476294789	25663848	S/G
Windows x86 web-based installer	Windows		1b670cfa0d117df52c3093ea371d07c	1324608	S/G

Fig 5.4: Files

To download Windows 32-bit python, you can select any one from the three options: Windows x86 embeddable zip file, Windows x86 executable installer or Windows x86 web-based installer. To download Windows 64-bit python, you can select any one from the three options: Windows x86-64 embeddable zip file, Windows x86-64 executable installer or Windows x86-64 web-based installer.

we will install Windows x86-64 web-based installer. Here your first part regarding which version of python is to be downloaded is completed. Now we move ahead with the second part in installing python i.e. Installation

Note: To know the changes or updates that are made in the version you can click on the Release Note Option.

Installation of Python:

Step 1: Go to Download and Open the downloaded python version to carry out the installation process.

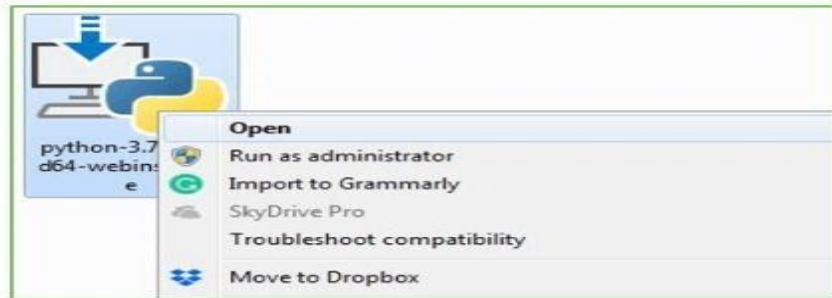


Fig 5.5: Open Python 3.7.4

Step 2: Before you click on Install Now, Make sure to put a tick on Add Python 3.7 to PATH.



Fig 5.6: Install Python 3.7.4



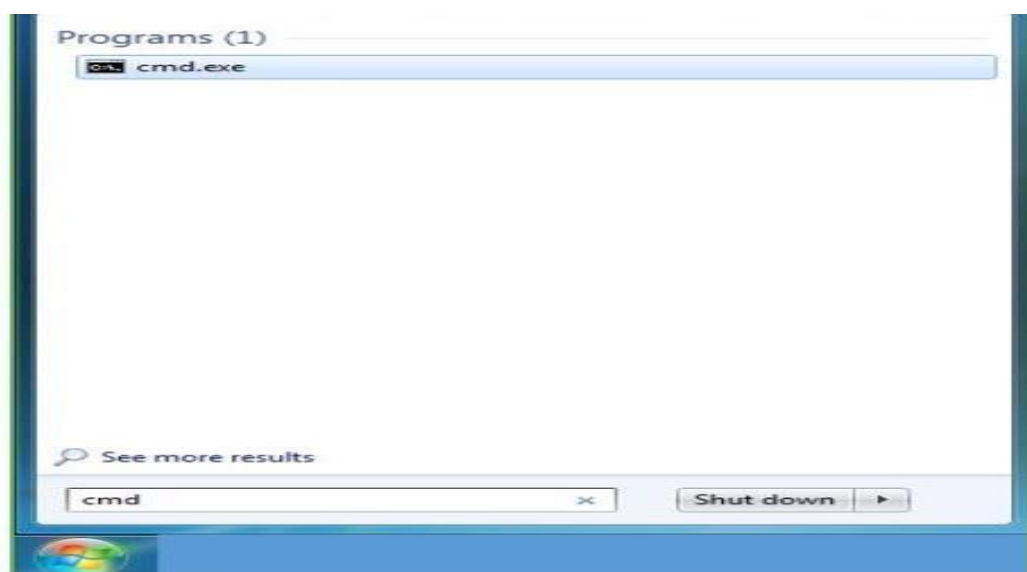
Fig 5.7: Installed Successfully

Step 3: Click on Install NOW After the installation is successful. Click on Close.

With these above three steps on python installation, you have successfully and correctly installed Python. Now is the time to verify the installation.

Note: The installation process might take a couple of minutes.

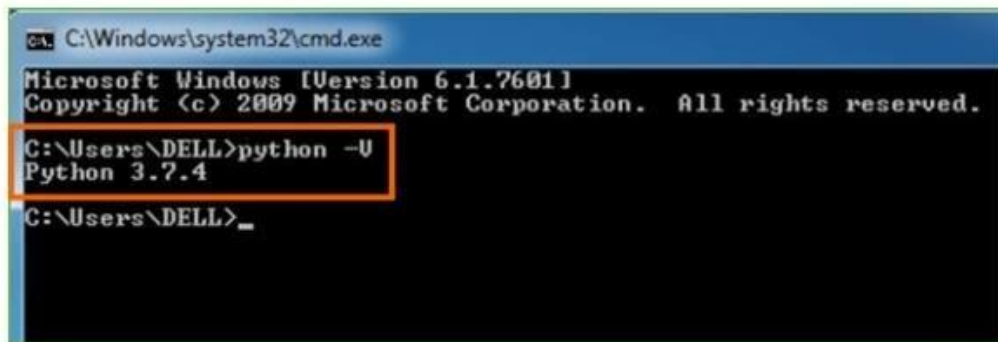
Verify the Python Installation Step 1: Click on Start the Windows Run Command, type “cmd”.



Step 2: In Fig 5.8: Select Command Prompt

Step 3: Open the Command prompt option.

Step 4: Let us test whether the python is correctly installed. Type **python -V** and press Enter.



```
C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\DELL>python -V
Python 3.7.4

C:\Users\DELL>_
```

Fig 5.9: Search Python Version

Step 5: You will get the answer as 3.7.4

Note: If you have any of the earlier versions of Python already installed. You must first uninstall the earlier version and then install the new one.

Check how the Python IDLE works Step 1: Click on Start

Step 2: In the Windows Run command, type “python idle”.

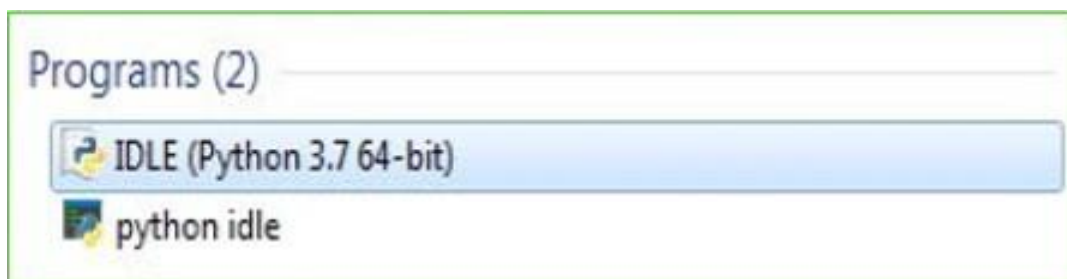


Fig 5.10: Idle Python 3.7.4

Step 3: Click on IDLE (Python 3.7 64-bit) and launch the program

Step 4: To go ahead with working in IDLE you must first save the file. **Click on File > Click on Save**

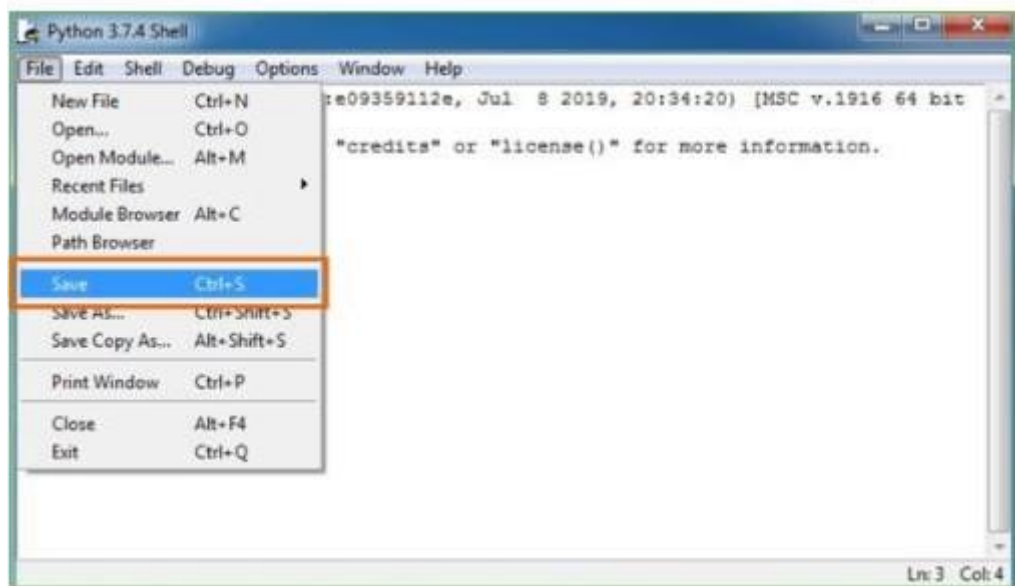


Fig 5.11: Save The File

Step 5: Name the file and save as type should be Python files. Click on SAVE. Here I have named the files as Hey World.

Step 6: Now for e.g. enter print.

5.2 EXTENSION OF KEY FUNCTION:

5.2.1 Advanced Key Generation

Cryptographic Algorithms: Utilize robust cryptographic algorithms (e.g., RSA, AES) for generating secure keys. This provides a higher level of security compared to simple or weak key generation methods.

Customizable Key Lengths: Allow users to specify key lengths according to their security needs. Longer keys generally offer better security but may require more computational resources.

5.2.2 Secure Key Storage

Encryption: Store keys in an encrypted format to prevent unauthorized access. Use strong encryption algorithms to secure the key storage.

Hardware Security Modules (HSMs): For highly sensitive applications, consider using

HSMs to manage and store keys securely. HSMs offer physical and logical protection against unauthorized access.

5.2.3 Key Retrieval and Usage

Secure Channels: Implement secure methods for retrieving keys, such as using encrypted communications (e.g., TLS) to protect keys in transit.

Access Control: Restrict access to keys based on user roles and permissions to ensure that only authorized personnel can retrieve or use the keys.

5.2.4 Key Validation

Integrity Checks: Incorporate mechanisms to verify the integrity of keys before they are used. This ensures that the keys have not been tampered with or corrupted.

Consistency Verification: Check that the provided key matches the key used during the encoding process to ensure successful decoding.

5.2.5 Key Rotation and Expiry

Automatic Rotation: Implement policies for periodic key rotation to minimize the risk of key compromise. Automated key rotation can help maintain ongoing security.

Expiry Policies: Define key expiration policies to ensure that keys are refreshed regularly.

5.2.6 Key Revocation

Revocation Mechanism: Provide a system for revoking keys that are suspected of being compromised or are no longer needed. This involves invalidating the old key and issuing a new one.

Notification System: Implement notifications to alert users when keys are revoked or replaced, ensuring they are aware of any changes.

5.2.7 User Interface for Key Management

Intuitive Design: Develop a user-friendly interface for managing keys, including generating, storing, retrieving, and rotating keys. This simplifies key management for users.

Logs and Alerts: Include logging and alerting features to track key management activities, such as key generation, retrieval, and usage. This aids in monitoring and auditing key-related operations.

5.2.8 Backup and Recovery

Secure Backup: Create secure backups of keys to prevent loss due to data corruption or other issues. Ensure that backups are encrypted and stored safely.

Recovery Plans: Develop plans for recovering keys in case of loss or system failures. This ensures continuity in the steganography process.

Evaluation

The evaluation of the extended key functions for the image steganography system using LSB focuses on four main areas. **Security** checks the strength of cryptographic methods, how well keys are protected and retrieved, and the effectiveness of key validation and revocation. **Usability** looks at how easy it is for users to manage keys, including the design of the user interface and the clarity of documentation. **Performance** measures the impact of key management on system speed and resource use, ensuring it operates efficiently. **Practicality** reviews how well these key functions fit with the existing system, adhere to standards, and their overall cost and maintenance needs. This ensures that the key management system is secure, user-friendly, efficient, and practical.

5.3 DESIGN ARCHITECTURE:

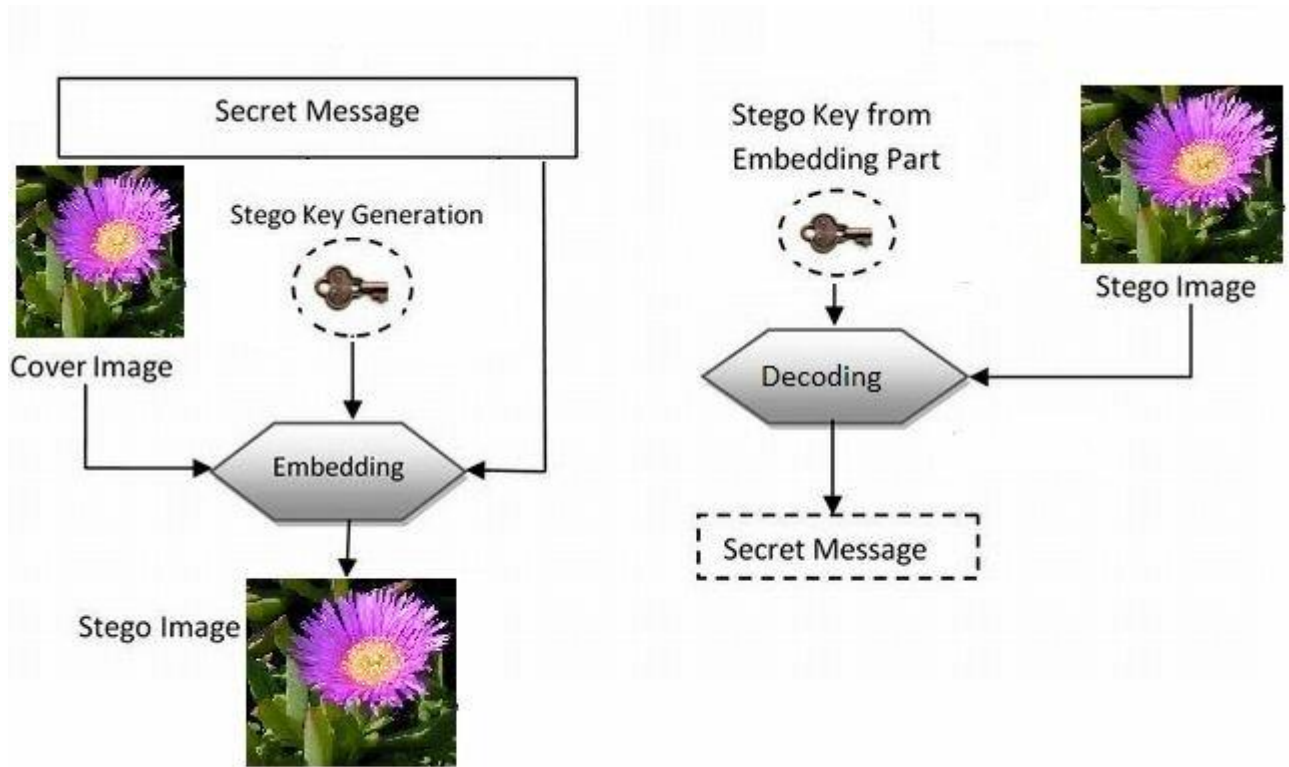


Fig 5.12 : Design Architecrure

5.4 SOURCE CODE:

5.4.1 Encoding Source Code:

```
import tkinter as tk
from tkinter import filedialog, messagebox
from PIL import Image

def encode_image(input_image_path, secret_message, output_image_path, key):
    image = Image.open(input_image_path)
    pixels = image.load()
    width, height = image.size
    max_message_length = width * height * 3 // 8
    if len(secret_message) > max_message_length:
        raise ValueError("Message is too long to fit in the image")
    encoded_message = ".join(chr(ord(char) ^ key) for char in secret_message)
    binary_message = ".join(format(ord(char), '08b') for char in encoded_message) +
'1111111111111110'
    binary_index = 0
    for y in range(height):
        for x in range(width):
            if binary_index >= len(binary_message):
                image.save(output_image_path)
                return
            pixel = list(pixels[x, y])
            for color in range(3):
                if binary_index >= len(binary_message):
                    break
                pixel_value = pixel[color]
                bit_to_encode = binary_message[binary_index]
                new_pixel_value = (pixel_value & ~1) | int(bit_to_encode)
                pixel[color] = new_pixel_value
                binary_index += 1
            pixels[x, y] = tuple(pixel)
        image.save(output_image_path)
def select_image():
```

```

    file_path = filedialog.askopenfilename(title="Select an Image", filetypes=[("Image files",
"*.*jpg *.jpeg *.png")])
    if file_path:
        input_image_path.set(file_path)
def encode():
    try:
        encode_image(input_image_path.get(), secret_message.get(), output_image_path.get(),
int(key.get()))
        messagebox.showinfo("Success", "Message encoded successfully!")
    except Exception as e:
        messagebox.showerror("Error", str(e))
# GUI Setup
root = tk.Tk()
root.title("Image Steganography - Encoding")
# Variables
input_image_path = tk.StringVar()
output_image_path = tk.StringVar()
secret_message = tk.StringVar()
key = tk.StringVar()
# Widgets
tk.Label(root, text="Select Image:").grid(row=0, column=0, padx=10, pady=10)
tk.Entry(root, textvariable=input_image_path, width=40).grid(row=0, column=1, padx=10,
pady=10)
tk.Button(root, text="Browse", command=select_image).grid(row=0, column=2, padx=10,
pady=10)
tk.Label(root, text="Secret Message:").grid(row=1, column=0, padx=10, pady=10)
tk.Entry(root, textvariable=secret_message, width=40).grid(row=1, column=1, padx=10,
pady=10)
tk.Label(root, text="Output Image Path:").grid(row=2, column=0, padx=10, pady=10)
tk.Entry(root, textvariable=output_image_path, width=40).grid(row=2, column=1, padx=10,
pady=10)
tk.Label(root, text="Key:").grid(row=3, column=0, padx=10, pady=10)
tk.Entry(root, textvariable=key, width=40).grid(row=3, column=1, padx=10, pady=10)

```



```
tk.Button(root, text="Encode", command=encode).grid(row=4, column=0, columnspan=3,
padx=10, pady=20) root.mainloop()
```

5.4.2 Decoding Source Code:

```
import tkinter as tk
from tkinter import filedialog, messagebox
from PIL import Image
def decode_image(image_path, key):
    image = Image.open(image_path)
    pixels = image.load()
    width, height = image.size
    binary_message = ""
    end_marker = '111111111111110'
    for y in range(height):
        for x in range(width):
            for color in range(3):
                pixel_value = pixels[x, y][color]
                binary_message += str(pixel_value & 1)
                if len(binary_message) >= len(end_marker) and binary_message[-
len(end_marker):] == end_marker:
                    break
            if len(binary_message) >= len(end_marker) and binary_message[-len(end_marker):]
== end_marker:
                break
            if len(binary_message) >= len(end_marker) and binary_message[-len(end_marker):]
== end_marker: break
        binary_message = binary_message[:-len(end_marker)]
    encoded_message = ""
    for i in range(0, len(binary_message), 8):
        byte = binary_message[i:i+8]
        if len(byte) == 8:
            encoded_message += chr(int(byte, 2))
    decoded_message = "".join(chr(ord(char) ^ key) for char in encoded_message)
    return decoded_message
```

```

def select_image():
    file_path = filedialog.askopenfilename(title="Select Encoded Image", filetypes=[("Image
files", "*.jpg *.jpeg *.png")])
    if file_path:
        encoded_image_path.set(file_path)
def decode():
    try:
        decoded_message = decode_image(encoded_image_path.get(), int(key.get()))
        decoded_message_output.set(decoded_message)
        messagebox.showinfo("Success", "Message decoded successfully!")
    except Exception as e:
        messagebox.showerror("Error", str(e))
# GUI Setup
root = tk.Tk()
root.title("Image Steganography - Decoding")
# Variables
encoded_image_path = tk.StringVar()
key = tk.StringVar()
decoded_message_output = tk.StringVar()
# Widgets
tk.Label(root, text="Select Encoded Image:").grid(row=0, column=0, padx=10, pady=10)
tk.Entry(root, textvariable=encoded_image_path, width=40).grid(row=0, column=1,
padx=10, pady=10)
tk.Button(root, text="Browse", command=select_image).grid(row=0, column=2, padx=10,
pady=10)
tk.Label(root, text="Key:").grid(row=1, column=0, padx=10, pady=10)
tk.Entry(root, textvariable=key, width=40).grid(row=1, column=1, padx=10, pady=10)
tk.Button(root, text="Decode", command=decode).grid(row=2, column=0, columnspan=3,
padx=10, pady=20)
tk.Label(root, text="Decoded Message:").grid(row=3, column=0, padx=10, pady=10)
tk.Entry(root, textvariable=decoded_message_output, width=40,
state='readonly').grid(row=3, column=1, padx=10, pady=10)

root.mainloop()

```

5.5 OUTPUT SCREENS :

5.5.1 ENCODING PROCESS:

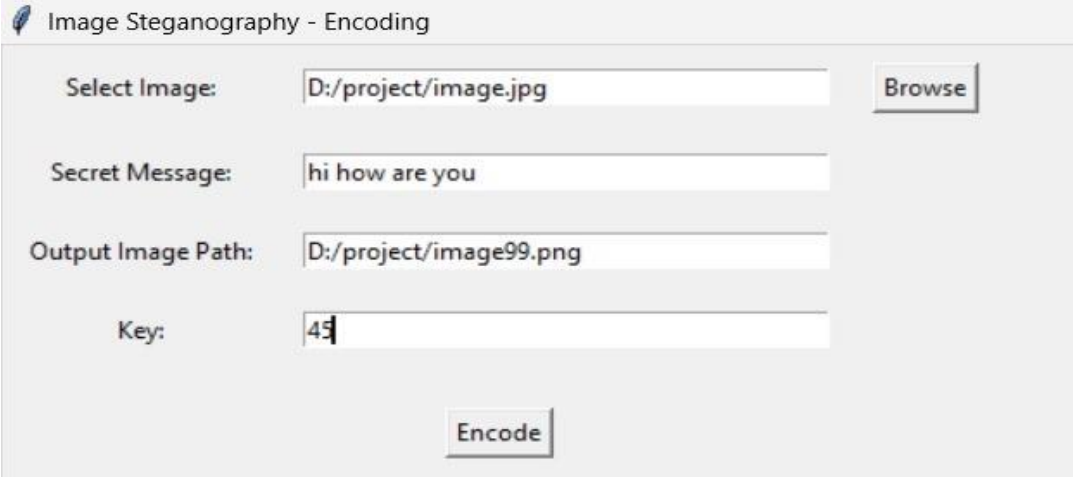


Image Steganography - Encoding

Select Image: D:/project/image.jpg

Secret Message: hi how are you

Output Image Path: D:/project/image99.png

Key: 45

Fig 5.13 : Encoding

ENCODING PROCESS FOR ABOVE FIGURE

Step 1: Choose a suitable cover image to hide the secret data.

Step 2: Now enter the secret message.

Step 3: Give output image path.

Step 4: Give secure key.

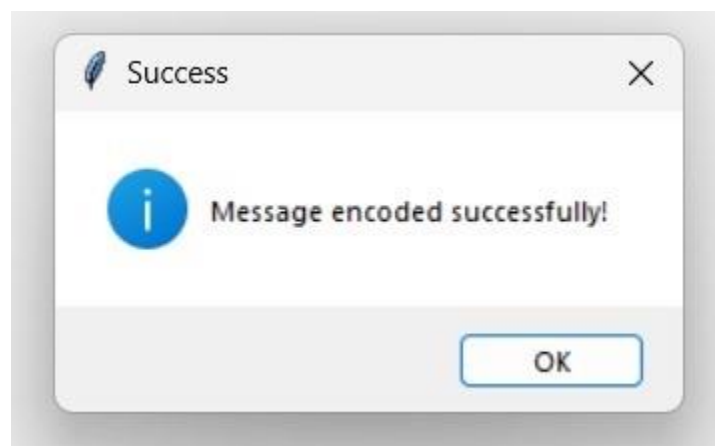


Fig 5.14 : Message encoded successfully.

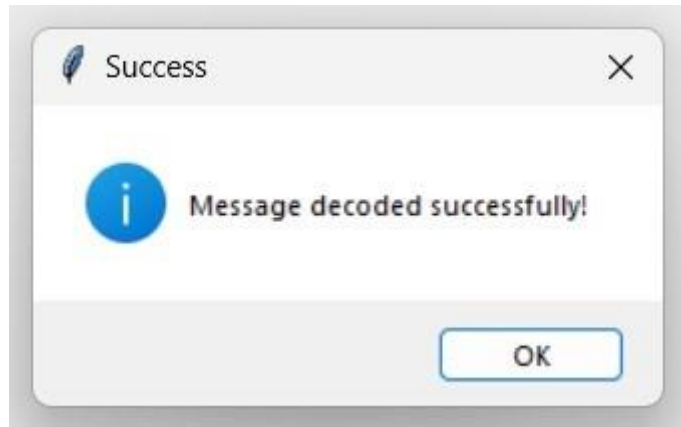


Fig 5.17 : Decoded successfully

STEPS FOR DECODING PROCESS:

Step 1: Select encoded image.

Step 2: Enter secure key to decode the image. It displays secret message.

Step 3: If secure key is invalid then, It displays other text instead of original text showed in fig:5.4.6.

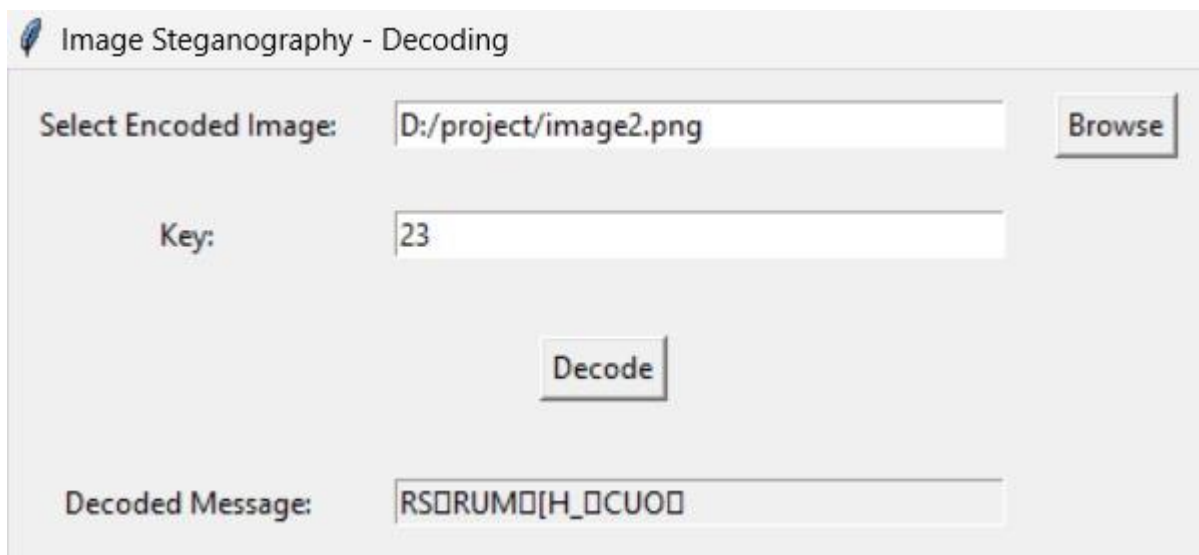


Fig 5.18 : Invalid key

6. SYSTEM TESTING

6.1 Introduction:

System testing for an image steganography application using the Least Significant Bit (LSB) technique involves verifying that all components work correctly and meet the specified requirements. There are various types of test. Each test type addresses a specific testing requirement.

6.1.1 TYPES OF TESTS:

Compatibility testing

Compatibility testing verifies that the application functions correctly across various operating systems and web browsers. This includes testing on different platforms like Windows and macOS to ensure consistent performance. Additionally, the system is tested with various image formats to confirm that it handles each format appropriately without errors or data loss.

Edge case testing

Edge case testing examines how the system performs under less common conditions. This includes testing with large messages to see how well the system handles embedding them into images without significant quality degradation. It also involves checking how different levels of image compression and modifications affect the integrity of the hidden message.

Error Handling Testing

Error handling testing evaluates how the system manages invalid inputs and potential issues. This involves simulating scenarios with corrupted image files, incorrect keys, or unsupported message formats to ensure the system responds with appropriate error messages. Additionally, it assesses the system's resilience to crashes, ensuring that it recovers gracefully and maintains data integrity.

Functional test

Functional testing of the image steganography system focuses on verifying that the core functionalities work as intended. This includes testing the image upload feature to ensure compatibility with various formats, such as PNG and JPEG. It also involves checking that the system can accurately encode and decode secret messages using the Least Significant Bit (LSB) technique, and confirming that secure key management is correctly implemented. The system should handle key input and validation properly, requiring the correct key for both encoding and decoding operations.

Non-functional testing

Non-functional testing assesses aspects of the system beyond its basic functionality. Performance testing is conducted to evaluate how efficiently the system processes images of different sizes and resolutions. Security testing ensures that encryption methods and key management processes are robust against unauthorized access. Usability testing focuses on the user interface, ensuring that the system is intuitive and easy to navigate, allowing users to perform encoding and decoding tasks effortlessly.

User Acceptance Testing (UAT)

User Acceptance Testing involves real users interacting with the system to gather feedback on its functionality and ease of use. This testing phase helps identify areas for improvement based on user experiences and ensures that the system meets their needs and expectations. Adjustments are made based on this feedback to enhance the overall user experience and effectiveness of the application. This structured approach to system testing ensures that the image steganography application is reliable, secure, and user-friendly, meeting the required standards and providing a robust solution for its intended purpose.

6.2 VARIOUS TESTCASE SCENARIOS

Fig : 6.2.1 Testcases

Test case	ID Test case description	Test case steps	Test Data	Expected result	Actual result	Status
TC01	Verify decryption of an encrypted message.	1. Decrypt using correct key "mykey123".	Encrypted Message: [from Test Case 3], Key: "mykey123".	Output is "Secret Message".	As Expected	Success
TC02	Check handling of non-image file.	1. Attempt to embed in test.txt.	File: test.txt, Message: "Test".	Error indicating invalid image.	As Expected	Success
TC03	Test extraction after image resizing.	1. Embed message, resize image, extract.	Original Image: sample.bmp, Message: "Hidden Message".	Message still retrievable.	As Expected	Success
TC04	Verify embedding a long message.	1. Load sample.bmp, embed "This is a long hidden message."	Image: sample.bmp, Message: "This is a long hidden message."	Image modified with the long message embedded.	As Expected	Success

Test case	ID Test case Description	Test case steps	Test data	Expected result	Actual result	Status
TC05	Verify embedding of a message in an image.	1.Load sample.bmp, embed "Hello".	Image: sample.bmp, Message: "Hello".	Image modified with the message embedded.	As Expected	Success
TC06	Verify extraction of the embedded message.	1. Load modified image, extract message.	Image: modified_sample.bmp.	Extracted message is "Hello".	As Expected	Success
TC07	Test message encryption.	1.Encrypt "Secret Message" with key "mykey123".	Message: "Secret Message", Key:.	Encrypted, unreadable string.	As Expected	Success
TC08	Verify embedding of special characters in a message.	1.Load sample.bmp, embed "Message with special characters : !@#\$\$%^&*()".	Image: sample.bmp, Message: "Message with special characters: !@#\$\$%^&*()".	Image modified with the special characters embedded successfully.	As Expected	Success

Test case	ID Test case description	Test case steps	Test Data	Expected result	Actual result	Status
TC09	Verify extraction of a long embedded message.	1. Load modified image, extract message.	Image: modified_sample_long.bmp.	Extracted message is "This is a long hidden message."	As Expected	Success
TC10	Check message embedding with varying formats.	1. Load different formats (jpg, png, gif), embed "Sample".	Images: sample.jpg, sample.png, sample.gif, Message: "Sample".	All images modified with the message embedded.	As Expected.	Success

7. CONCLUSION AND FUTURE ENHANCEMENT

7.1 PROJECT CONCLUSION :

Least Significant Bit (LSB) steganography hides information in images by changing the least significant bit of each pixel's color value. This technique makes tiny, almost invisible changes to the image, allowing hidden data to blend in with the original picture. While it's easy to use and generally keeps the image looking the same, it has some drawbacks. The method can be detected because the pixel changes can create noticeable patterns, and if too much data is hidden or if the image is modified a lot, the image quality can suffer. Despite these issues, LSB steganography is useful for simple applications like embedding watermarks or small messages, especially when combined with encryption for added security.

7.2 FUTURE ENHANCEMENT:

To improve LSB steganography in the future, several key enhancements can be made. Using stronger encryption methods, like AES, will better protect hidden data. Adapting the technique to vary the number of bits used for hiding information based on the image can help maintain image quality and increase data capacity. To make the system harder to detect, advanced techniques like spread spectrum or adding subtle noise can be used. Improving error handling will ensure data integrity, and a more user-friendly interface can make the tool easier to use. Ensuring the system works across different platforms and can handle larger images efficiently is also important. Finally, combining LSB with other security measures and using machine learning for better detection could make the system more robust and versatile.

8. REFERENCES

8.1 PAPER REFERENCES :

Here are some references relevant to the image steganography project using the Least Significant Bit (LSB) technique and secure key management:

1. "A Survey of Digital Image Steganography" by M. K. Lee et al., published in the IEEE Transactions on Information Forensics and Security in 2020, provides a comprehensive review of various steganographic techniques, including LSB. It evaluates their effectiveness and limitations in different applications, highlighting the nuances of LSB and its place in the broader field of digital image steganography.
2. "Least Significant Bit (LSB) Steganography: Techniques and Applications" by R. K. Gupta and A. S. Kumar, featured in the Journal of Computer Science and Technology in 2021, delves into the specifics of the LSB technique. The paper discusses various LSB variations and applications, addressing potential challenges and solutions in embedding data within the least significant bits of image pixels.
3. "Enhanced LSB Based Image Steganography Using Cryptography" by A. K. Singh et al., published in the International Journal of Computer Applications in 2019, explores enhancements to the traditional LSB technique by integrating cryptographic methods. This approach aims to improve the security and integrity of hidden messages in steganographic systems.
4. "A Novel Approach to Image Steganography Using Least Significant Bit (LSB) with Key Management" by N. Kumar et al., presented at the IEEE International Conference on Computer Vision and Pattern Recognition (CVPR) in 2022, introduces a method that combines LSB steganography with advanced key management techniques. It focuses on key generation, storage, and retrieval to secure the embedding and extraction of hidden messages.
5. "Improving Security in LSB-Based Image Steganography Using Hybrid Encryption Techniques" by T. K. Sharma and R. S. Mehta, published in the International Journal of

Information Security in 2021, investigates the application of hybrid encryption techniques to enhance the security of LSB steganography. The paper assesses how different encryption methods impact the effectiveness of the steganographic process.

8.2 WEBLINKS

- [1] <https://ieeexplore.ieee.org/Xplore/home.jsp>
- [2] <https://link.springer.com/>
- [3] <https://pillow.readthedocs.io/en/stable/>
- [4] <https://stackoverflow.com/>
- [5] <https://www.cryptography-textbook.com/>

8.3 TEXT BOOKS

1. **"Steganography: The Art and Science of Hiding Information"** by R. Anderson and F. Petitcolas
2. **"Digital Watermarking and Steganography: Fundamentals and Techniques"** by Ingemar J. Cox, Matthew Miller, and Jeffrey A. Bloom
3. **"Information Hiding: Steganography and Digital Watermarking"** by Neil F. Johnson and Sushil Jajodia
4. **"Handbook of Digital Forensics and Investigation"** edited by Eoghan Casey
5. **"Practical Cryptography for Developers"** by Svetlin Nakov