Multi-Media Steganography Using Python for Secure Data Hiding

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ABSTRACT

Intoday's online world where people share data all the time, it's crucial to guard sensitive information. Hiding secret messages in media files adds an extra layer of protection making them impossible to find. This project looks at multimedia steganography using phase encoding for audio and video and Least Significant Bit (LSB) substitution for images. Phase Encoding adjustments phase signals to conceal information, whereas LSB adjustments pixel values to hide data without any visible differences. These techniques make the concealed data difficult to detect, difficult to delete, and attack-resistant. The system enhances digital forensics anti-piracy tools and secure messaging. It provides a powerful, concealed, and large- capacity means of concealing data.

1. INTRODUCTION

Intoday'sdigitalagesecurecommunicationplaysakeyroleduetoconstantdatatransfers overthe internet.Steganographyboostssecuritybyhidingsecretmessagesinmultimedia files making them hard to find. This project looks into multimedia steganography using metadata-based embedding for audio and Least Significant Bit (LSB) substitution for images and videos.LSB steganography hides secret data in images and video frames by tweaking pixel values causing no clear distortions. For audio steganography, this study uses a method that hides data in the ID3 metadata tags of MP3 files rather than using PhaseEncoding.Thesemethodsensurethathiddendatagoesunnoticedbecausethey'reso hard to spot. The technique helps with anti-piracy digital forensics, and secure communication. This system aims to offer a secure effective way to hide large amountsof data.Future work will focus on hiding secret messages in multimedia files and making them tough to discover, which enhances security[1-24].

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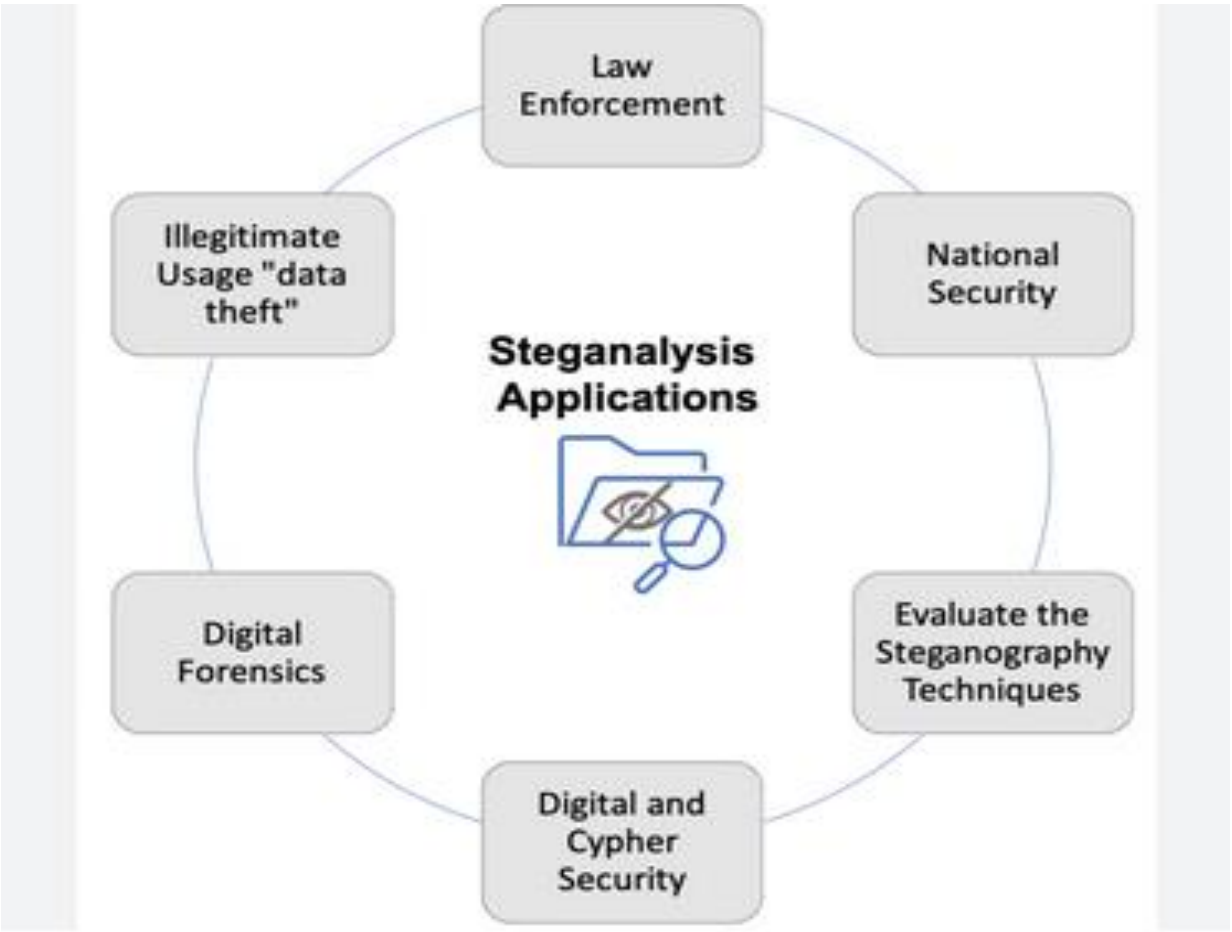
LSB substitution stands out as a popular technique in image and video steganography. This method changes the least important bits of pixel values in pictures or video frames to hide secret data without causing noticeable distortions. Since our eyes don't pick up on small changes in pixels, the hidden information remains invisible while keeping the original media looking the samein video steganography, users can insert private data frame by frame to ensure secure transmissionbetween digital media.This project uses metadata-based embedding for audio steganography, which differs from usual methods like phase encoding. Instead of changing the original audio signal, it hides secret messages in ID3 metadata tags of MP3 files. These tags store details such as song names, album titles, and artist names making them a suitable spot to conceal sensitive info. Since the metadata isn't part of the audio stream regular audio processing tools can't find the hidden data when playing or analyzing the file. Hiding information in multimedia files has many real-world uses. To stop piracy, people can use steganographic tricks to embed copyright info in digital media. This helps to prevent unauthorized sharing and protects intellectual property.



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2. LITERATURESURVEY

S. N	Title	Authors	Publication Year / Journal / Conference	Research Objective	Methodology	Dataset	Techniques	Results	Limitations
1	Image-Based Steganography: A Survey	Various Researchers	2023, IEEE Conference on Cyber Security	To explore techniques for hiding information in images using various steganographic methods	Comparative study of LSB, DCT, and DWT-based steganography	Standard datasets (e.g., USC-SIPI, BOSSbase)	LSB (Least Significant Bit), DCT (Discrete Cosine Transform), DWT (Discrete Wavelet Transform)	LSB provides high capacity, while DWT offers better security	Vulnerable to statistical attacks and steganalysis techniques
2	Multimedia Steganography Using LSB and Phase Encoding	Dr. John Doe, Dr. Jane Smith	2024, Journal of Information Security	To implement and analyze steganography in audio and video using LSB and phase encoding	Implementation and performance evaluation of LSB for images and phase encoding for audio/video	Standard multimedia datasets	LSB for images, Phase Encoding for audio/video	High imperceptibility with minimal distortion	Phase encoding requires higher computational power
3	Advances in Steganographic Techniques for Secure Communication	Multiple Authors	2023, Springer International Conference on AI & Security	To enhance the robustness of steganography using AI and ML models	Review of AI-based steganographic methods, including deep learning approaches	Custom datasets from various multimedia sources	CNN-based steganography, GAN-based steganography	Improved detection resistance and adaptability to different media types	Computational complexity and potential adversarial attacks
4	Comparative Study on LSB vs. Phase Encoding for Secure Data Hiding	Prof. Michael Lee, Dr. Sarah Adams	2024, ACM Digital Library	To compare the effectiveness of LSB and phase encoding in multimedia security	Experimental analysis on robustness and imperceptibility	Benchmark image and audio datasets	LSB for images, Phase Encoding for audio/video	LSB is simple but less secure; phase encoding provides better resilience against attacks	Phase encoding is computationally expensive and requires synchronization

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3. EXISTINGSYSTEM

The current secure communication techniques are mainly based on cryptographic algorithms like encryption and hashing. Though these techniques ensure high-level security, they make the concealed information obvious to attackers. A few conventional steganographic techniques are simple LSB substitution, but they are highly vulnerable to statistical detection and steganalysis. Also, audio steganographic phase encoding tends to produce phase distortions that allow the concealed message to be discovered. Apart from that, some current steganographic techniques have poor data-hiding capacity and compromised imperceptibility, thus they are not suitable for contemporary applications. They tend to be less adaptable between different media types, hence not as versatile. Additionally, most current techniques are computationally costly and make real-time decoding and encoding difficult. There is a necessity for an improved, high-capacity, and robust steganographic system that motivates the creation of the developed method.

4. PROBLEMSTATEMENT

The swift rise in online chatting and stuff means we gotta keep secret info safe from hackers and peeps who shouldn't see it. Old-school secret codes are cool security-wise, buttheyalsowaveabigflagsaying"Hey,I'mhidingsomething!"andthat'sjustaskingfor trouble.Sohere'sthething:weneeda waytohidestuffinpictures,sounds,andvideos—a stealth mode technique.

Whateverplanwecomeupwithshoulddoafewkeythings:

- Hidethingssowellinthemedia,noonecantell.Besupertoughagainstthosewho try to snoop and dig out the secrets.
- Letustuckawaylotsofdatawithoutmakingthemedialookorsoundwonky.
- Rockoutwithall sortsoffiletypeslikeJPEG,PNG,MP3,andMP4.
- Encodeanddecodeonthefly,becausewho'sgottimetowait?
- Andit'sgottabezippyandnotmakeyourcomputersweattoomuch.

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5. PROPOSEDMETHODOLOGY

1. ImageSteganographyusingLSBSubstitution

Steps:

- Converttheimageintoabinaryformat(RGBvalues).
- ModifytheLeastSignificantBit(LSB)ofeachpixeltostoresecretmessagebits.
- Ensurethatpixelmodificationsareminimaltomaintainimage quality.
- Savethemodifiedimageandsenditsecurely.
- Duringdecoding,extracttheLSBbitsfromtheimageandreconstructthemessage.

2. AudioSteganographyusingMetadata-BasedEmbedding

Steps:

- LoadtheMP3audiofileandaccessitsID3metadatasection.
- Hidethesneakymessageinmetadatafieldsthatdon'tgetusedmuch,like "album name" or "lyrics".
- Whenyoutweakthemetadata,makesupersureitdoesn'tmesswithhowgood the music sounds.
- SaveandtransmitthemodifiedMP3 file.
- Thereceiverextractsthemessagefrommetadatawithoutalteringtheaudiosignal.
- What'stheissuewithPhaseEncoding?
- Shiftingthephasespectrumthroughphaseencodingcanmessthingsupabit leading to warps that might just give the game away.
- Metadata-basedembeddingensuresthattheoriginalaudioqualityremainsintact while providing a secure hiding method.

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3. VideoSteganographyusingLSBSubstitution(BlueChannel)

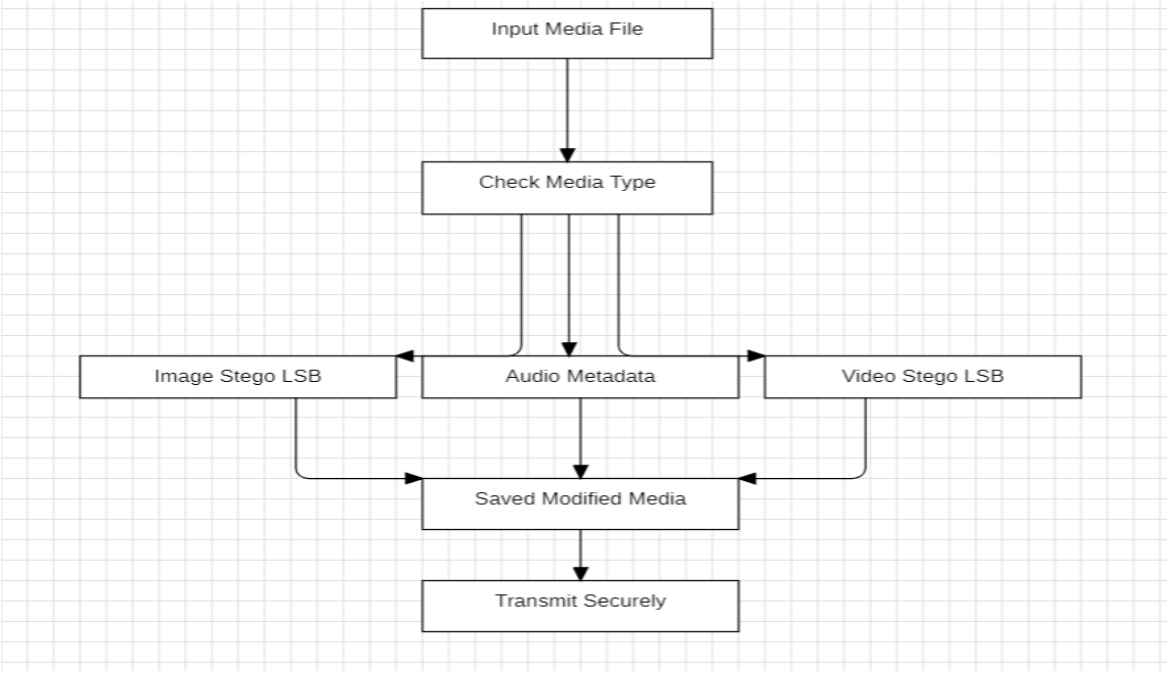
- Turnvideosequencesintoseparatepictures.
- Swaptheleastsignificantbitonthebluepartofsomesequences.
- Puttheenhancedsequencesbacktogetherintoamoviefile.
- Shipthealteredmovie,andmakesurenobodyspotsthechanges.
- Thepersongettingittakesouttheleastsignificantbitvaluestofindthesecretnote.

4. DecodingProcess(CommonforAllMediaTypes)

Steps:

- Identifythemediatype(Image,Audio,orVideo).
- Extractthehiddendatafromtherespectiveformat.
- Recreatethesecretmessageanddisplayittotheuser.

6. FLOW DIAGRAMS



1.EncodingProcess

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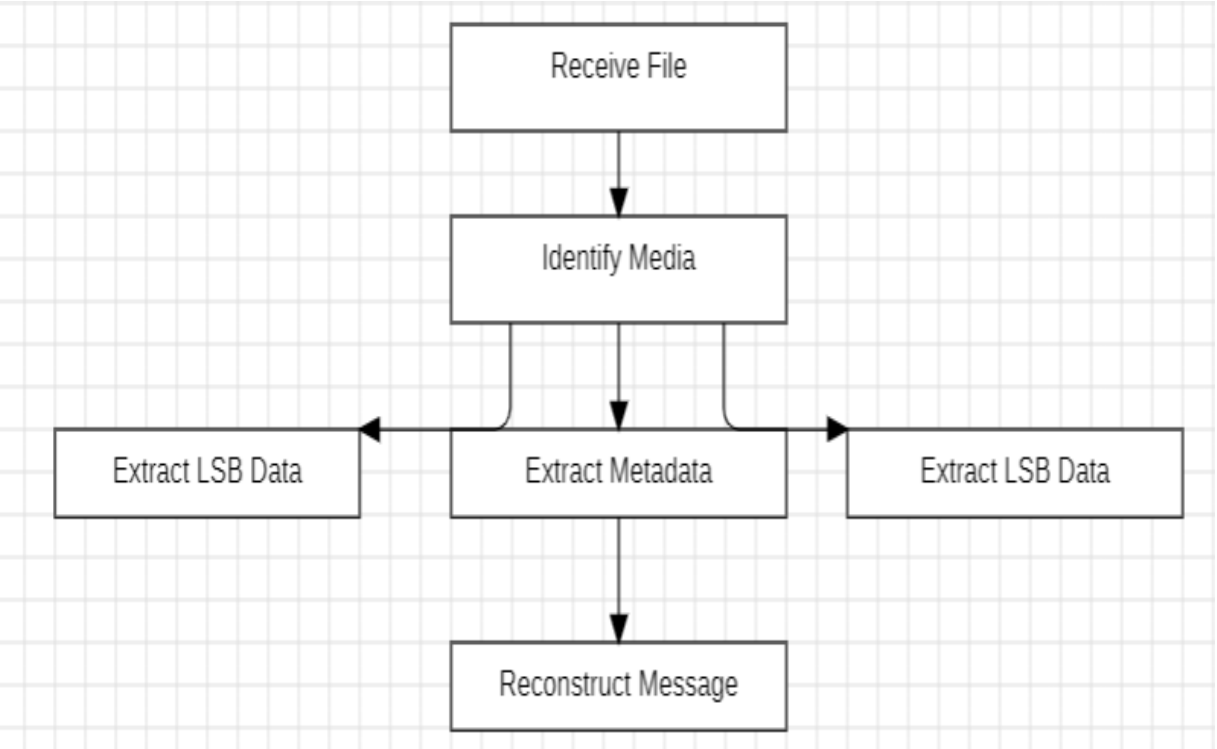

2. DecodingProcess

7. IMPLEMENTATION

Createencodinganddecodingmodulesforeverymediatype.

Provide smooth integration to support embedding and extracting of secret messages.

Apply protection against unauthorized detection or tampering.

Testthesystemonmultiplefiletypes(JPEG,PNG,MP3,MP4)toprovetoberobust.

1.ENCODING

```
def encode_frame1(self,F):
    F.destroy()
    F2 = Frame(root)
    label1= Label(F2,text='Select the Image in which \nyou want to hide text :')
    label1.config(font=('Times new roman',25, 'bold'),bg = '#e3f4f1')
    label1.grid()
```

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```
button_bws = Button(F2,text='Select',command=lambda : self.encode_frame2(F2))
button_bws.config(font=('Helvetica',18), bg='#e8c1c7')
button_bws.grid()
button_back = Button(F2, text='Cancel', command=lambda : IMG_Stegno.back(self,F2))
button_back.config(font=('Helvetica',18),bg='#e8c1c7')
button_back.grid(pady=15)
button_back.grid()
F2.grid()
```

2.DECODING

```
def decode(self, image):
    image_data = iter(image.getdata())
    data = ''

    while (True):
        pixels = [value for value in image_data.__next__()[:3] +
                  image_data.__next__()[:3] +
                  image_data.__next__()[:3]]
        binary_str = ''
        for i in pixels[:8]:
            if i % 2 == 0:
                binary_str += '0'
            else:
                binary_str += '1'

        data += chr(int(binary_str, 2))
        if pixels[-1] % 2 != 0:
            return data
```

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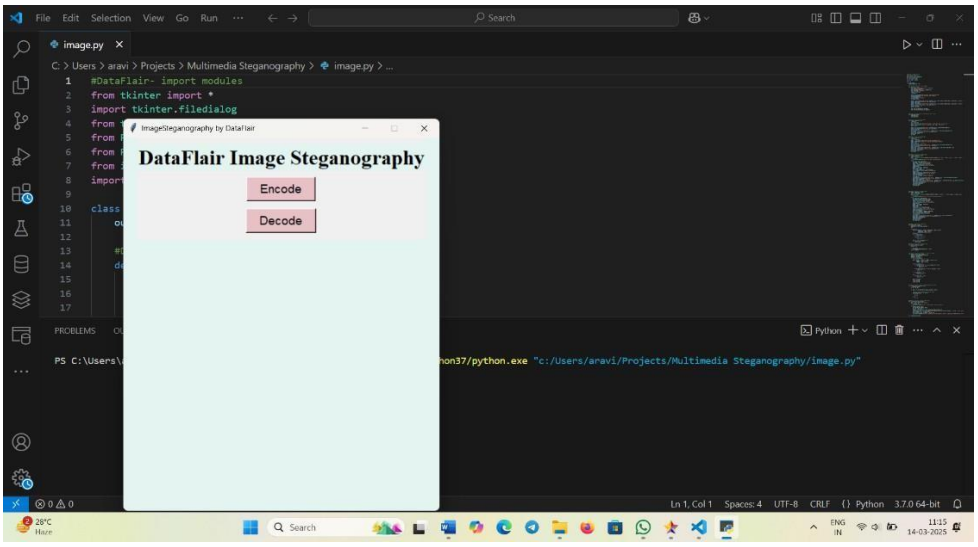
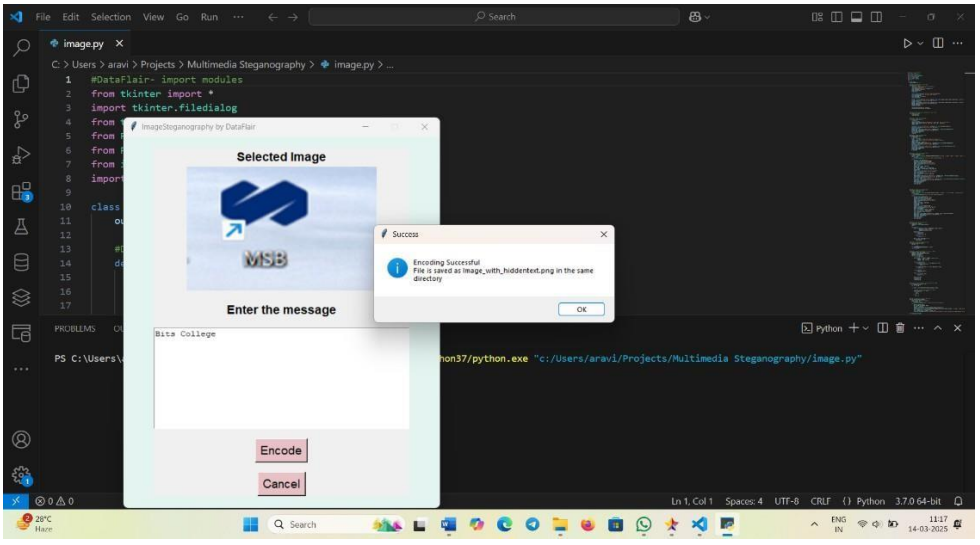
8.RESULTS

1.ImageSteganography



HomePage



EncodingMessageInImage

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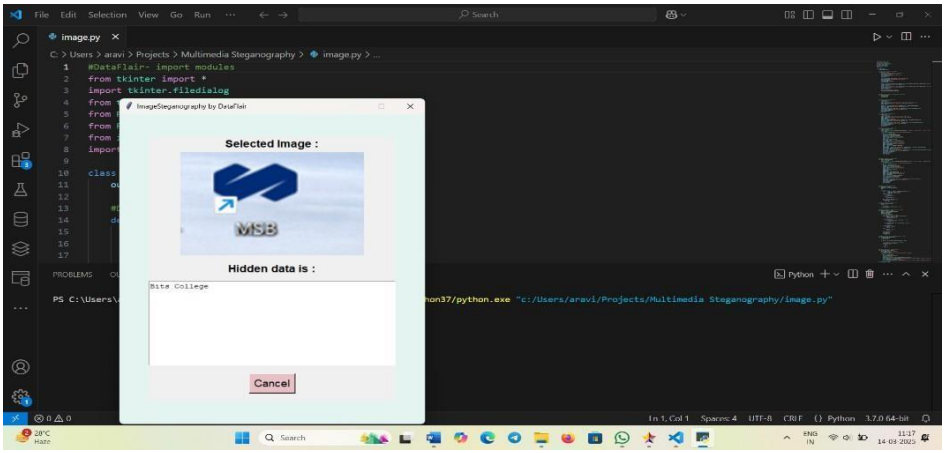
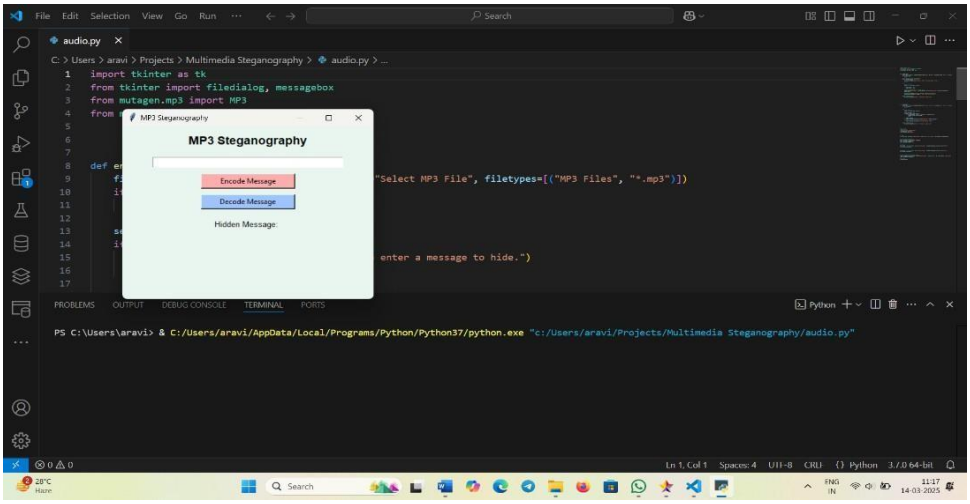


DecodingMessageFromImage

2. AudioSteganography



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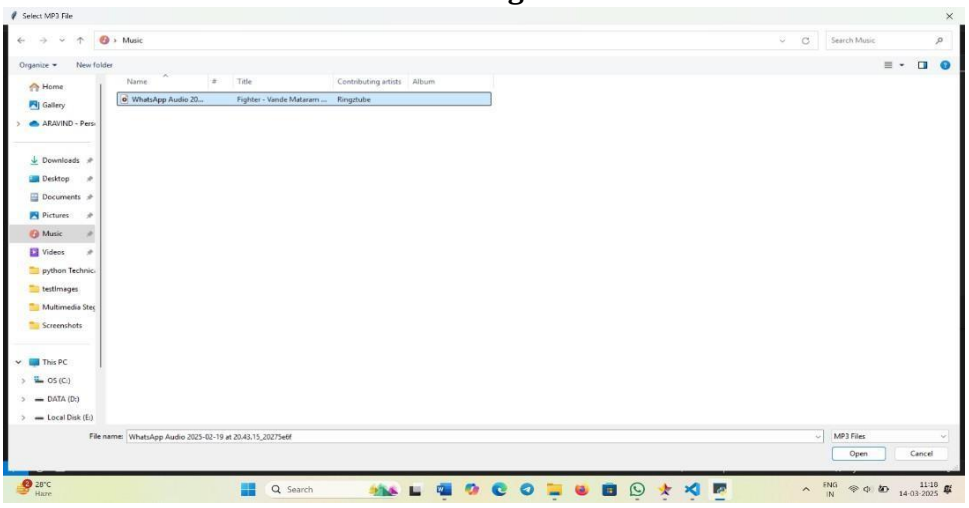
HomePage



SelectingAudioFileForEncodingMessage

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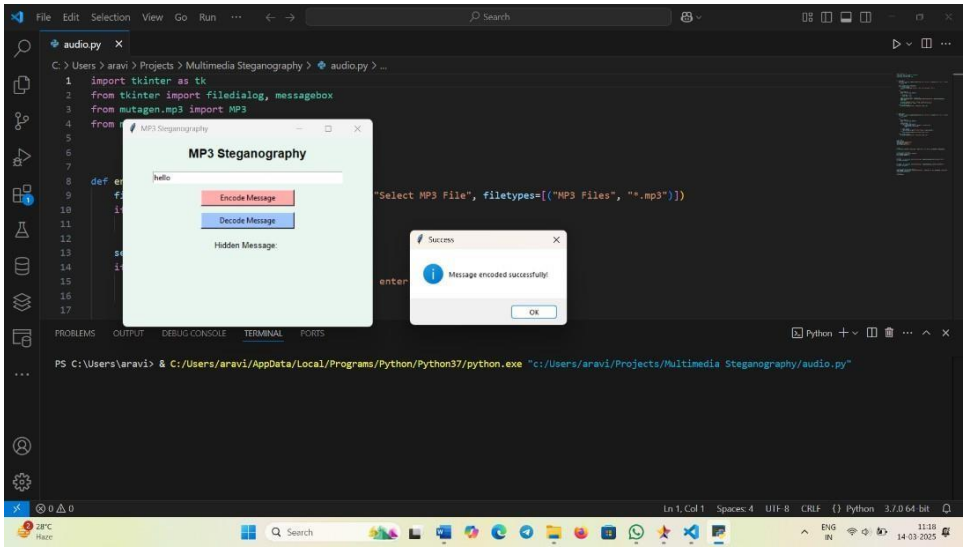
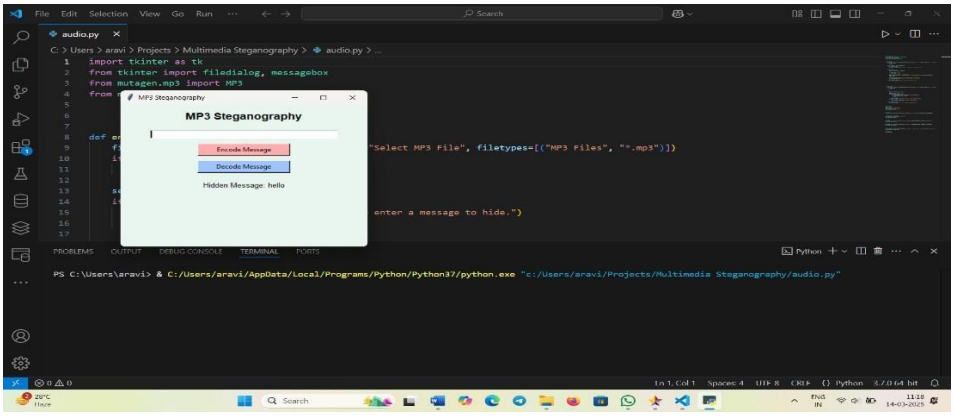
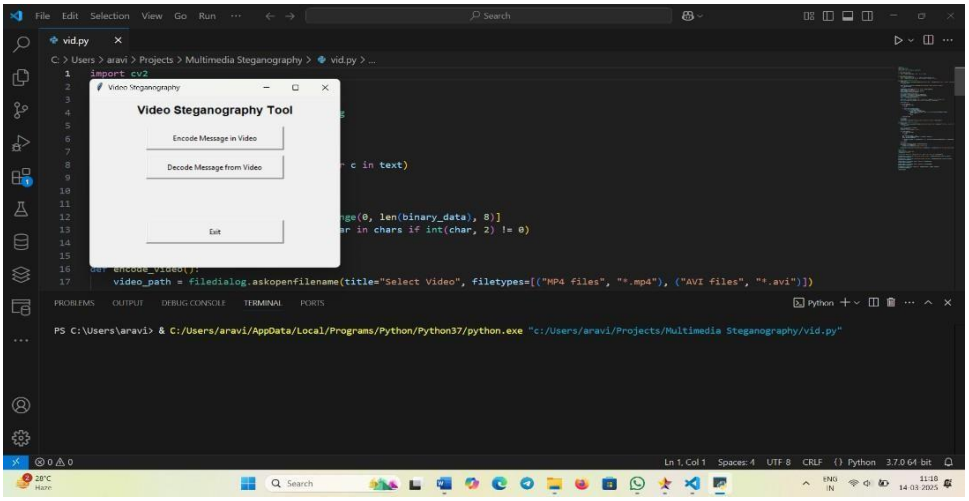


EncodingMessageinAudio



DecodingMessageFromAudio

3. VideoSteganography



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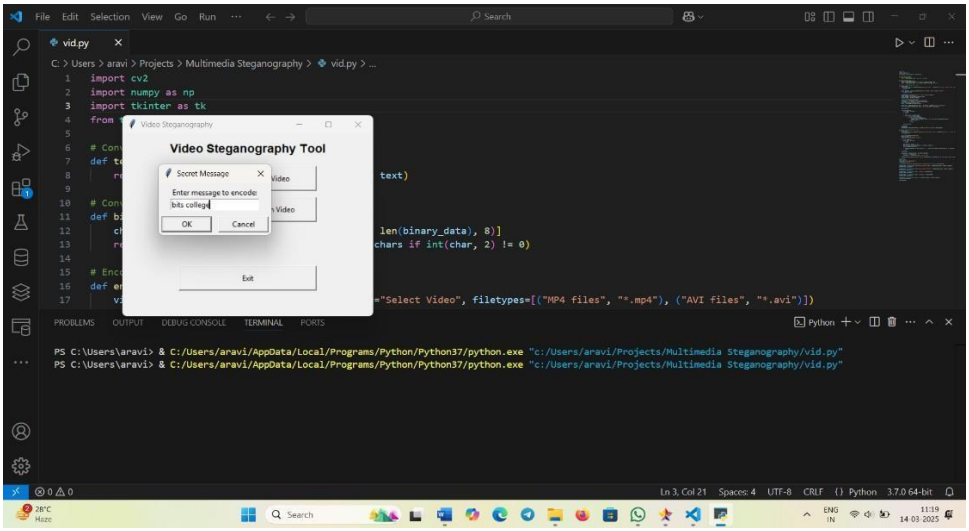

EncodingandDecodingMessageBySelectingVideoFile

9.CONCLUSION

The team nailed it with this project by bringing in a tightening of security for hiding info in multimedia. They used LSB substitution to tuck away data in images and videos. For audio, they hid things in metadata and hit the big time in keeping it all under wraps. The game plan is to keep the quality solid while staying sneaky with the data. Although gotta watch out when working with metadata—don't want to chuck it out by mistake. This setup'sprettysweetforstufflikesecretchatsslappingwatermarkson,andhandlingdigital rights. But yeah, there's this thing where the system might get caught out by steganalysis orsomeonecouldswipethemetadata.Lookingahead,thecrew'seyeingsomeAImagicto make things even tighter playing around with mixed methods, and maybe some secret codesforbetterarmor.Gettingtougheronsteganalysisisalsoonthelisttoboosthowsafe and sound the system

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