Stenographic File Integrity Checker

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This is a File Integrity Checker using Steganography.

- **File Integrity Checker** → It tells you if a file has been changed (tampered, corrupted, or hacked).
- **Steganography** → It means "hiding secret data inside normal files (like images or audio)" so no one knows it's there.

- **In this project:**

To build a lightweight file integrity verification tool that:

1. Generates cryptographic hashes (SHA256) of files.

   What are Cryptographic Hashes?

   A cryptographic hash is like a **digital fingerprint** of a file.

   It takes any input file (big or small: text, PDF, image, video) and converts it into a fixed-length string (e.g., 64 characters for SHA256).

   Even a tiny change in the file (adding a space, changing 1 letter, or editing 1 pixel) produces a completely different hash.

   File: "hello"

   Hash:
   2cf24dba5fb0a30e26e83b2ac5b9e29e1b161e5c1fa7425e73043362938b9824

   File: "hello!" (just one character added)
   Hash:
   334d74cdb3ef87c7ec7d1e9e9f25e6cf6a9ad9ba9a6d6e0d495fac16a2fefc2c

2. Embeds these hashes inside a **cover file** (image) using steganography.
3. Extracts hidden hashes later to verify if the original file was **safe** or **tampered**.

4. This ensures **confidential file integrity monitoring** while keeping the verification hidden from attackers.

- **Why do we do this? (Usefulness)**

1. Detect file tampering
    - Suppose you have a report, code, or config file.
    - An attacker modifies it secretly.
    - By comparing with the hidden hash, you can detect this modification immediately.
2. Hidden verification (Steganography advantage)
    - Normally, integrity tools save the hash in a .txt file.
    - Hackers can easily find and replace that file too.
    - But if we hide the hash inside an innocent image/audio, no one knows where the real verification code is.
3. Digital forensics & security
    - Investigators can hide file authenticity information inside an image/audio and later prove if evidence is original.
4. Secure data distribution
    - If you send files over the internet, you can also send a stego image separately.
    - Receiver can check file integrity secretly.

- **Tools and Setup:**

1. Language: Python
2. Libraries:
    - hashlib → to generate file hashes (SHA256/SHA3).
    - Pillow → for image steganography (hide data inside PNG).
      pip install pillow
    - wave (optional) → for audio steganography (hide data inside WAV).
    - argparse → for CLI options (embed/extract/verify).

- **Code** (steg_integrity.py):

```
import sys
import hashlib
from PIL import Image

# ------------------ Generate SHA256 Hash ------------------
def generate_hash(file_path):
    hasher = hashlib.sha256()
    with open(file_path, "rb") as f:
        while chunk := f.read(4096):
            hasher.update(chunk)
    return hasher.hexdigest()

# ------------------ Embed Hash into Image ------------------
def embed_hash(cover_img, hash_str, stego_img):
    img = Image.open(cover_img)
    binary_hash = ''.join(format(ord(c), '08b') for c in hash_str)
    pixels = list(img.getdata())

    new_pixels = []
    hash_index = 0

    for pixel in pixels:
        r, g, b = pixel[:3]
        if hash_index < len(binary_hash):
            r = (r & ~1) | int(binary_hash[hash_index])  # Put bit in Red channel
            hash_index += 1
        new_pixels.append((r, g, b))

    img.putdata(new_pixels)
    img.save(stego_img)
    print(f"[+] Hash embedded into {stego_img}")

# ------------------ Extract Hash from Image ------------------
def extract_hash(stego_img, hash_len=64):
    img = Image.open(stego_img)
    pixels = list(img.getdata())

    bits = ""
    for pixel in pixels:
        r, g, b = pixel[:3]
        bits += str(r & 1)
        if len(bits) >= hash_len * 8:
            break

    extracted = ""
```

```
    for i in range(0, len(bits), 8):
        extracted += chr(int(bits[i:i+8], 2))
    return extracted

# ------------------ Verify File Integrity ------------------
def verify(file_path, stego_img):
    current_hash = generate_hash(file_path)
    hidden_hash = extract_hash(stego_img)

    print(f"Hidden hash:  {hidden_hash}")
    print(f"Current hash: {current_hash}")

    if current_hash == hidden_hash:
        print("[SAFE] File is original")
    else:
        print("[ALERT] File has been modified")

# ------------------ Main Program ------------------
if __name__ == "__main__":
    if len(sys.argv) < 2:
        print("Usage: python steg_integrity.py <mode> [args]")
        print("Modes: genhash, embed, extract, verify")
        sys.exit(1)

    mode = sys.argv[1]

    if mode == "genhash":
        print(generate_hash(sys.argv[2]))

    elif mode == "embed":
        file_to_protect = sys.argv[2]
        cover_img = sys.argv[3]
        stego_img = sys.argv[4]
        hash_val = generate_hash(file_to_protect)
        embed_hash(cover_img, hash_val, stego_img)

    elif mode == "extract":
        print(extract_hash(sys.argv[2]))

    elif mode == "verify":
        verify(sys.argv[2], sys.argv[3])
```

1. Add a report.pdf file in same folder (StegFileIntegrity)
2. Take any image which has extension .png save that image as cover.png

- **Run the code:**
  1. Generate hash of a file:
     Make file fingerprint.
     python steg_integrity.py genhash report.pdf

```
PS C:\Users\Lenovo\Desktop\harshali\digisurkhsha\StegFileIntegrity> python steg_integrity.py genhash report.pdf
e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
```

  2. Embed hash into image:
     Hide it inside an image.
     python steg_integrity.py embed report.pdf cover.png stego.png

```
PS C:\Users\Lenovo\Desktop\harshali\digisurkhsha\StegFileIntegrity> python steg_integrity.py embed report.pdf cover.png stego.png
[+] Hash embedded into stego.png
```

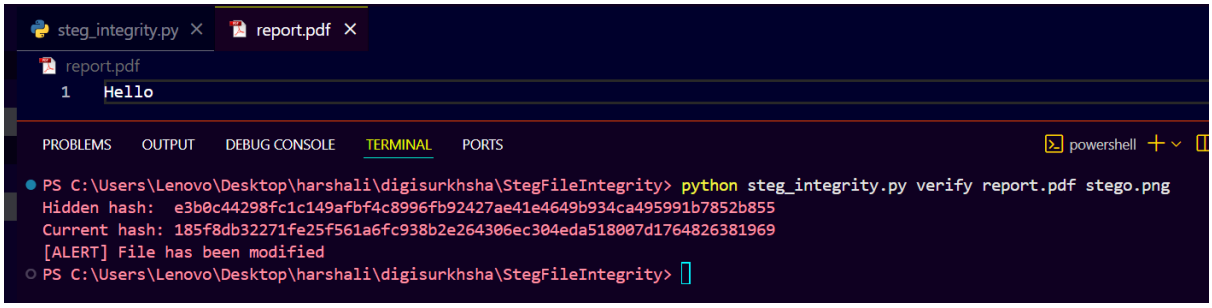
  3. Extract hidden hash:
     Pull it back
     python steg_integrity.py extract stego.png

```
PS C:\Users\Lenovo\Desktop\harshali\digisurkhsha\StegFileIntegrity> python steg_integrity.py extract stego.png
e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
```

  4. Verify integrity:
     Check if file is unchanged or tampered
     It compares hidden hash (from stego image) vs current hash of report.pdf.
     python steg_integrity.py verify report.pdf stego.png
     Case 1: If file is safe =>

```
PS C:\Users\Lenovo\Desktop\harshali\digisurkhsha\StegFileIntegrity> python steg_integrity.py verify report.pdf stego.png
Hidden hash:  e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
Current hash: e3b0c44298fc1c149afbf4c8996fb92427ae41e4649b934ca495991b7852b855
[SAFE] File is original
PS C:\Users\Lenovo\Desktop\harshali\digisurkhsha\StegFileIntegrity>
```

     Case2: If file was modified =>
     Add something in report.pdf file



- **Observations:**
  1. Normal (original) file → System marked it [SAFE].
  2. Modified file → System detected mismatch and raised [ALERT].
  3. Steganography successfully hid file fingerprints inside an image without visible changes.

- **Conclusion:**
  1. The tool successfully generated hashes, embedded them into images, and verified file integrity.
  2. It can differentiate between safe and tampered files.
  3. Demonstrates a practical approach to hidden file integrity monitoring using Python.