CHAPTER 1: INTRODUCTION

This project presents a user-interactive application developed to perform feature extraction using Seven Hu Moment Invariants, a widely used technique in image processing and pattern recognition. With the growing importance of intelligent visual systems, extracting consistent and robust shape-based features has become essential for tasks such as object detection, character recognition, and shape classification.

The system is implemented in Python and utilizes libraries such as OpenCV and NumPy for image processing. A graphical user interface (GUI) built with Tkinter allows users to easily select and analyze images in a user-friendly environment. Upon selecting an image, the application processes it by converting it to grayscale, applying thresholding, computing image moments, and then calculating the seven Hu moment invariants, which are invariant to rotation, scaling, and translation.

The output consists of the original image preview and the corresponding Hu moments, clearly displayed for user interpretation. These moment values uniquely represent the geometric structure of the shape in the image and can be used for further classification or recognition models.This tool is designed to assist students, researchers, and engineers in understanding and applying shape feature extraction techniques. It serves as a foundational project for building more advanced image analysis and machine learning systems, offering insight into the practical use of mathematical shape descriptors in computer vision..

CHAPTER 2: PROBLEM STATEMENT

It is difficult to recognize shapes in images when they are rotated, resized, or moved. This project solves that by using Hu Moments, which give special values that stay the same no matter how the shape changes. These values help in identifying and comparing shapes accurately.

CHAPTER 3: OBJECTIVES

- **Unified Shape Feature Extraction**
  To extract shape-based features from images using the seven Hu moment invariants for consistent analysis.
- **Transformation-Invariant Analysis**
  To ensure that extracted features remain unchanged under translation, scaling, and rotation of the input image.
- **Simple and Intuitive Interface**
  To provide a user-friendly GUI that allows users to easily upload images and view extracted features.
- **Visual Feedback with Real-Time Results**
  To display both the selected image and the corresponding Hu moment values instantly for better understanding.
- **Support for Pattern and Object Recognition**
  To enable future use of extracted features in recognition tasks such as shape matching or classification.
- **Educational and Research Utility**
  To help students and researchers gain hands-on experience with geometric feature extraction methods.
- **Lightweight and Standalone Application**
  To develop a portable Python-based tool that can run independently without complex setup requirements.
- **Foundation for Advanced Vision Projects**
  To serve as a base for integrating into larger projects involving machine learning or computer vision.

CHAPTER 4: MOTIVATION

In the field of computer vision and pattern recognition, accurately identifying and analyzing shapes within images is a key challenge—especially when objects appear in different positions, sizes, or orientations. As image-based applications continue to grow in areas such as object detection, OCR, medical imaging, and biometric systems, the need for reliable and consistent shape descriptors has become more important than ever.Traditional pixel-based or coordinate-based feature extraction methods often fail when images undergo transformations like rotation or scaling. This creates a gap between raw image data and meaningful shape-based insights that can be used for further analysis or classification.

The motivation behind this project is to develop a simple and interactive tool that uses Seven Hu Moment Invariants to extract robust, transformation-invariant shape features from images. By providing a user-friendly interface that performs real-time image processing and feature display, this project aims to help students, researchers, and developers understand and utilize moment-based shape descriptors effectively in a variety of computer vision tasks.

CHAPTER 5 : THEORY

In image processing and computer vision, feature extraction is the process of transforming input data (such as images) into a set of measurable characteristics that can describe the contents of the image. These features are used for classification, recognition, and other analytical tasks. Features can be based on color, texture, or shape. For shape-based analysis, one of the most effective and mathematically robust approaches is the use of image moments.

Feature Extraction in Image Processing

- Feature extraction is a key process in image analysis, where raw image data is converted into a set of quantifiable features that represent the image's essential characteristics. These features can be used for tasks like classification, recognition, and comparison.
- In shape recognition, feature extraction aims to identify and describe the object in an image based on its shape rather than its color or texture

Image Moments

Image moments are scalar values that summarize the distribution of pixel intensities in an image.They are typically used to calculate geometric properties of objects, such as:

Area: The total number of pixels that belong to the object.

Centroid: The center of mass of the shape.

Orientation: The angle of the shape’s principal axis.

Inertia: The spread of the shape around its centroid.

Image moments provide a mathematical way to represent the shape of an object, independent of size, orientation, or position.

Types of Image Moments

- **Raw (Spatial) Moments**:
    - These moments are the basic statistical moments and are computed using pixel intensities directly. They help capture the overall properties of the image but are not invariant to transformations like rotation or scaling.

- Formula:

  mpq=∑x ∑y xp yq I(x,y)

  Where I(x,y)I(x, y)I(x,y) is the intensity at pixel (x,y)(x, y)(x,y) and p,q, representhe order of the moment.

Central Moments:

- Central moments are calculated relative to the **centroid** of the image. The centroid is the center of mass of the shape, computed using the first-order moments.
- Formula:

  μpq=∑x∑y(x−x¯)p(y−y¯)qI(x,y)\

  Where x¯ and y¯ are the centroid coordinates.

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Normalized Central Moments:

- These moments are scale-invariant and are calculated to compensate for variations in size. They allow for comparisons between images of different sizes.

  Normalized central moments provide a more robust set of features for shape analysis.

Hu Moment Invariants

- **Hu Moment Invariants** are a set of **seven values** derived from the **normalized central moments**. These seven moments are invariant under three major transformations:
  1. **Translation** (shifting the position of the object),
  2. **Scaling** (changing the size of the object),
  3. **Rotation** (rotating the object).
- **Ming-Kuei Hu** introduced the concept of these invariants in 1962. The primary advantage of Hu moments is that they provide a compact representation of an object's shape that remains unchanged even if the object is rotated, scaled, or translated.

Applications of Hu Moments

- **Object Recognition**: Hu moments are extensively used for recognizing and matching shapes in images, making them vital in areas like robotics, machine vision, and autonomous vehicles.
- **Character Recognition**: Hu moments play a key role in optical character recognition (OCR), where handwritten or typed characters are identified based on their shape.
- **Biometric Analysis**: They are used in fingerprint or iris recognition systems, where the shape of the biometric feature is key to identification.
- **Medical Imaging**: Hu moments are used for detecting and identifying tumors, lesions, or organ shapes in medical scans.
- **Image Retrieval**: In content-based image retrieval systems, Hu moments can help in shape matching, enabling users to search for similar shapes in a large image database.

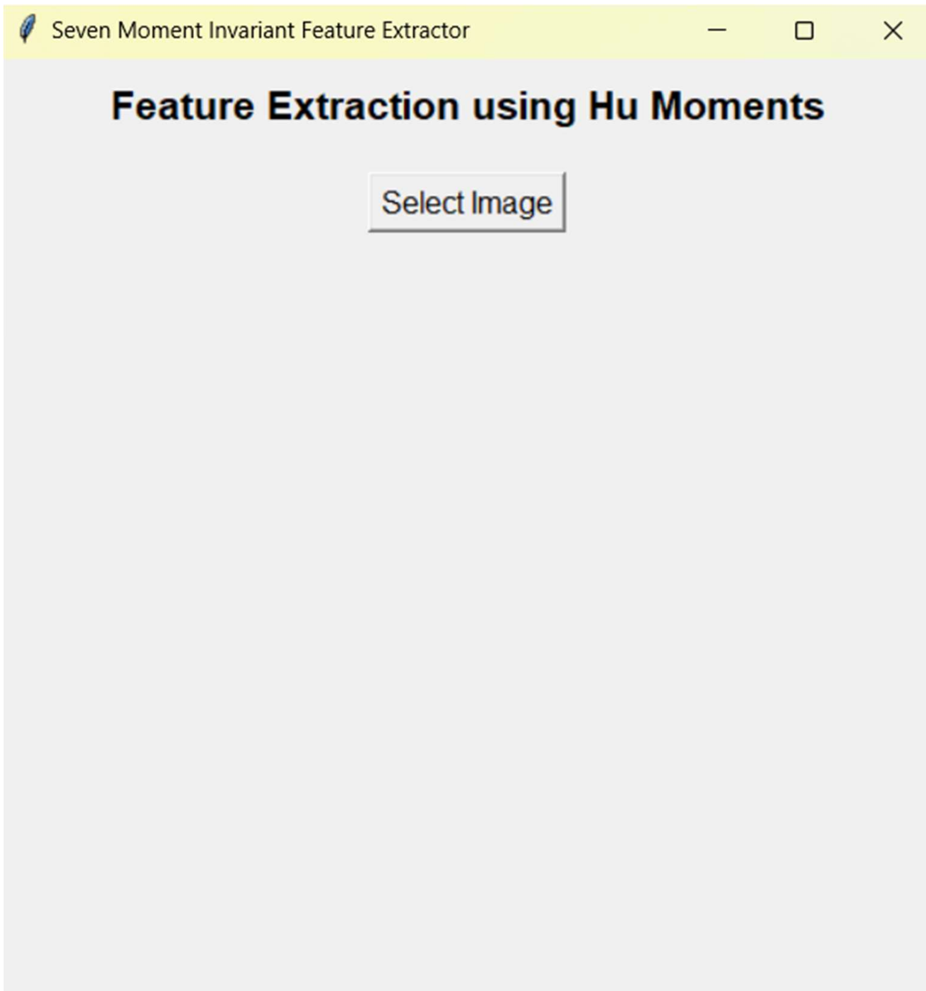
CHAPTER 6 : IMPLEMENTATION

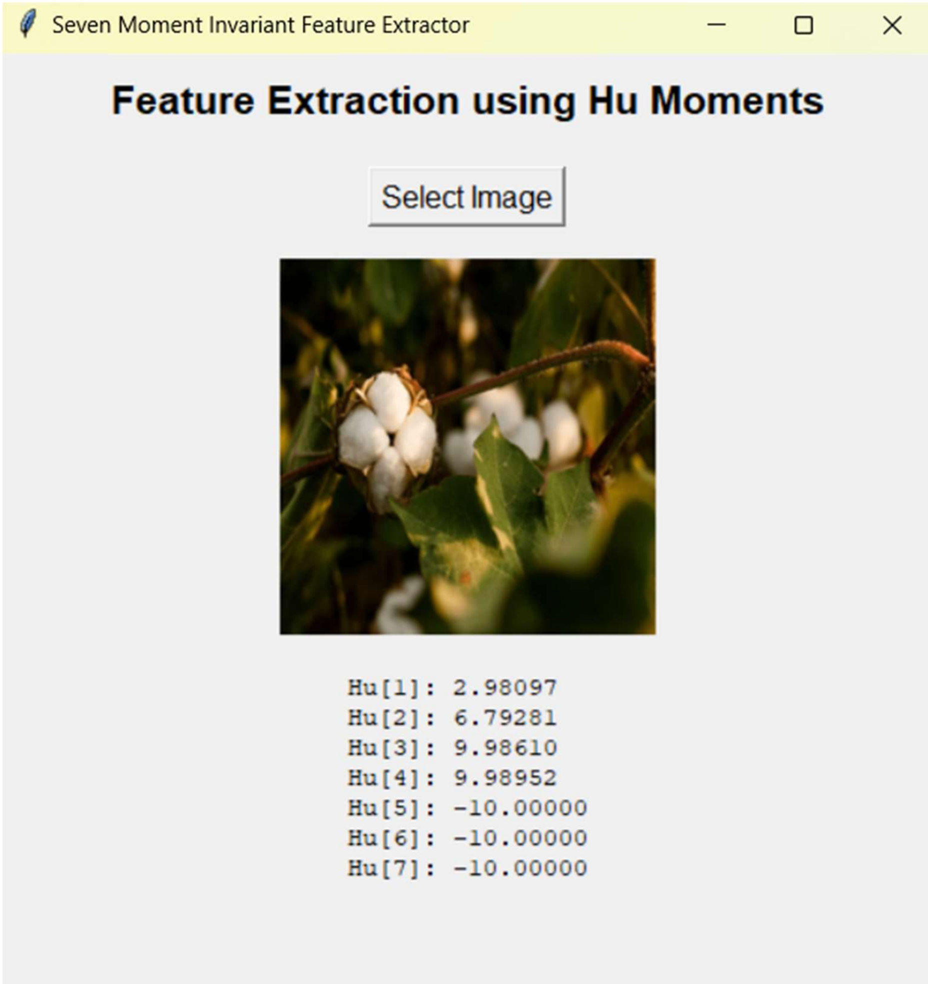
```
import cv2
import numpy as np
import tkinter as tk
from tkinter import filedialog, messagebox
from PIL import Image, ImageTk

# Function to extract Hu Moments
def extract_hu_moments(image_path):
    image = cv2.imread(image_path, cv2.IMREAD_GRAYSCALE)
    if image is None:
        raise ValueError("Could not read the image.")

    _, thresh = cv2.threshold(image, 128, 255, cv2.THRESH_BINARY_INV +
cv2.THRESH_OTSU)
    moments = cv2.moments(thresh)
    hu_moments = cv2.HuMoments(moments)

    # Log transform for better visualization
    for i in range(0, 7):
        hu_moments[i] = -1 * np.sign(hu_moments[i]) * np.log10(abs(hu_moments[i]) + 1e-10)

    return hu_moments.flatten()

# Function to handle image selection and feature extraction
def select_image():
    file_path = filedialog.askopenfilename(filetypes=[("Image files", "*.png *.jpg *.jpeg
*.bmp")])

    if file_path:
```

```
    try:
        # Display the selected image
        img = Image.open(file_path)
        img = img.resize((200, 200))
        img_tk = ImageTk.PhotoImage(img)
        image_label.config(image=img_tk)
        image_label.image = img_tk

        # Extract Hu Moments
        hu_features = extract_hu_moments(file_path)
        result_text = "\n".join([f"Hu[{i+1}]: {moment:.5f}" for i, moment in
enumerate(hu_features)])
        result_label.config(text=result_text)
    except Exception as e:
        messagebox.showerror("Error", str(e))

# Tkinter GUI setup
root = tk.Tk()
root.title("Seven Moment Invariant Feature Extractor")
root.geometry("500x500")
root.configure(bg="#f0f0f0")

title = tk.Label(root, text="Feature Extraction using Hu Moments", font=("Arial", 16,
"bold"), bg="#f0f0f0")
title.pack(pady=10)

select_button = tk.Button(root, text="Select Image", command=select_image, font=("Arial",
12))
select_button.pack(pady=10)

image_label = tk.Label(root, bg="#f0f0f0")
```

```
image_label.pack(pady=5)

result_label = tk.Label(root, text="", font=("Courier", 10), bg="#f0f0f0", justify="left")
result_label.pack(pady=10)

root.mainloop()
```

CHAPTER 7 : RESULT




Seven Moment Invariant Feature Extractor
Feature Extraction using Hu Moments
Select Image
Hu[1]: 2.98097
Hu[2]: 6.79281
Hu[3]: 9.98610
Hu[4]: 9.98952
Hu[5]: -10.00000
Hu[6]: -10.00000
Hu[7]: -10.00000

CHAPTER 8 : CONCLUSION

This project on Feature Extraction Using Seven Hu Moment Invariants successfully demonstrates a method for shape recognition in image processing. By calculating Hu Moments, we can extract transformation-invariant features that remain unaffected by changes in position, size, or orientation of an object.

The project achieved its goal of computing and displaying the seven Hu moment invariants for any given image. It provides a user-friendly interface that allows easy image analysis. The method is particularly useful in fields like object detection, biometric analysis, and medical imaging.

In conclusion, Hu Moments offer a reliable and efficient technique for shape recognition, with potential applications in various domains of computer vision and image processing.

CHAPTER 9 : REFERENCE

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CHAPTER 9 : PLAGIARISM