**Computer Vision Project**

1. **Introduction**

In today's digital age, image processing plays a crucial role in various fields such as computer vision, photography, and surveillance, with panoramic photography gaining tremendous popularity for its seamless wide-angle scene capture. However, traditional methods of manual image stitching are time-consuming and challenging to achieve precise alignment and blending. To address these challenges, this project aims to develop an innovative application that seamlessly stitches a selection of images into a panoramic masterpiece. Beyond conventional stitching, the application integrates advanced edge detection techniques like Canny Edge Detection, Difference of Gaussians (DoG) with adjustable morphological operations, and an AI-powered human figure detection module with a confidence threshold of 50% or higher. Users can interact with the application through a user-friendly interface, fine-tuning parameters and comparing outcomes visually, offering a more efficient and advanced solution in panoramic image creation.

1. **Project Overview**
   1. **Motivation**

The motivation behind this project is to address the growing demand for user-friendly yet powerful tools in panoramic image creation, driven by the proliferation of high-resolution cameras in smartphones and digital cameras. There is a clear need for software solutions that can leverage these capabilities to effortlessly produce captivating panoramic views. By developing an application that combines image stitching with advanced edge detection algorithms, we aim to provide users with a comprehensive toolset that not only enhances their creative capabilities but also delivers superior results. This project focuses on enhancing efficiency by automating manual image stitching processes, improving edge detection accuracy, especially in scenarios involving human figures, and exploring diverse applications ranging from artistic photo editing to crucial surveillance systems. Moreover, integrating AI-driven solutions for human figure recognition drives innovation in image processing, catering to evolving industry requirements and anticipating future technological trends.

* 1. **Advantages Over Current System**
* **Seamless Panoramic Image Stitching**: The core functionality of the application revolves around seamlessly stitching multiple images into a panoramic view. By automating this process, users can focus on capturing the desired scenes without worrying about manual alignment or blending issues.
* **Integration of Advanced Edge Detection**: The application incorporates state-of-the-art edge detection techniques such as Canny Edge Detection and Difference of Gaussians (DoG) with adjustable morphological operations. This allows for precise detection of edges and contours in the stitched panoramic image, resulting in enhanced clarity and detail.
* **AI-Based Human Figure Detection**: In addition to traditional edge detection methods, the application integrates an AI-based object detection model specifically designed to identify human figures within the panoramic image. This feature is particularly useful for applications such as landscape photography, where the presence of human subjects adds context and scale to the scene.
* **Interactive User Interface**: The user interface of the application is designed to be intuitive and user-friendly. Users can easily upload images, adjust parameters such as morphological operation size, and visualize the results in real-time. This interactive approach empowers users to fine-tune the output according to their preferences and artistic vision.
  1. **Proposed System Architecture**

The proposed system architecture comprises the following components:

* **User Interface (UI) Component**: The UI allows users to interact with the application, upload images, adjust parameters, and view the stitched panoramic image and edge detection results.
* **Image Selection and Stitching Module**: This module is responsible for selecting a group of images provided by the user and stitching them together to create a panoramic image. Advanced algorithms ensure accurate alignment and blending of images.
* **Edge Detection Implementation**: The edge detection module includes Canny Edge Detection, DoG edge detection with morphological operations, and an AI-based human figure detection algorithm. These techniques collectively enhance the visual quality and detail of the panoramic image.
* **Visualization Windows**: The application includes multiple visualization windows to display various stages of processing, including individual images, the stitched panoramic image, edge detection results, and detected human figures.

The system architecture utilizes HTML and CSS for the UI, Python for operational implementation, the OpenCV library for image stitching and edge detection, and the Flask library for executing Python code within the UI environment.

* + 1. **Formulation of Problem With using Technology**

The problem addressed by this project is to develop an advanced image stitching and edge detection system using cutting-edge technologies. This involves integrating sophisticated techniques such as Canny Edge Detection, Difference of Gaussians (DoG) with adjustable morphological operations, and an AI-based edge detector customized for human figure recognition. Additionally, the project utilizes HTML and CSS for creating the user interface, Python for executing essential operations, the OpenCV library for image merging and edge detection, and the Flask library to run Python code seamlessly on the user interface. Furthermore, the project employs the large SSD MobileNet V3 technology with the COCO dataset to achieve AI-based human object detection, enhancing the system's capabilities and performance.

* 1. **Organization of the Project**

The project will be organized into phases including requirement analysis, system design, implementation using Python and OpenCV, testing, and deployment using the Flask library. This structured approach ensures systematic development, testing, and delivery of a high-quality image processing application.

1. **Project Work Requirements**
   1. **Objectives**

The specific objectives of the project include:

* Enabling users to select and stitch a group of images into a single panoramic image.
* Implementing various edge detection techniques, including Canny Edge Detection, Difference of Gaussians (DoG) with adjustable morphological operations, and AI-based human figure recognition.
* Providing an intuitive user interface for uploading images, adjusting parameters for edge detection, and visually comparing the results of different techniques.
  1. **Image Selection and Stitching:**
* The project allows users to upload a group of images through the "Image Stitching" page (‘ **/image\_stitching** ' route).
* It checks if the uploaded files are valid image files and saves them to the specified upload folder.
* The uploaded images are then processed using the **‘ image\_stitch ‘** function from **‘ compVision.py ‘** , which stitches them together into a panoramic view using OpenCV's stitching algorithm ( **‘ cv2.Stitcher.create() ‘** ).
* The stitched panoramic image is displayed on the "Image Stitching" page for users to view ( **‘ image\_stitching.html ‘** ).
  1. **Edge Detection Implementation:**
* The project performs edge detection operations through the "Edge Detection" page (**‘ /edge\_detection ‘** route).
* It utilizes Canny Edge Detection and Difference of Gaussians (DoG) algorithms implemented in **‘ compVision.py ‘** ( **‘ canny\_image ‘** and **‘ DoG ‘** functions).
* Users can adjust the morphological operation's kernel size using a slider ( **‘ rangeInput ‘** ).
* The processed edge detection results (Canny, DoG, and morphological) are displayed on the "Edge Detection" page for visual comparison ( **‘ edge\_detection.html ‘**).
  1. **AI-Based Human Edge Detection:**
* The project includes AI-based human object detection functionality accessed via the "AI-based Object Detection" page ( **‘ /human\_object\_detection ‘** route).
* It utilizes an object detection model implemented in **‘ compVision.py ‘** ( **‘ ImgFile ‘** function) using OpenCV's DNN module and pre-trained weights.
* The model detects and marks human figures with bounding boxes on the stitched panoramic image.
* Detected human figures with confidence levels above 50% are displayed on the "AI-based Object Detection" page ( **‘ human\_object\_detection.html ‘** ).
  1. **User Interface (UI):**
* The project provides a user-friendly interface implemented using HTML, CSS, and Flask's templating system.
* The UI includes navigation links ( **‘ home ‘** , **‘ image\_stitching ‘** , **‘ edge\_detection ‘** , **‘ human\_object\_detection ‘)** for easy access to different functionalities.
* It allows users to upload images, adjust edge detection parameters, and view processed results dynamically.
* The UI components are structured in separate HTML templates ( **‘ base.html ‘** , **‘ home.html ‘** , **’ image\_stitching.html ‘** , **‘ edge\_detection.html ‘** , **‘ human\_object\_detection.html ‘**).
  1. **File Management and Security:**
* The project ensures secure file uploads and management using Flask's **‘secure\_filename ‘** function and configuration **‘(app.config['UPLOAD\_FOLDER'] ’** ).
* It implements file extension validation ( **‘ allowed\_file ‘** function) to restrict uploads to specified image formats (png, jpg, jpeg, gif).
  1. **Integration of Libraries and Frameworks:**
* The project integrates external libraries such as OpenCV ( **‘ cv2 ‘** ), Flask ( **‘ Flask ‘** , **‘ render\_template ‘** , **‘ request ’** , **‘ session ‘** ), and Werkzeug ( **‘ secure\_filename ‘** , **‘ utils ‘** ) for image processing, web development, and file handling functionalities.