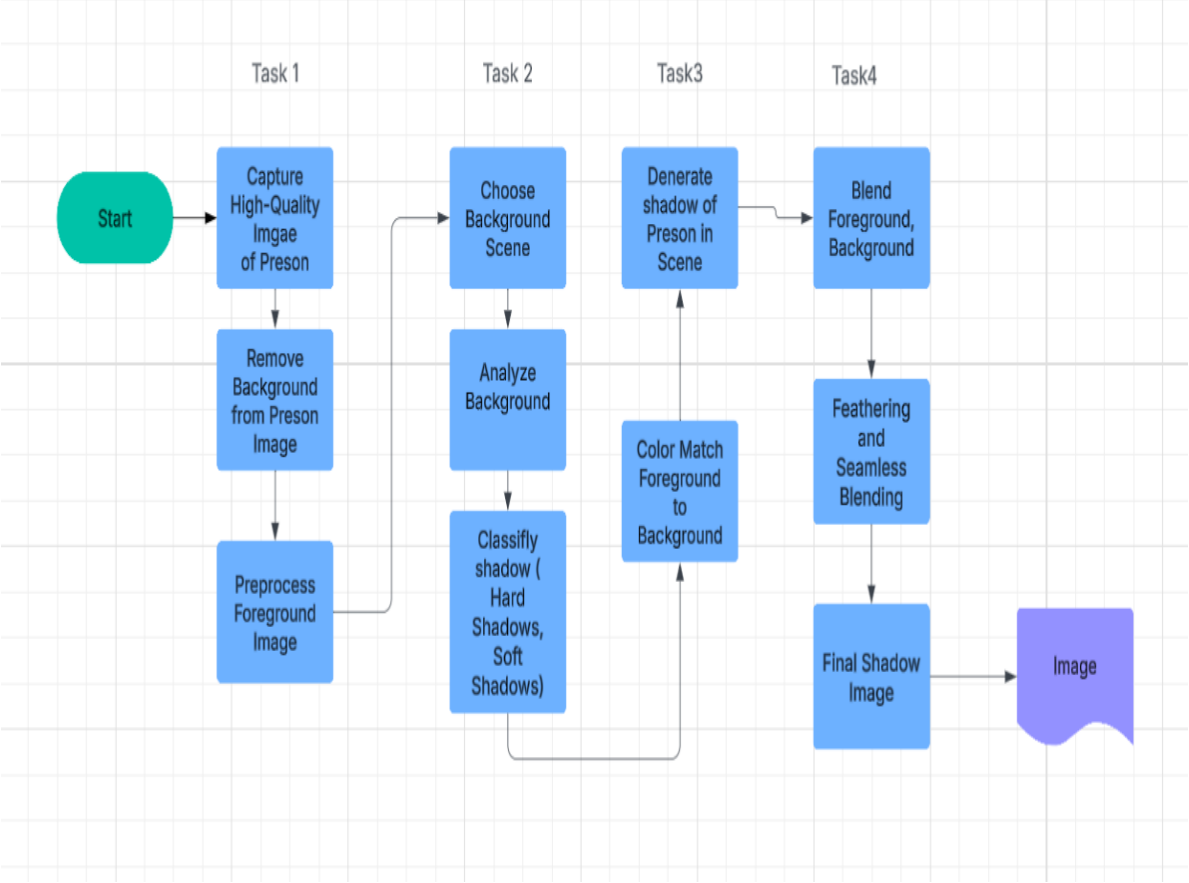
Seamlessly Integrating a Person into a Scene

Objective:- The objective of this assignment is to implement a step-by-step process to place a person into a given scene and seamlessly blend them to make the result look photo-realistic. You need to do the research and make a plan of action on how this can be achieved. A few of the steps have been provided, follow these steps. Some steps might be missing, add those steps to complete the Algorithm.

Flow Digram



Task1:-Capturing and Preparing the Person's Image

Step 1: Capture a High-Quality Image of the Person and Background

- DSLR or Mirrorless Camera (Best Quality).
- High-End Smartphone Camera.

Step 2: Remove the background and isolate the person.

- Tool used: rembg, remove.bg.
- The person is extracted using semantic segmentation (e.g., U^2-Net) to create a transparent PNG image.

- This removes distractions and isolates the foreground subject for blending.

Reason: I use multiple libraries, but rembg (U^2-Next) gives the best accuracy, and it gives fast results and is easy to use.

- Comparison with MODNet, Remove.bg, DeepLabV3+.

OutPut:-

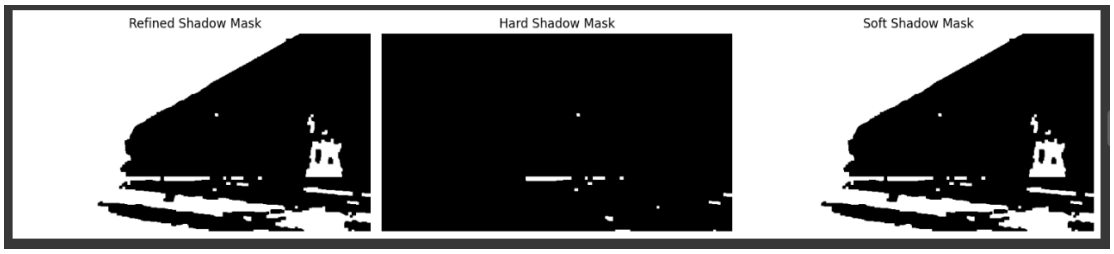
Background Image:-

<u>Task 2: Analyzing Shadows and Lighting in the Background Scene</u>

Step 1:Detect and Classify Shadows

- **Tool used**: OpenCV, NumPy, Matplotlib.
- Convert the background image to grayscale and apply thresholding or adaptive thresholding to extract shadow areas.
- Shadows are classified into:
    - **Hard Shadows** – high contrast, sharp edges.
    - **Soft Shadows** – low contrast, feathered/blurred edges.
- · Binary masks are generated for these detected shadows.

- **Output:-**



Task 3:Determining Light Direction

Step 1: Compute Light Direction for Outdoor Scenes

- Using shadows of objects in the background, compute the light direction vector by comparing the object's base and shadow tip.
- This direction (angle) helps in deciding where the person's shadow should be projected.

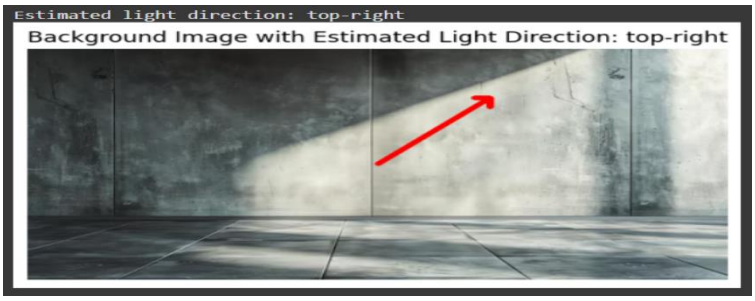
Step 2: Estimate Lighting for Indoor Scenes

- If no clear shadows exist, estimate light source based on bright areas (e.g., windows or lamps) using brightness gradients.
- Assumption: Indoor lighting is mostly soft and diffused; exact direction may be approximated.

Step 3: Depth and Perspective Matching

- **Purpose:**To ensure the person fits naturally into the background in terms of size, distance, and eye-level alignment.
- Estimate background perspective using vanishing points or depth maps (e.g., MiDaS).
- Resize and reposition the person to match the ground plane and surrounding objects.
- Avoid floating or oversized appearances.

OutPut:-



Task 4: Coloring and Blending

Step 1: Color Harmonization

- Tool: LAB color transfer (OpenCV)
- Match the average color and tone of the person with the background using statistical normalization.
- Align brightness, saturation, and contrast to avoid mismatched tones.

Step 2: Feathering and Seamless Blending

- Use Gaussian blur around the person's edges to avoid harsh cutouts.
- Apply multi-scale blending (Gaussian Pyramid) to soften transitions between foreground and background.
- Optionally apply histogram equalization or sharpening.

OutPut:-

Final Output Image in RGB

Tools and Libraries

Purpose	Tools / Libraries
Background Removal	rembg
Image Processing	OpenCV, NumPy, PIL
Shadow Detection	Thresholding, Contours, Morphology
Light Direction	Vector Estimation, Manual Annotation
Color Harmonization	LAB Color Space, Reinhard Transfer
Blending	Gaussian Pyramid, Alpha Compositing
Depth Estimation (Optional)	MiDaS, DPT, Segment Anything