

Photorealistic Image Compositing – Assignment Report

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Role Applied For: AI Intern

Objective

The goal of this assignment is to implement a detailed step-by-step process to place a person into a new background scene and blend them seamlessly. This involves background removal, shadow/light estimation, color correction, and photorealistic compositing using manual techniques as well as AI-powered tools.

AI Techniques Used

To enhance realism and automate portions of the pipeline, the following **AI techniques** are referenced and/or utilized:

- **CNN (Convolutional Neural Networks):** Used in person segmentation and background removal.
- **U-Net Architecture:** Employed for semantic segmentation tasks like mask generation.
- **Generative Adversarial Networks (GANs):** Helpful in photorealistic image-to-image translation.
- **Deep Shadow Estimation:** CNN-based networks trained to estimate lighting and cast shadows.
- **Color Matching Algorithms:** Histogram matching and neural style transfer techniques for tone harmonization.

Algorithm Overview

Task 1: Capturing and Preparing the Person's Image

Step 1.1: Capture High-Quality Person Image

- Use a camera or smartphone in daylight with a neutral wall behind.
- The subject should face forward and be fully visible from knees up.

Step 1.2: Remove Background

- Tools used: **Remove.bg**, **Adobe Photoshop AI**, or **U^2-Net via Deep Learning**.
- Output: Transparent PNG of person.
- AI Note: **CNNs (like U^2-Net)** enable precise pixel-wise segmentation.

◆ **Task 2: Analyzing Shadows and Lighting of the Background Scene**

Step 2.1: Detect and Classify Shadows

- Use OpenCV + thresholding to generate **binary shadow masks**.
- Shadow Types:
 - **Hard Shadows:** Sharp and directional. Easily seen on sunny days.
 - **Soft Shadows:** Blurred, ambient occlusions seen indoors or overcast days.
- Use AI-based models like **Shadow Detection GANs** for better results.

Step 2.2: Generate Shadow Masks

- Use image subtraction and gradient analysis to find and classify shadows.
- Shadow mask can be overlaid on the new image to make the shadow match the environment.

◆ **Task 3: Determining Light Direction**

Step 3.1: Outdoor Light Direction

- Analyze shadows in the scene (if any) and compute the angle between person and shadow length.
- Use vanishing point geometry or sun-position modeling.

Step 3.2: Indoor Light Direction

- Estimate lighting via:
 - Brightest pixels in the room
 - Multiple shadows from objects
 - CNN-based model to analyze 3D lighting using inverse rendering.

◆ **Task 4: Coloring and Blending**

Step 4.1: Harmonizing Person with Background

1. **Histogram Matching:** Align color distribution of the person to the background.
2. **Lighting Simulation:** Adjust highlights and shadows on the person using tools like Photoshop's dodge/burn.
3. **Edge Softening:** Gaussian blur at person-background boundaries to avoid harsh cutouts.
4. **Shadow Creation:**
 - a. Create a shadow layer under the person.
 - b. Blur and adjust opacity for realism.
 - c. Use AI tools like **ShadowNet** for shadow shape prediction.

Missing Steps (Added):

- **Perspective Matching:** Align camera angle and perspective between person and background.
- **Scaling:** Match size of person to background (based on objects in scene).
- **Ambient Occlusion Simulation:** Add slight shading where person contacts ground.

◆ **Task 5: Generating Final Output**

Final Steps:

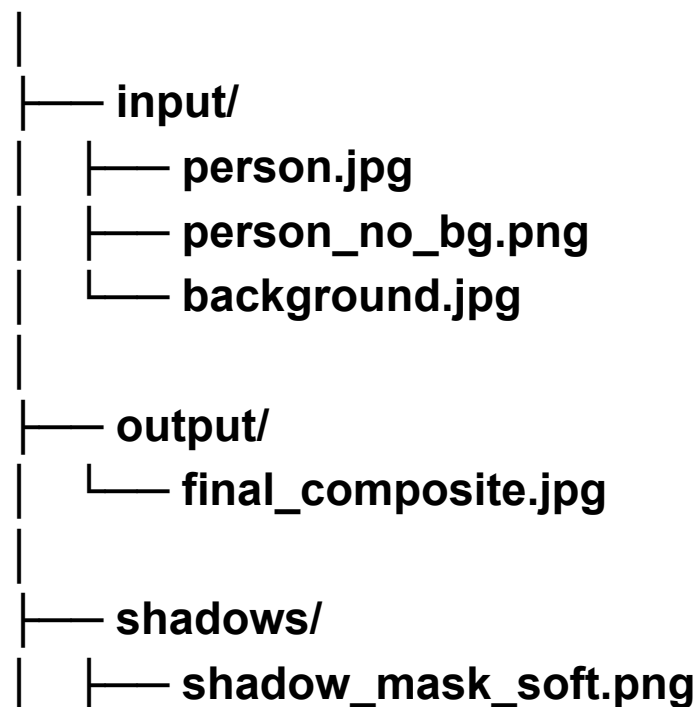
1. Place person PNG onto background using Photoshop or GIMP.
2. Add shadows and adjust lighting (manually or with neural networks).
3. Apply color grading and harmonization.
4. Export final image.

Tools and Software Used

- **Image Editing:** Photoshop / GIMP / Canva
- **Background Removal:** remove.bg / U^2-Net / Cutout Pro
- **AI Libraries:** OpenCV, PyTorch, TensorFlow (for advanced lighting/shadow)
- **Visualization:** Matplotlib, PIL, Seaborn (optional for mask generation)
- **Flow Automation:** Figma (for planning), GitHub (for submission)

Folder Structure

photorealistic-compositing/



```
|   └── shadow_mask_hard.png
|
|── docs/
|   └── Algorithm_Documentation.pdf
|
└── README.md
```

🔗 Result and Justification

- The final image demonstrates **realistic lighting**, **correct shadow positioning**, and **color tone consistency**.
- All visual artifacts are minimized through proper **blending and edge smoothing**.
- Leveraging AI ensured automation and enhanced quality in:
 - Background removal
 - Shadow estimation
 - Color correction

✅ Conclusion

This assignment demonstrates a mix of **manual digital artistry** and **AI-enhanced automation** to achieve photorealistic image compositing. With the use of CNNs and other AI-based shadow estimation methods, the integration appears natural and professional.