

Report

This report details my approach, methodology, assumptions, challenges, and the final output for matching icons from the Schedule and Room Plan PDFs. The goal was to accurately identify and count occurrences of icons using image processing techniques.

1. Approach and Methodology

Approach Overview: I developed the program using a systematic process:

- **PDF Conversion:** Used pdf2image to convert PDF pages into grayscale images.
- **Icon Extraction:** Employed thresholding and contour detection to isolate icons within the grayscale images, resizing them to a standard 64x64 pixels for consistency.
- **Preprocessing:** Applied histogram equalization and adaptive thresholding for feature enhancement and clarity.
- **Template Matching:** Utilized OpenCV's matchTemplate function to compare icons from the Schedule and Room Plan, setting a similarity threshold of 0.8.
- **Visualization:** A function visualized the processing steps for icons, assisting in identifying inconsistencies.

Methodology:

1. **Image Conversion:** Converted PDFs to images for high-quality output.
2. **Contour Detection:** Detected and extracted icon shapes using contours in thresholded images.
3. **Feature Enhancement:** Applied histogram equalization and adaptive thresholding for contrast and clarity.
4. **Template Matching:** Compared icons using matchTemplate, recording matches based on a similarity threshold.
5. **Visualization:** Displayed different processing stages for problematic icons for debugging.

2. Assumptions Made

- **Grayscale Sufficiency:** Assumed grayscale conversion was enough for icon detection, adjusted for varying contrast levels.
- **Uniform Icon Size:** Icons were resized to 64x64 pixels, assuming this size would be efficient and consistent.
- **Same Orientation:** Initially assumed icons were consistently oriented; later modified the approach to handle slight variations.
- **Image-Based Matching:** Assumed that icons would be graphical without associated text, focusing solely on image processing.

3. Challenges and Solutions

- **PDF Processing:** Initially used PyPDF2 for image extraction, which failed. Switching to pdf2image with poppler-utils resolved the issue.
- **Inconsistent Icon Extraction:** Early thresholding was ineffective. Adaptive thresholding dynamically adjusted based on pixel values, improving accuracy.
- **Template Matching Limitations:** Initial template matching was insufficient for varying icons. Switching to ORB (Oriented FAST and Rotated BRIEF) for feature-based matching improved results significantly.
- **Execution Speed:** Large icons caused delays. Resizing and keypoint-based matching (ORB) enhanced execution speed.
- **Zero Matches:** Some icons weren't detected due to variability. Edge detection and morphological operations (e.g., dilation, erosion) enhanced features, resolving the issue.

4. Explanation of the Code

PDF Conversion: The code uses the pdf2image library to convert each page of the PDF files (Schedule and Room Plan) into grayscale images. This step ensures that the icons are in a suitable format for image processing and subsequent analysis.

Grayscale and Contour Detection: Once converted, the images are transformed into grayscale to simplify the processing. The code then applies contour detection to identify and isolate individual icons within these grayscale images, effectively segmenting each icon for further processing.

Icon Preprocessing: To enhance the features of the extracted icons, the code applies histogram equalization, which improves contrast, and adaptive thresholding, which adjusts the brightness dynamically across different regions of the icon. These steps make the icon details clearer and more consistent for matching.

Template Matching: The preprocessed icons from the Schedule are compared to those in the Room Plan using OpenCV's cv2.matchTemplate function. The code evaluates the similarity between icons based on a defined threshold, identifying matches where the similarity exceeds this value. This helps determine how many times each icon appears in the Room Plan.