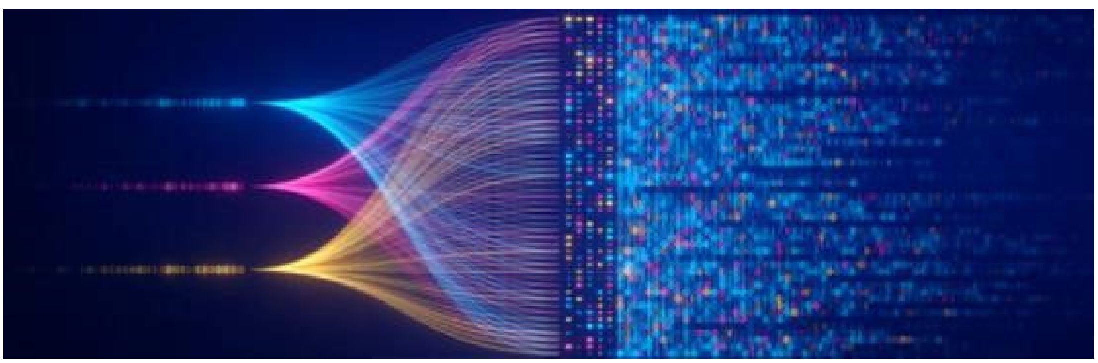

Generate Skeleton Mask of the Object in an Image

A COMPUTER VISION APPROACH TO OBJECT DETECTION

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ABSTRACT

Skeletonization is a fundamental process in image processing that reduces objects in a binary image to their skeletal structure while preserving their essential shape. This project focuses on extracting the skeleton mask of an object from an image using preprocessing, thresholding, and morphological operations. The skeleton representation is essential in shape analysis, pattern recognition, and feature extraction in computer vision applications. The study aims to explore the effectiveness of different image processing techniques to improve the accuracy and efficiency of skeletonization.

INTRODUCTION

Image processing techniques are widely used in various fields, including medical imaging, robotics, forensic analysis, and object recognition. One such technique, **skeletonization**, reduces an object in an image to a thin, connected representation while maintaining its structural properties. The skeleton mask provides essential shape information, making it highly valuable for applications such as handwriting recognition, fingerprint analysis, biomedical imaging, and biological structure analysis.

The process of skeletonization involves multiple steps, including image preprocessing, noise removal, and morphological operations, to obtain a thin and connected skeleton of the object. This report explores the approach to generating a skeleton mask using MATLAB and discusses its significance in real-world applications.

OBJECTIVES

The primary objectives of this project are:

1) To extract the skeletal structure of an object from an image.
2) To utilize morphological operations to remove noise and enhance the skeleton representation.
3) To compare different thresholding techniques to determine the most effective method.
4) To analyze the efficiency and accuracy of the skeletonization process.
5) To implement the process using MATLAB for practical application.
6) To explore real-world applications of skeletonization in different fields.
7) To discuss the limitations and possible improvements in skeletonization techniques.

Methodology

The methodology for this project consists of several key steps:

Image Acquisition

The process begins with selecting an image that contains the object of interest. The image can be in grayscale or color format.

Preprocessing

If the image is in RGB format, it is converted to grayscale.Contrast enhancement techniques may be applied to improve visibility.

Thresholding and Binarization

The grayscale image is converted to a binary image using Otsu's thresholding or a manually set threshold.

This step helps differentiate the object from the background.

Noise Removal

Morphological operations such as erosion and dilation are applied to remove small noise and unwanted regions.

Small connected components that are not part of the main object are eliminated.

Skeletonization

The binarized image is processed using morphological thinning operations to generate a skeleton.

This step ensures the object’s structure is reduced to a thin, connected representation while maintaining its shape.

Post-processing

Any unwanted branches or small fragments in the skeleton are removed using further morphological operations.

Result Analysis

The extracted skeleton mask is analyzed and compared with the original image to evaluate accuracy.

Application Testing

The generated skeleton mask is tested in different real-world scenarios to assess its effectiveness.

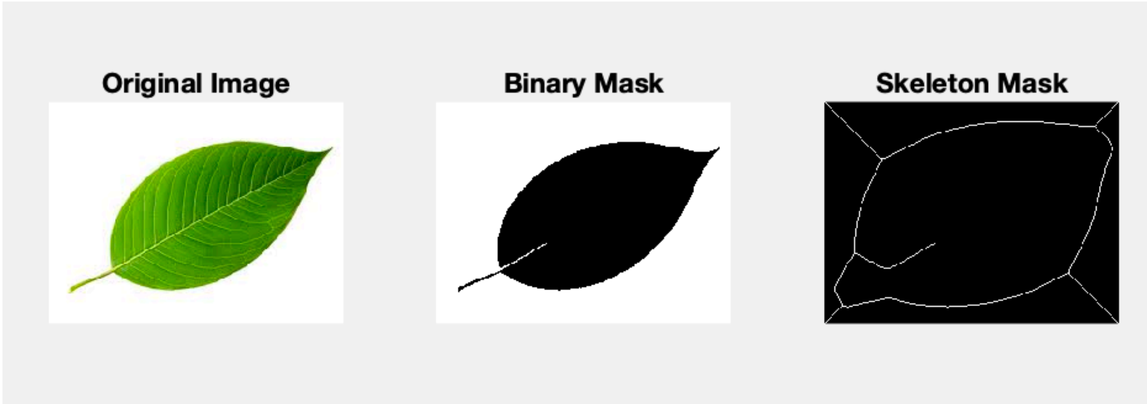
IMPLEMENTATION

Skeletonization is widely applied in various real-world fields, including:

1. **Medical Imaging**
    - Used to analyze blood vessel structures, bone structures, and tissue segmentation in radiology and pathology.
2. **Forensic Science**
    - Helps in fingerprint analysis, handwriting recognition, and crime investigation.
3. **Robotics and Artificial Intelligence**
    - Applied in robot navigation, pathfinding algorithms, and object recognition for autonomous systems.
4. **Manufacturing and Quality Control**
    - Used for defect detection in industrial automation and quality assurance processes.
5. **Agriculture and Plant Biology**
    - Assists in analyzing plant structures, root system studies, and leaf vein extraction for crop monitoring.
6. **Archaeology and Geology**
    - Helps in mapping ancient scripts, petroglyphs, and fossil structure identification.
7. **Traffic and Surveillance Systems**
    - Used for road network extraction and object tracking in intelligent transportation systems.

RESULTS AND OBSERVATIONS

- The skeleton mask successfully extracts the core structure of the object while maintaining its connectivity.
- Noise and small unwanted regions are effectively removed using preprocessing steps.
- The accuracy of skeleton extraction depends on the choice of thresholding method.
- Morphological operations ensure that the skeleton remains thin and connected.
- The extracted skeleton is useful for feature extraction, pattern recognition, and object shape analysis.
- The effectiveness of skeletonization varies based on the quality of the input image and the presence of noise.



CONCLUSION

This project successfully implemented a skeletonization technique for extracting the skeleton mask of an object in an image. The process involves image preprocessing, thresholding, and morphological operations to achieve an accurate skeletal representation. The results demonstrate the importance of image preprocessing in obtaining a clean skeleton output.

The study also highlights the various real-world applications of skeletonization, making it a valuable technique in numerous fields, including medical imaging, robotics, and forensic analysis. Future work can focus on improving the robustness of skeletonization by incorporating adaptive thresholding techniques, handling complex object shapes, and optimizing the algorithm for real-time applications.

MATLAB code

```matlab
% CMATLAB code for skeleton mast generation

clc; clear all; close all;

% Read the input image
img = imread('/Users/Admin/Documents/COLLEGE/leaf.jpeg');
% Convert to grayscale if needed
if size(img, 3) == 3
    img_gray = rgb2gray(img);
else
    img_gray = img;
end

% Convert to binary image using Otsu's thresholding
threshold = graythresh(img_gray);
bw = imbinarize(img_gray, threshold);

% Perform morphological operations to remove noise
bw_clean = bwareaopen(bw, 50); % Remove small objects

% Compute the skeleton of the binary image
skeleton = bwmorph(bw_clean, 'skel', Inf);

% Display results
figure;
subplot(1,3,1), imshow(img), title('Original Image');
subplot(1,3,2), imshow(bw_clean), title('Binary Mask');
subplot(1,3,3), imshow(skeleton), title('Skeleton Mask');

% Save the skeleton mask
imwrite(skeleton, 'skeleton_mask.png');
```

REFERENCES

MATLAB Documentation - Image Processing Toolbox.