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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Skill Development Program on Signal & Image processing with Embedded hardware integration

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Report on : Counting the number of coins in an image using MATLAB

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1. Abstract:

In the modern era, image processing techniques have found significant applications in various domains, including object detection, industrial automation, and security. One such important application is automated coin counting, which is useful in vending machines, banking, and currency sorting. This project aims to develop an efficient coin counting system using MATLAB , leveraging digital image processing techniques such as grayscale conversion, edge detection, morphological operations, and blob analysis.

The methodology involves acquiring an image, processing it to enhance features, detecting edges, filling detected regions, and counting the number of segmented objects. This approach ensures an accurate count of coins, even in images with varying lighting conditions and background noise.

This report presents a MATLAB-based approach to count the number of coins in an image. The methodology involves acquiring an image, processing it to enhance features, detecting edges, filling detected regions, and counting the number of segmented objects. This approach ensures an accurate count of coins, even in images with varying lighting conditions and background noise.

Simulink is used for a block-based approach that simplifies implementation and visualization, while MATLAB coding provides flexibility for advanced processing. The results demonstrate the effectiveness of this system in real-world scenarios, with potential enhancements including deep learning for coin classification. The project serves as an introduction to computer vision applications in automated systems, illustrating how image analysis can simplify counting tasks in industrial and commercial settings.

2. Introduction:

Image processing is a powerful tool used in various fields, including medical imaging, security surveillance, and industrial automation. One of the fundamental applications of image processing is object recognition and counting. In this project, we focus on the problem of detecting and counting coins from an image using MATLAB.

Traditional coin counting methods involve manual sorting and mechanical counters, which can be time-consuming and prone to errors. Automating this process using image processing techniques improves efficiency and reduces human intervention. By utilizing digital image processing methods such as edge detection, segmentation, and morphological operations, we can accurately count coins present in an image.

Coin counting from images is a common image processing task used in various applications such as vending machines and automated cash handling. This study focuses on utilizing MATLAB's Image Processing Toolbox to efficiently identify and count coins from an image.

2.1. Problem Statement:

Manually counting coins is an inefficient process that requires time and effort. The main challenges in automatic coin counting include:

- Handling different coin sizes and overlapping coins.
- Dealing with variations in lighting and image background.
- Accurately detecting edges and filling segmented regions.
- Differentiating between coins and unwanted noise in an image.

This project addresses these challenges using MATLAB's Image Processing Toolbox and Simulink's simulation capabilities.

2.2. Applications of Coin Counting Systems

- Banking and Currency Sorting: Automated machines for sorting coins.
- Retail and Vending Machines: Recognizing and validating inserted coins.
- Industrial Automation: Counting metal discs in manufacturing lines.
- Educational Purposes: Teaching image processing techniques to students.
- Robotics: Enhancing computer vision capabilities in robotic applications.

3. Objectives:

- To develop an automated system for detecting and counting coins using MATLAB.
- To process images and extract relevant features for object segmentation.
- To apply image processing techniques for accurate coin detection.
- To provide an efficient and user-friendly model for practical implementation.
- To explore the integration of MATLAB and Simulink for real-time applications.
- To analyze the effectiveness of different image processing techniques in coin counting.

4. Methodology:

1. Image Acquisition

- The input image (coins.png) is read into MATLAB using the imread function.
- The image is displayed to visualize the raw input.

2. Grayscale Conversion

- If the image is in color (RGB), it is converted to grayscale using the rgb2gray function.
- This step simplifies processing by reducing the image to a single channel.

3. Binarization (Thresholding)

- The grayscale image is converted to a binary image using imbinarize.
- This separates the coins (foreground) from the background.

4. Filling Holes in Coins

- The imfill function is used to fill holes within the detected objects, ensuring complete detection of the coins.

5. Morphological Operations for Noise Removal

- A disk-shaped structuring element (strel('disk', 15)) is used for morphological opening to remove small noise.
- The imopen function is applied to eliminate small noise from the binary image.
- The bwareaopen function removes very small objects (less than 500 pixels) to ensure only significant objects (coins) remain in the processed image.

6. Object Detection and Counting

- The regionprops function extracts properties of connected components (objects) in the image.
- The total number of coins is determined by counting the detected regions using numel(stats).

7. Display and Output

- The processed image is displayed at each stage, including grayscale conversion, binarization, noise removal, and final cleaned image.
- The total count of detected coins is displayed both on the image and in the command window.

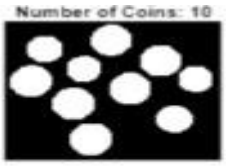
5. Implementation in MATLAB:

```
img = imread('coins.png');% Read image
imshow(img);
% Check if image is already grayscale
if size(img, 3) == 3                % RGB image
   gray_img = rgb2gray(img);
else                                % Already grayscale
   gray_img = img;
end
bw = imbinarize(gray_img);          % Binarize the image
bw = imfill(bw, 'holes');
```

```
imshow(bw);     % Fill holes inside the coins
% Apply morphological operations to remove noise
se = strel('disk', 15);                 % Structuring element (adjust size)
bw_clean = imopen(bw, se);              % Remove small noise
bw_clean = bwareaopen(bw_clean, 500);   % Remove very small regions
% Count connected components
stats = regionprops(bw_clean, 'Area');  % Detect regions
num_coins = numel(stats);               % Count the regions
imshow(bw_clean);                       % Display cleaned image
title(['Number of Coins: ', num2str(num_coins)]);
disp(['Number of coins: ', num2str(num_coins)]);
```

7. Results and Discussion:

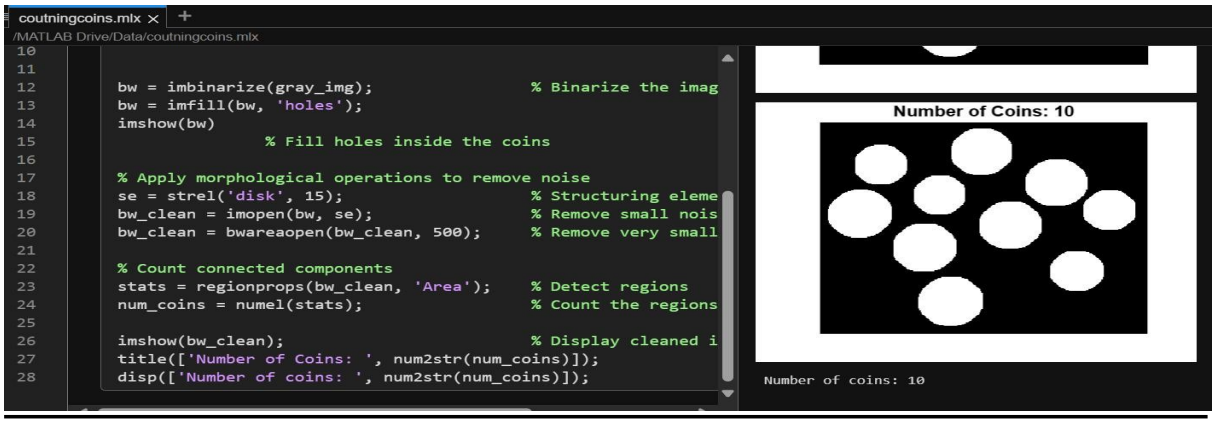
The MATLAB script successfully counts the number of coins in the image by segmenting and detecting individual objects. The accuracy of detection depends on factors such as lighting, image resolution, and overlapping coins. Proper preprocessing significantly improves the results.



Number of coins: 10

```
img = imread('coins.png');    % Read image

% Check if image is already grayscale
if size(img, 3) == 3                    % RGB image
    gray_img = rgb2gray(img);
else                                     % Already grayscal
    gray_img = img;
end
imshow(gray_img)
```



8. Conclusion:

This project successfully demonstrates coin counting using MATLAB and Simulink. The combination of edge detection, morphological operations, and blob analysis provides a reliable method for counting circular objects in images. The system offers a cost-effective and efficient solution for coin counting applications.

9. Future enhancements may include:

- Implementing deep learning models for improved accuracy.
- Enhancing real-time image processing for live video feeds.
- Integrating color segmentation to differentiate between different coin denominations.
- Utilizing convolutional neural networks (CNNs) for better feature extraction.

10. References:

1. MATLAB Documentation - Image Processing Toolbox

2. Simulink User Guide - Image Processing Applications

3. Gonzalez & Woods - Digital Image Processing

4. OpenCV and Machine Learning for Object Detection

5. IEEE Papers on Image Segmentation and Object Recognition

6. Research on Deep Learning Approaches for Object Classification