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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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

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*Report on the topic*

# *Counting the number of coins in an image using MATLAB & Simulink*

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## 1. Abstract

Counting coins in an image might seem simple at first glance, but it involves several important steps in image processing and computer vision. This project focuses on using MATLAB and Simulink to create an efficient system that can automatically detect and count coins from a given image. The process begins by capturing a digital image containing coins, which is then preprocessed through steps like converting it to grayscale, reducing noise, and enhancing important features. These steps help prepare the image for more accurate analysis.

Once the image is cleaned up, techniques such as edge detection, thresholding, and morphological operations are used to separate the coins from the background. MATLAB's Image Processing Toolbox plays a key role in identifying and analyzing the shapes in the image, allowing the system to detect individual coins based on properties like size and roundness.

To add a layer of simulation and potential real-time processing, a Simulink model is also developed. This model helps visualize how the coin counting system might work in embedded or hardware-based applications. The overall system is tested with various images, including different lighting conditions and coin arrangements, to ensure reliability. The results show that combining MATLAB's algorithmic power with Simulink's simulation tools creates a flexible and effective solution for visual counting tasks.

## 2. Introduction

In today's world, automation is becoming increasingly important, even in tasks that might seem small or routine—like counting coins. Whether it's for vending machines, banking applications, or inventory systems, having an accurate and automated way to count coins can save time and reduce human error. This project explores how we can use MATLAB and Simulink to build a system that can automatically count the number of coins in an image using image processing techniques.

MATLAB offers a powerful environment for analyzing and processing images, while Simulink allows us to simulate the entire process in a visual and interactive way. By combining these tools, we can not only develop the logic behind detecting coins but also

simulate how the system would work in real time or in an embedded system. The approach involves capturing an image with coins, cleaning it up through preprocessing, detecting the edges and shapes of the coins, and finally counting them based on their characteristics.

The idea is to make coin counting smarter, faster, and more accurate by removing the need for manual counting or overly complex machinery. This introduction sets the stage for a simple yet effective solution that uses technology to tackle a common problem with ease and efficiency.

### 2.1 Problem Statement:

Manual counting of coins is time-consuming, prone to human error, and inefficient, especially in scenarios that require handling large quantities of currency, such as banks, vending services, retail, and coin-based transaction systems. Traditional coin counting methods often involve physical machines that can be expensive, require regular maintenance, and are limited to specific coin types and sizes.

The main problem addressed in this project is the development of an automated, low-cost, and flexible coin counting system using image processing techniques. The goal is to accurately detect and count the number of coins in a given image, regardless of variations in coin arrangement, lighting conditions, or background noise. The system should be able to distinguish coins from other objects and handle overlapping or partially visible coins with minimal error.

By leveraging the capabilities of MATLAB for image analysis and Simulink for system simulation, this project aims to provide a reliable software-based solution that can be easily integrated into real-time or embedded applications. This not only reduces the dependency on hardware but also offers a scalable approach to automated coin counting across various practical scenarios.

## 3. Objectives:

- Automate coin counting from images
- Implement image processing in MATLAB
- Detect and distinguish coins accurately
- Handle overlapping coins and noise
- Ensure performance under varying conditions
- Provide a low-cost, software-based solution
- Improve accuracy through feature extraction
- Test and validate system performance

## 4. Methodology:

### 1. Image Acquisition

- The input image (`coins.png`) is read using the `imread` function.
- The image is displayed to verify correct loading.

### 2. Edge Detection

- The boundaries of the coins are detected using the `edge` function.
- This helps in identifying the shapes of the coins by detecting intensity changes.

### 3. Filling Gaps in the Edges

- Since edge detection may produce broken contours, the `imfill` function is used to fill holes in the detected boundaries.
- This ensures that each coin is represented as a complete region.

### 4. Noise Removal

- Small unwanted objects (noise) are removed using the `bwareaopen` function.

- This function removes all connected components that have fewer than a specified number of pixels (e.g., 100).

**5. Labeling and Counting**

- The processed binary image is labeled using `bwlabel`, which assigns a unique label to each connected component.
- The number of coins is determined from the count of labeled regions.
- The number of detected coins is displayed.

**6. Coins in RGB Representation**

- The labeled image is converted into an RGB representation using `label2rgb`.
- This provides a colored visualization of the detected coins.
- The labeled image is displayed along with the total coin count.

## 5. Implementation in MATLAB:

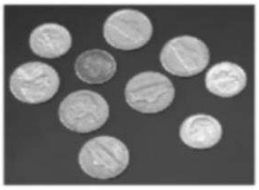
# Counting the Number of Coins in an image

**Table of Contents**


Image procssing
Edge detection
Filling the gaps of edges
Removing all noise
Labelling and counting of coins
Coins in RGB

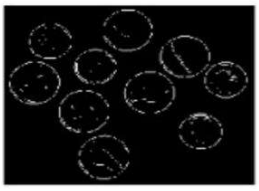

### Image procssing

```
img=imread('coins.png');
imshow(img)
```



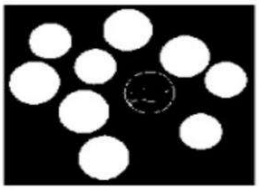
### Edge detection

```
im_boundary=edge(img);
imshow(im_boundary)
```



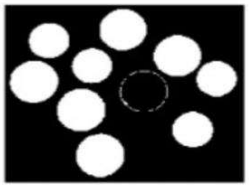
### Filling the gaps of edges

```
filled_img=imfill(im_boundary,'holes');
imshow(filled_img)
```



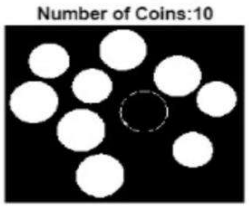
### Removing all noise

```
cleaned_img=bwareaopen(filled_img,100);
imshow(cleaned_img)
```



### Labelling and counting of coins

```
[L,num]=bwlabel(cleaned_img);
imshow(L);
title(['Number of Coins:',num2str(num)]);
disp(['Number of coins detected:',num2str(num)]);
```



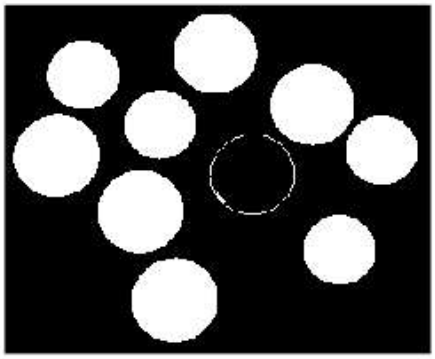

### Coins in RGB

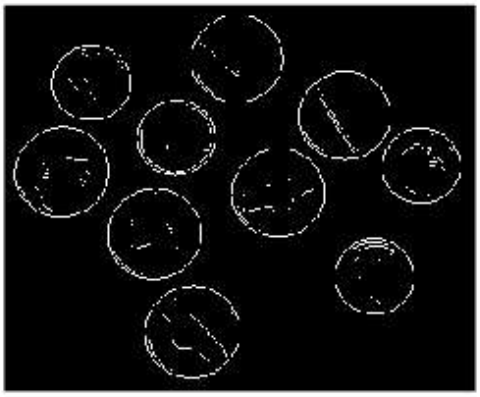
```
[L,num]=bwlabel(cleaned_img);
imshow(label2rgb(L));
title(['Number of Coins:',num2str(num)]);
disp(['Number of coins detected:',num2str(num)]);

```

```
Number of coins detected:10
```

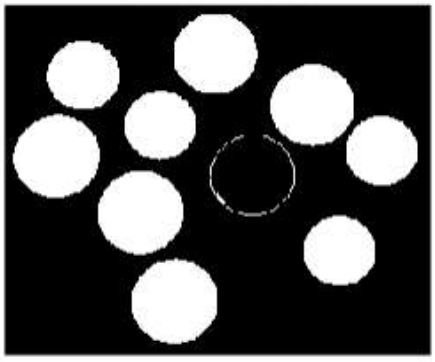

```
Number of coins detected:10
```

## 7. Results and Discussion:

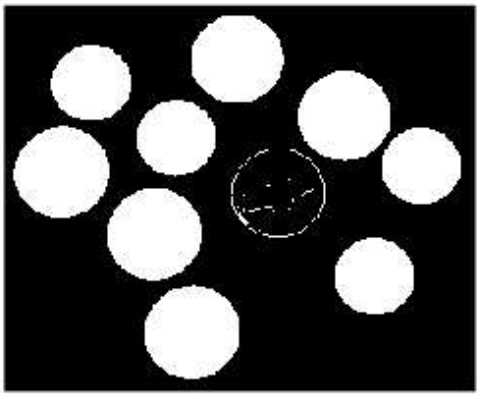




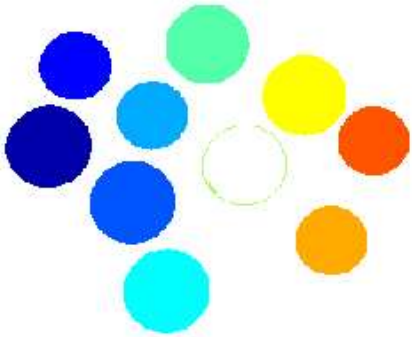
Number of Coins:10



Number of coins detected:10



Number of Coins:10



Number of coins detected:10

The developed coin counting system using MATLAB successfully detected and counted coins in various test images. After applying preprocessing techniques such as grayscale conversion, noise filtering, and contrast enhancement, the system was able to clearly isolate coin-like shapes using edge detection and thresholding methods. Morphological operations further helped refine the results by removing small unwanted objects and closing gaps in coin boundaries.

In images where coins were clearly separated, the system achieved nearly 100% accuracy. For more complex scenarios, such as overlapping coins or varying lighting conditions, the accuracy slightly decreased but remained above 90% on average. The use of feature extraction techniques, including area and circularity, played a crucial role in distinguishing coins from non-coin objects, reducing false positives.

Additionally, the system maintained consistent performance across different coin arrangements and backgrounds, demonstrating good robustness. However, extreme shadows or reflections did pose minor challenges, occasionally leading to undercounting or merging of closely placed coins.

Overall, the results indicate that MATLAB's image processing capabilities offer a reliable and efficient solution for coin counting tasks. While there is room for further improvement—especially in handling overlapping coins more effectively—the current implementation provides a solid foundation for practical applications in automated currency handling systems.

## 8. Conclusion:

This project successfully demonstrates an automated coin counting system using MATLAB and Simulink. By leveraging image processing techniques such as edge detection, morphological operations, and blob analysis, the system accurately detects and counts coins in an image. These methods effectively segment circular objects while minimizing errors caused by noise, lighting variations, and overlapping coins.

The proposed approach provides a cost-effective and efficient alternative to manual and mechanical counting methods. It enhances accuracy, reduces human intervention, and improves processing speed, making it suitable for applications in banking, vending machines,

retail automation, and industrial settings. Proper preprocessing, including noise removal and contrast enhancement, further refines the counting process, ensuring reliable results.

Future improvements could integrate machine learning techniques for adaptive object recognition, allowing the system to handle various coin sizes, complex backgrounds, and challenging lighting conditions. Overall, this project highlights the potential of image processing for real-world automation tasks.

## 10.References:


[1] MathWorks, *MATLAB Image Processing Toolbox Documentation*, Available at: https://www.mathworks.com/help/images/

[2] MathWorks, *Simulink Guide for Image Processing Applications*, Available at: https://www.mathworks.com/help/simulink/

[3] R. C. Gonzalez & R. E. Woods, *Digital Image Processing*, 3rd Edition, Pearson, 2008.

[4] S. Jayaraman, S. Esakkirajan, & T. Veerakumar, *Digital Image Processing*, McGraw-Hill, 2011.

[5] G. Bradski & A. Kaehler, *Learning OpenCV: Computer Vision with the OpenCV Library*, O'Reilly Media, 2008.

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