

**GLASGOW CALEDONIAN UNIVERSITY**

MEng Group Research Project

MMH723842-24-AB-GLAS

**Design and implementation of a PSD-Based  
Analogue 2D Sun Sensor**

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Date: April 6, 2025

# Contents

<b>Abstract</b>	<b>5</b>
<b>1 Introduction</b>	<b>6</b>
<b>2 LiteratureReview</b>	<b>7</b>
<b>3 Methodology</b>	<b>8</b>
3.1 System Design Overview . . . . .	8
3.1.1 Functional Requirements . . . . .	9
3.1.2 Design Approach . . . . .	9
3.1.3 System Architecture . . . . .	9
3.2 Sensor Array Development . . . . .	9
3.2.1 Functional Requirements . . . . .	10
3.2.2 Design Approach . . . . .	10
3.2.3 System Architecture . . . . .	10
3.3 Signal Conditioning Circuitry . . . . .	10
3.3.1 Functional Requirements . . . . .	12
3.3.2 Design Approach . . . . .	12
3.3.3 System Architecture . . . . .	12
3.4 Enclosure Design And Fabrication . . . . .	12
3.4.1 Functional Requirements . . . . .	13
3.4.2 Design Approach . . . . .	13
3.4.3 System Architecture . . . . .	13
3.5 Data Acquisition System . . . . .	13
3.5.1 Functional Requirements . . . . .	15
3.5.2 Design Approach . . . . .	15
3.5.3 System Architecture . . . . .	15
3.6 Testing Apparatus . . . . .	15
3.6.1 Functional Requirements . . . . .	16
3.6.2 Design Approach . . . . .	16
3.6.3 System Architecture . . . . .	16

3.7	Prototype Development Lifecycle . . . . .	16
3.7.1	Functional Requirements . . . . .	18
3.7.2	Design Approach . . . . .	18
3.7.3	System Architecture . . . . .	18
<b>4</b>	<b>Results</b>	<b>19</b>
4.1	Sensor Characterization . . . . .	19
4.1.1	Functional Requirements . . . . .	20
4.1.2	Design Approach . . . . .	20
4.1.3	System Architecture . . . . .	20
4.2	Amplification Performance . . . . .	20
4.2.1	Functional Requirements . . . . .	22
4.2.2	Design Approach . . . . .	22
4.2.3	System Architecture . . . . .	22
4.3	Photodiode Angular Response . . . . .	22
4.3.1	Functional Requirements . . . . .	23
4.3.2	Design Approach . . . . .	23
4.3.3	System Architecture . . . . .	23
4.4	Enclosure Effectiveness . . . . .	23
4.4.1	Functional Requirements . . . . .	25
4.4.2	Design Approach . . . . .	25
4.4.3	System Architecture . . . . .	25
4.5	Data Acquisition System Evaluation . . . . .	25
4.5.1	Functional Requirements . . . . .	26
4.5.2	Design Approach . . . . .	26
4.5.3	System Architecture . . . . .	26
4.6	System Performance Analysis . . . . .	27
4.6.1	Operational Constraints Identified . . . . .	27
4.6.2	Environmental Factors Impact . . . . .	27
4.6.3	System Stability and Repeatability . . . . .	27
4.6.4	Recommendations for Improvement . . . . .	27
4.7	Comparative Analysis . . . . .	27
4.7.1	Breadboard vs. Stepboard Results . . . . .	28
4.7.2	Iteration Improvements Analysis . . . . .	28
4.7.3	Performance Against Design Requirements . . . . .	28
4.7.4	Design Evolution Assessment . . . . .	28
4.8	System Limitations And Considerations . . . . .	28
4.8.1	Functional Requirements . . . . .	29
4.8.2	Design Approach . . . . .	29

4.8.3	System Architecture . . . . .	29
<b>5</b>	<b>Conclusions</b>	<b>32</b>
	<b>Bibliography</b>	<b>32</b>

# List of Figures

3.1	System Design Overview Flowchart . . . . .	8
3.2	System Architecture Diagram . . . . .	9
3.3	System Design Overview Flowchart . . . . .	10
3.4	System Architecture Diagram . . . . .	11
3.5	System Design Overview Flowchart . . . . .	11
3.6	System Architecture Diagram . . . . .	12
3.7	System Design Overview Flowchart . . . . .	13
3.8	System Architecture Diagram . . . . .	14
3.9	System Design Overview Flowchart . . . . .	14
3.10	System Architecture Diagram . . . . .	15
3.11	System Design Overview Flowchart . . . . .	16
3.12	System Architecture Diagram . . . . .	17
3.13	System Design Overview Flowchart . . . . .	17
3.14	System Architecture Diagram . . . . .	18
4.1	System Design Overview Flowchart . . . . .	20
4.2	System Architecture Diagram . . . . .	21
4.3	System Design Overview Flowchart . . . . .	21
4.4	System Architecture Diagram . . . . .	22
4.5	System Design Overview Flowchart . . . . .	23
4.6	System Architecture Diagram . . . . .	24
4.7	System Design Overview Flowchart . . . . .	24
4.8	System Architecture Diagram . . . . .	25
4.9	System Design Overview Flowchart . . . . .	26
4.10	System Architecture Diagram . . . . .	27
4.11	Environmental Testing Results . . . . .	27
4.14	System Design Overview Flowchart . . . . .	28
4.12	Overall System Performance Analysis . . . . .	30
4.13	Prototype Iteration Comparison . . . . .	31
4.15	System Architecture Diagram . . . . .	31

# Abstract

add abstract here

# 1. Introduction

Write intro here [1]

## 2. LiteratureReview



## 3. Methodology

### 3.1 System Design Overview

This section provides an overview of the System Design Overview.

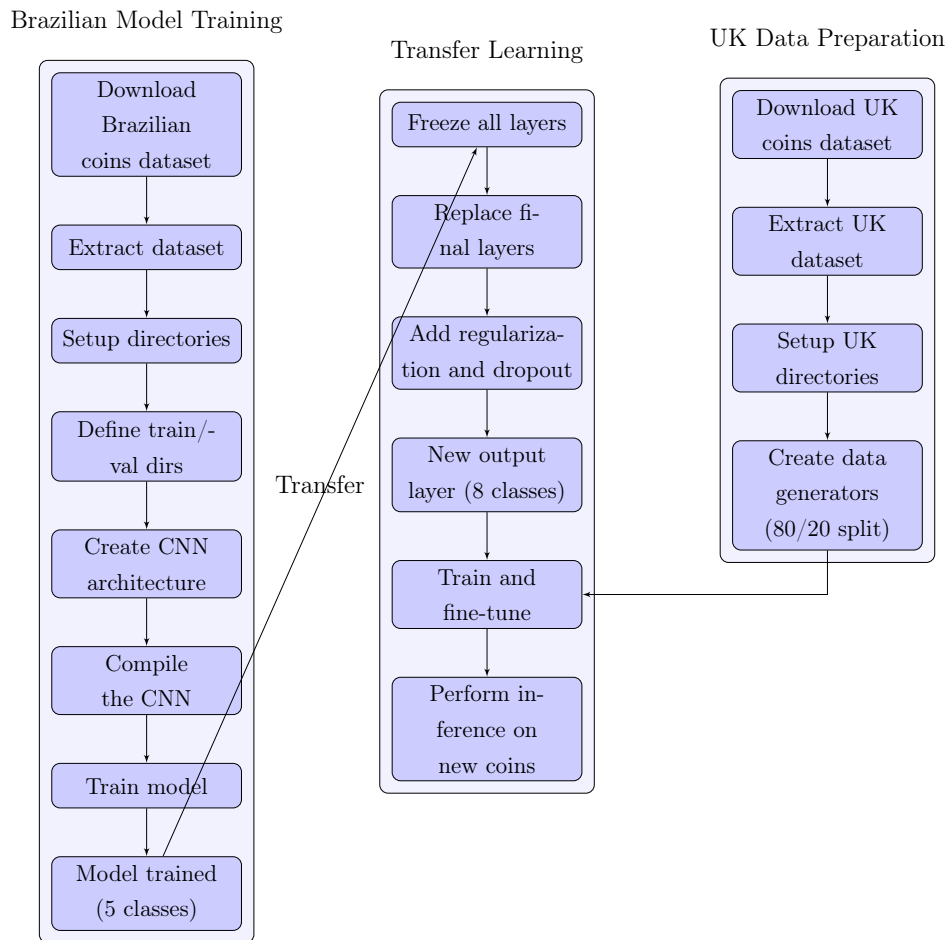


Figure 3.1: System Design Overview Flowchart

### 3.1.1 Functional Requirements

### 3.1.2 Design Approach

### 3.1.3 System Architecture

As shown in Figure 3.1 the system architecture consists of various components.

```
1 # Your code here
```

Listing 3.1: System Architecture Code Example

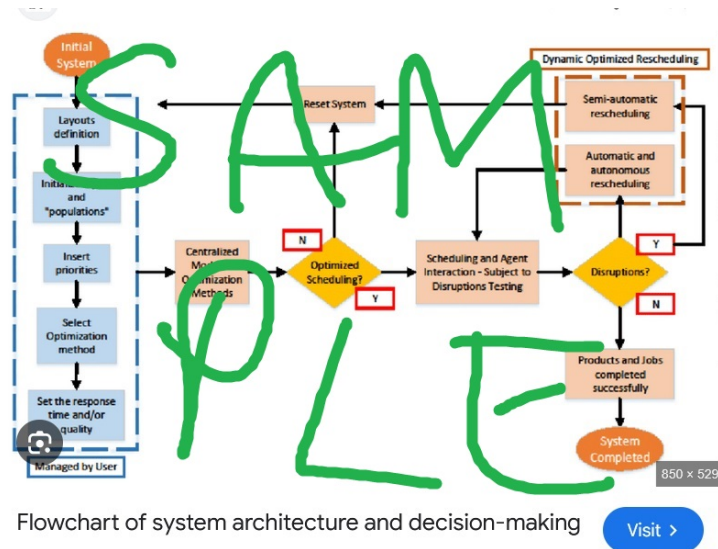


Figure 3.2: System Architecture Diagram

## 3.2 Sensor Array Development

This section provides an overview of the Sensor Array Development.

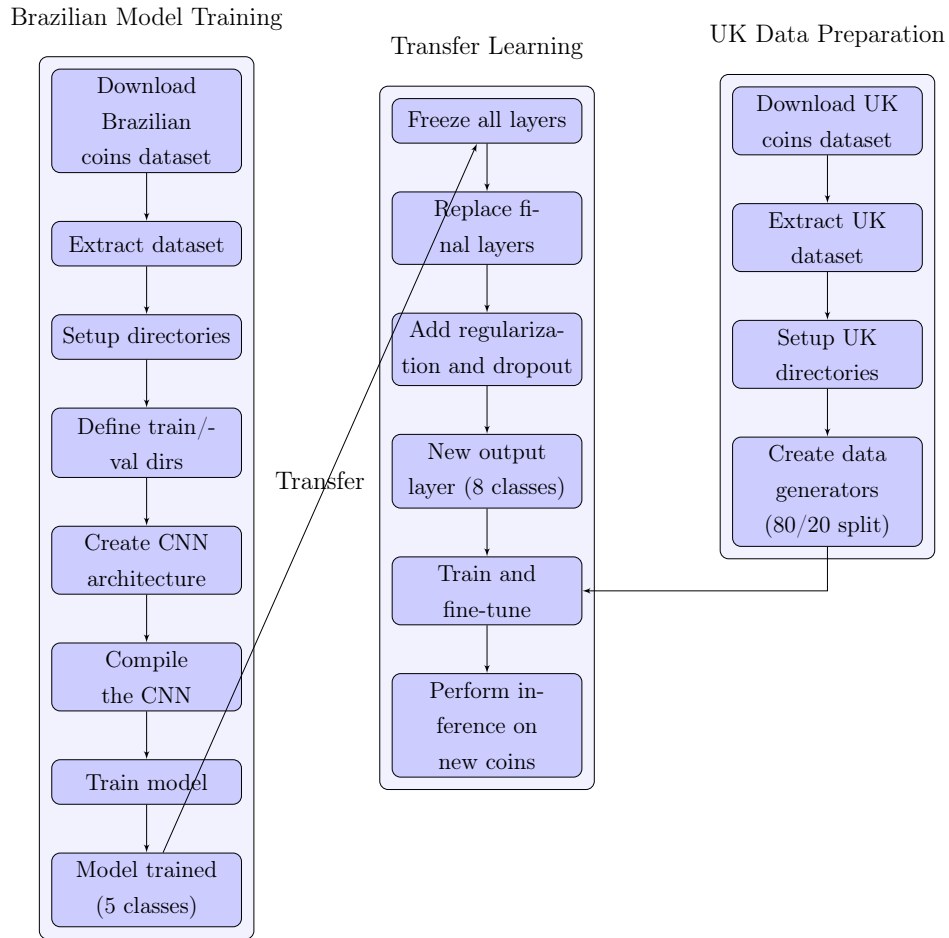


Figure 3.3: System Design Overview Flowchart

### 3.2.1 Functional Requirements

### 3.2.2 Design Approach

### 3.2.3 System Architecture

As shown in Figure 3.3 the system architecture consists of various components.

```
1 # Your code here
```

Listing 3.2: System Architecture Code Example

## 3.3 Signal Conditioning Circuitry

This section provides an overview of the Signal Conditioning Circuitry.

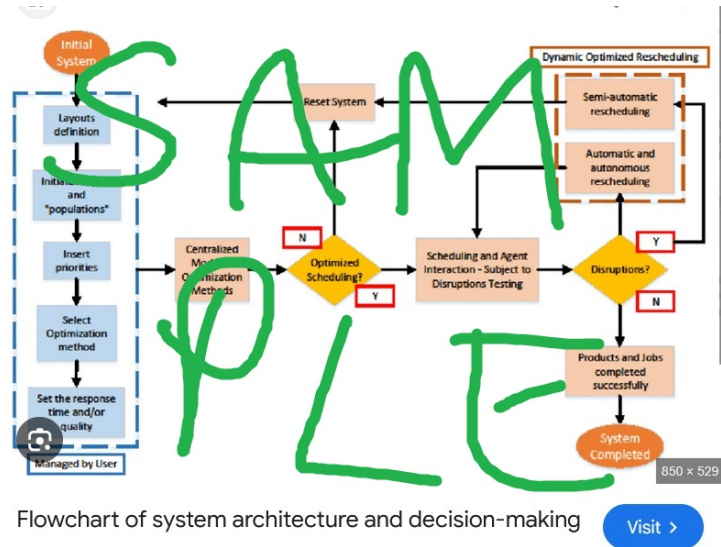
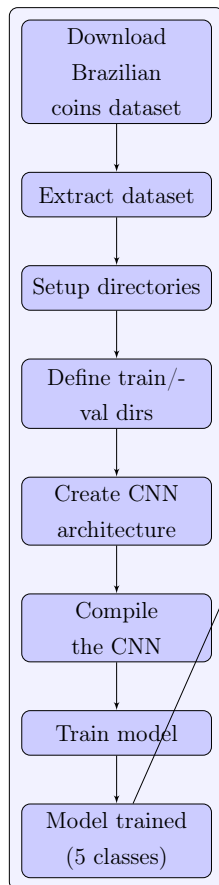
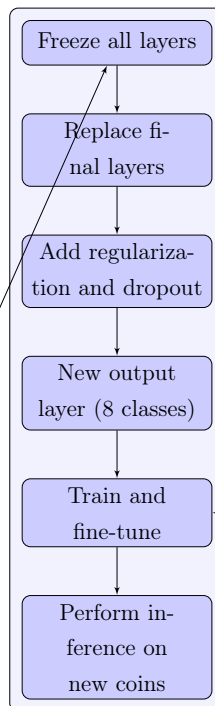


Figure 3.4: System Architecture Diagram

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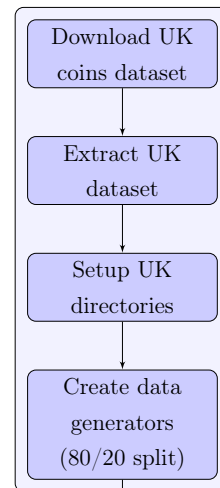


Figure 3.5: System Design Overview Flowchart

### 3.3.1 Functional Requirements

### 3.3.2 Design Approach

### 3.3.3 System Architecture

As shown in Figure 3.5 the system architecture consists of various components.

```
1 # Your code here
```

Listing 3.3: System Architecture Code Example

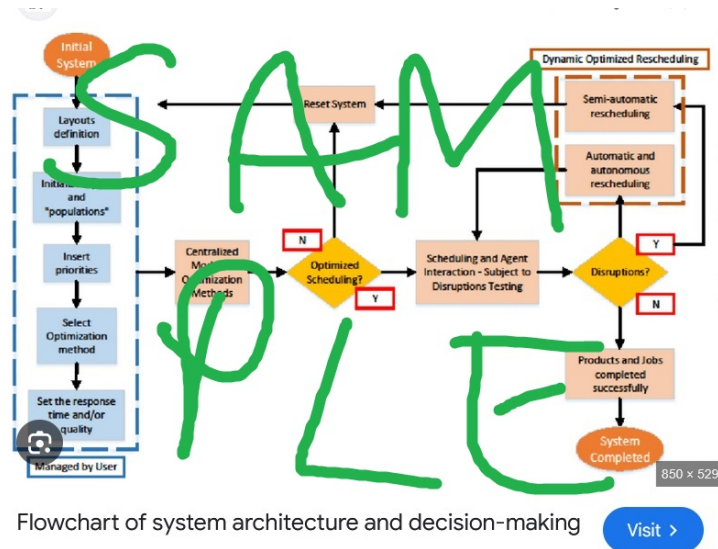


Figure 3.6: System Architecture Diagram

## 3.4 Enclosure Design And Fabrication

This section provides an overview of the Enclosure Design And Fabrication.

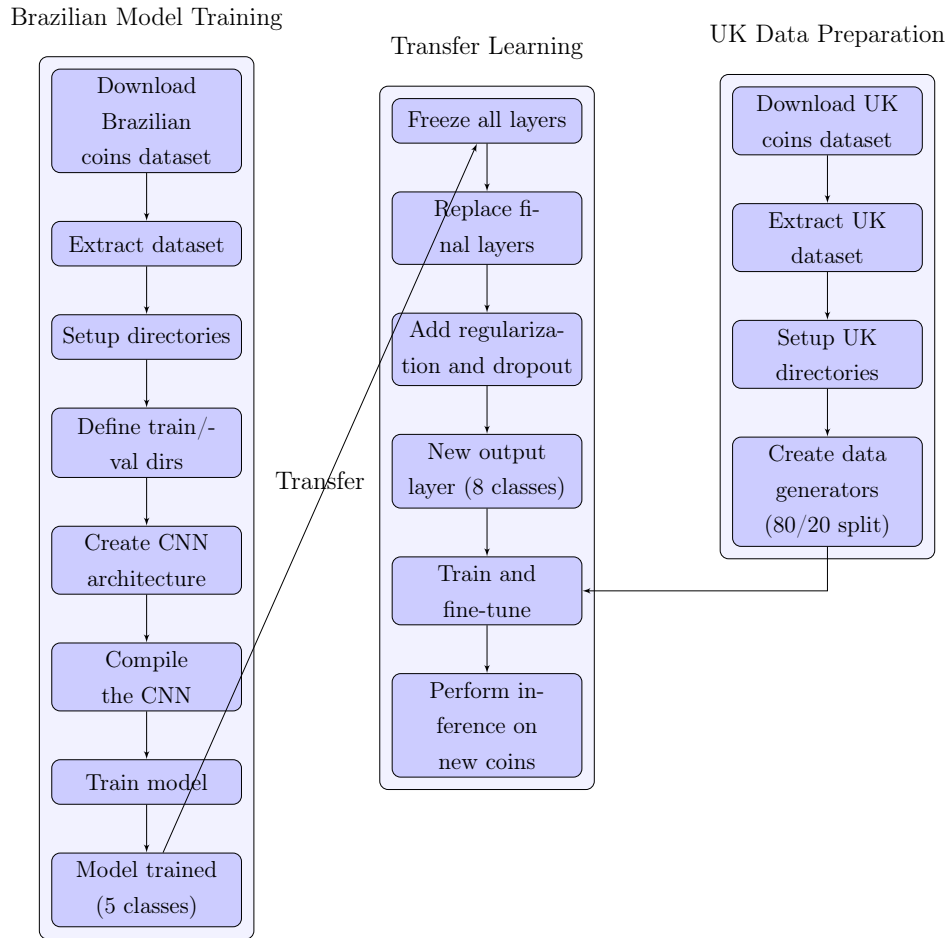


Figure 3.7: System Design Overview Flowchart

### 3.4.1 Functional Requirements

### 3.4.2 Design Approach

### 3.4.3 System Architecture

As shown in Figure 3.7 the system architecture consists of various components.

```
1 # Your code here
```

Listing 3.4: System Architecture Code Example

## 3.5 Data Acquisition System

This section provides an overview of the Data Acquisition System.

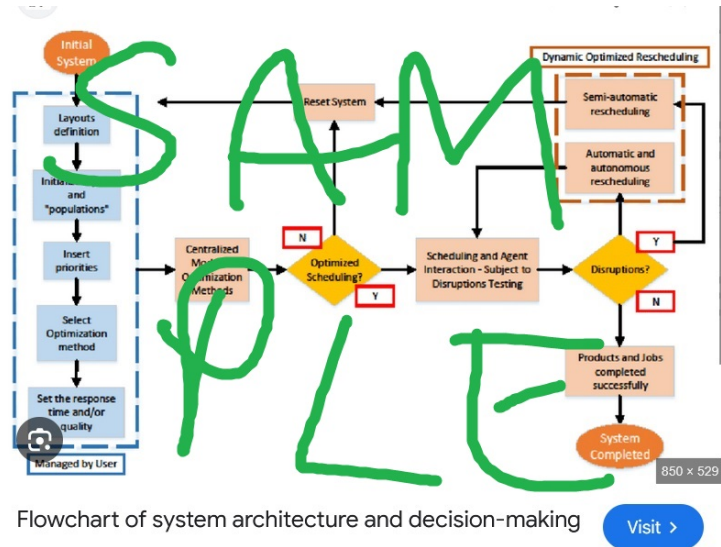
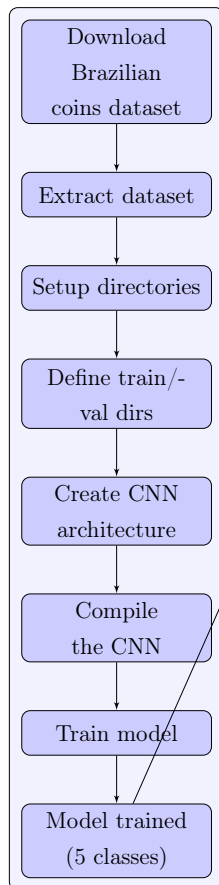
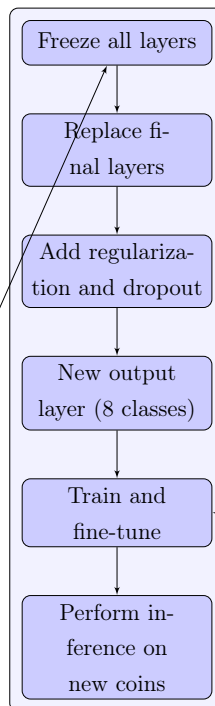


Figure 3.8: System Architecture Diagram

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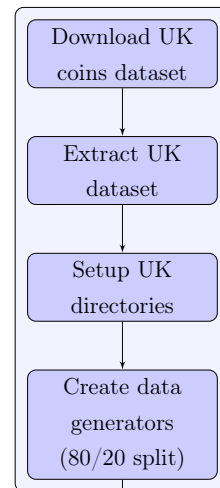


Figure 3.9: System Design Overview Flowchart

### 3.5.1 Functional Requirements

### 3.5.2 Design Approach

### 3.5.3 System Architecture

As shown in Figure 3.9 the system architecture consists of various components.

```
1 # Your code here
```

Listing 3.5: System Architecture Code Example

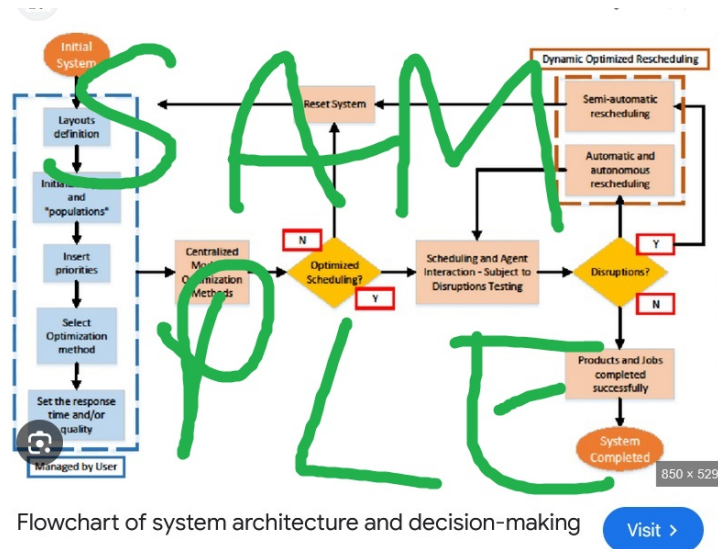


Figure 3.10: System Architecture Diagram

## 3.6 Testing Apparatus

This section provides an overview of the Testing Apparatus.



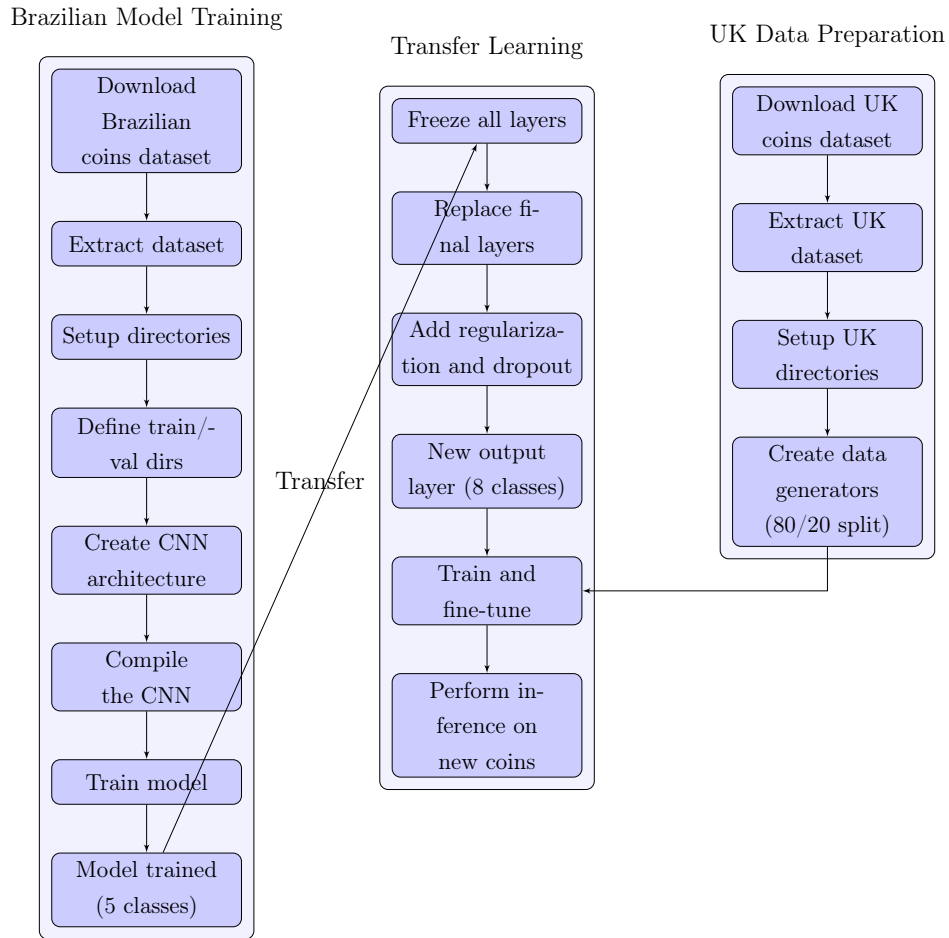


Figure 3.11: System Design Overview Flowchart

### 3.6.1 Functional Requirements

### 3.6.2 Design Approach

### 3.6.3 System Architecture

As shown in Figure 3.11 the system architecture consists of various components.

```
1 # Your code here
```

Listing 3.6: System Architecture Code Example

## 3.7 Prototype Development Lifecycle

This section provides an overview of the Prototype Development Lifecycle.

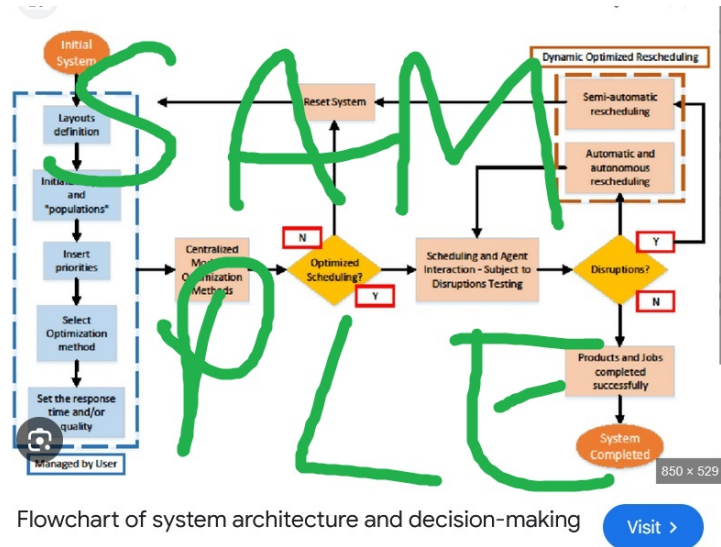
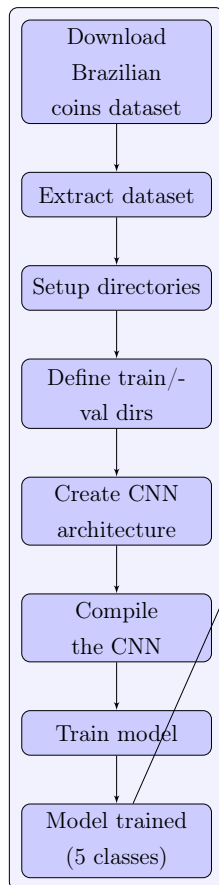
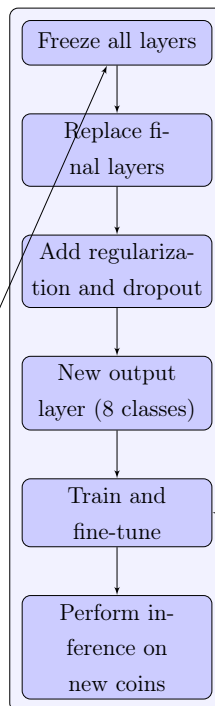


Figure 3.12: System Architecture Diagram

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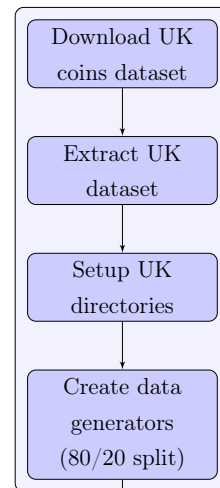


Figure 3.13: System Design Overview Flowchart

### 3.7.1 Functional Requirements

### 3.7.2 Design Approach

### 3.7.3 System Architecture

As shown in Figure 3.13 the system architecture consists of various components.

```
1 # Your code here
```

Listing 3.7: System Architecture Code Example

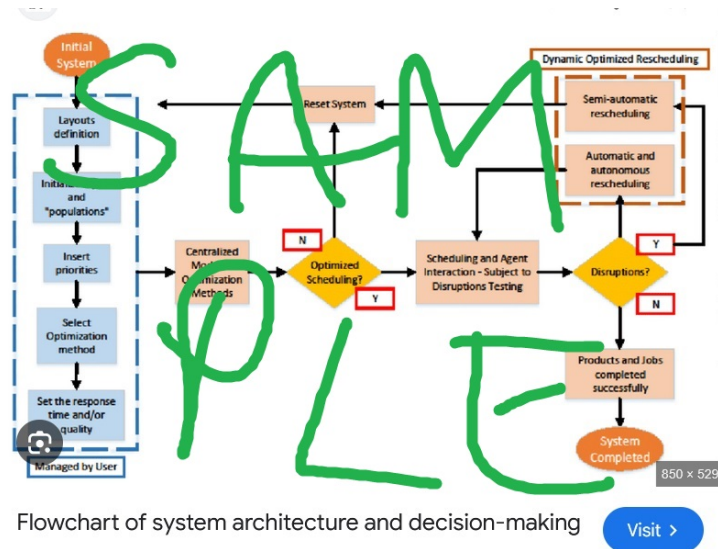


Figure 3.14: System Architecture Diagram

## 4. Results

### 4.1 Sensor Characterization

For the SensorCharacterization.tex file, you'd want to focus on the fundamental properties and performance of your photodiodes themselves, distinct from the other subsections. Here are some key elements that would belong specifically under SensorCharacterization:

- Basic Photodiode Electrical Characteristics:

- Dark current measurements
  - Junction capacitance
  - I-V characteristics in different lighting conditions
  - Spectral response profiles (sensitivity vs. wavelength)

- Individual Sensor Benchmarking:

- Performance comparison between the 4 photodiodes (matching/differences)
  - Responsivity measurements (A/W)
  - Quantum efficiency calculations
  - Detection threshold levels

- Response Linearity:

- Measurements showing linear range of the photodiodes
  - Saturation point characterization
  - Recovery time from saturation

- Temperature Dependency:

- Performance drift with temperature
  - Baseline shift measurements
  - Temperature compensation data

- Aging/Stability Tests:

- Long-term drift measurements
  - Repeatability of measurements over time

This section should focus on the inherent properties of the photodiodes themselves - essentially providing the baseline characterization data that underpins all the other analysis. The other sections then build on this foundation by examining how these sensors perform when integrated into the complete system with amplification, angular positioning, enclosure effects, etc.

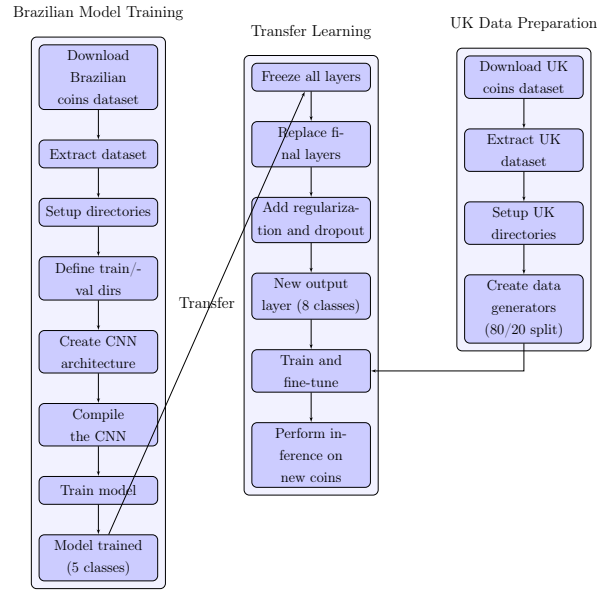


Figure 4.1: System Design Overview Flowchart

### 4.1.1 Functional Requirements

### 4.1.2 Design Approach

### 4.1.3 System Architecture

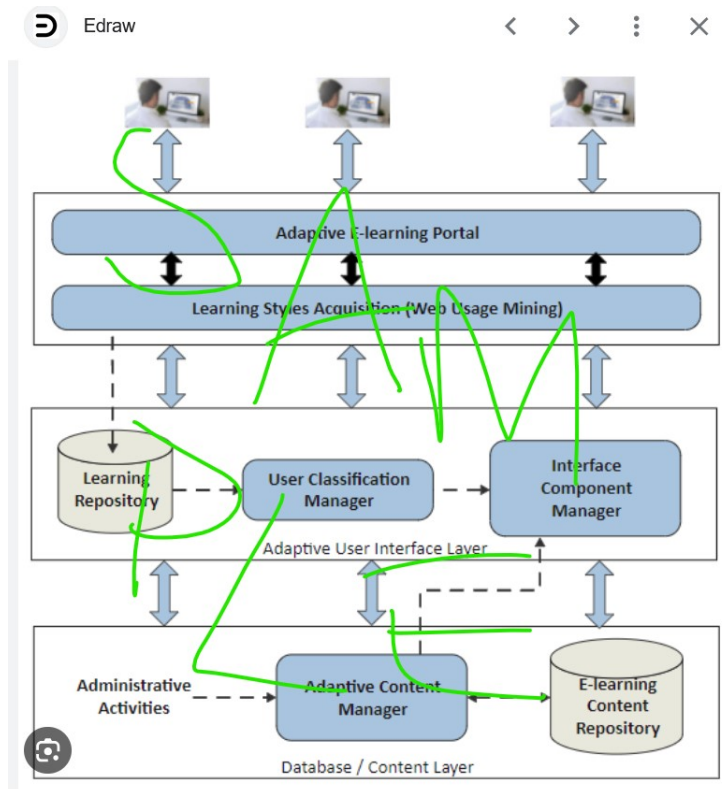
As shown in Figure 4.1 the system architecture consists of various components.

```
1 # Your code here
```

Listing 4.1: System Architecture Code Example

## 4.2 Amplification Performance

This section provides results of the amplifier performance.



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Figure 4.2: System Architecture Diagram

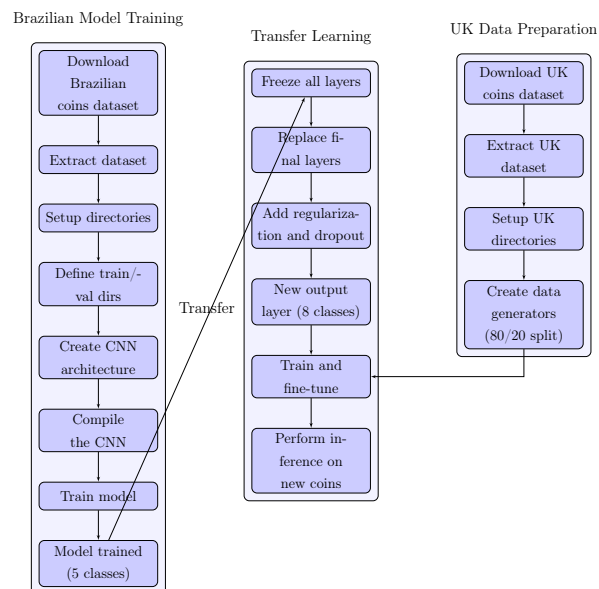


Figure 4.3: System Design Overview Flowchart

### 4.2.1 Functional Requirements

### 4.2.2 Design Approach

### 4.2.3 System Architecture

As shown in Figure 4.3 the system architecture consists of various components.

```
1 # Your code here
```

Listing 4.2: System Architecture Code Example

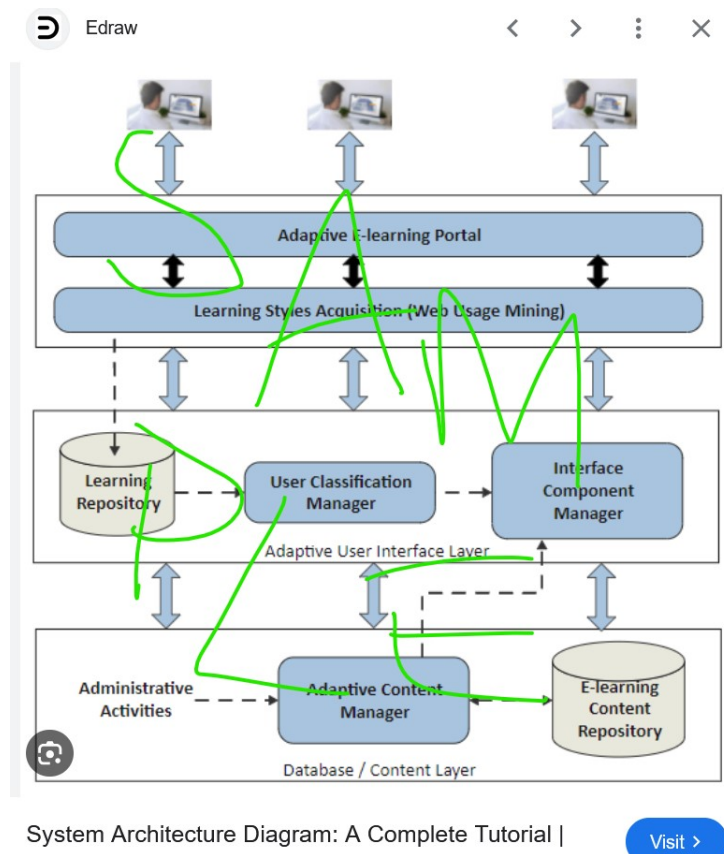


Figure 4.4: System Architecture Diagram

## 4.3 Photodiode Angular Response

This section discusses the results of the response of the solar sensor to angular changes of the light source.



Figure 4.5: System Design Overview Flowchart

### 4.3.1 Functional Requirements

### 4.3.2 Design Approach

### 4.3.3 System Architecture

As shown in Figure 4.5 the system architecture consists of various components.

```
1 # Your code here
```

Listing 4.3: System Architecture Code Example

## 4.4 Enclosure Effectiveness

This section discusses the effectiveness of the Photodiode enclosure.



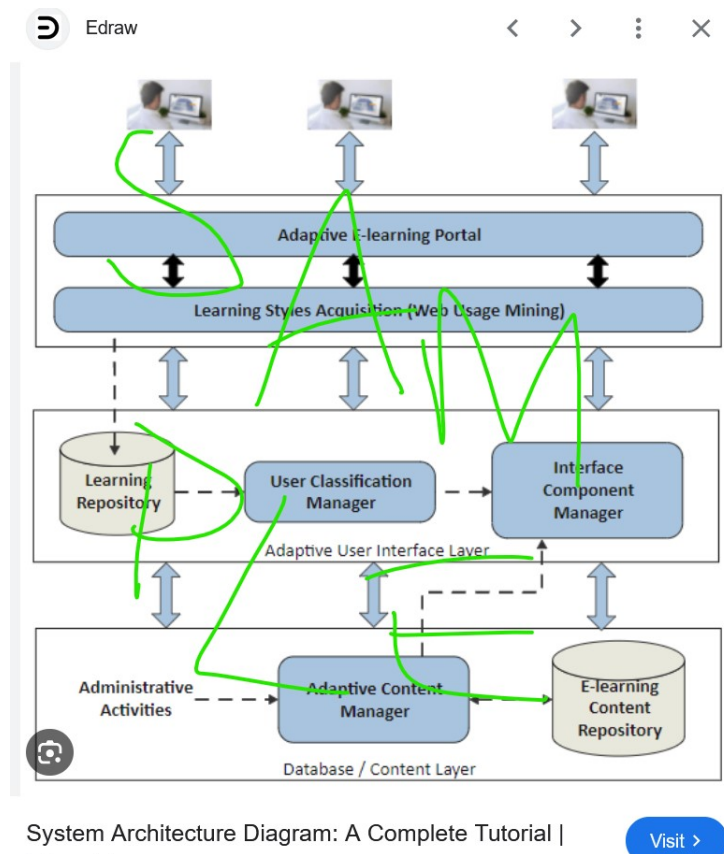
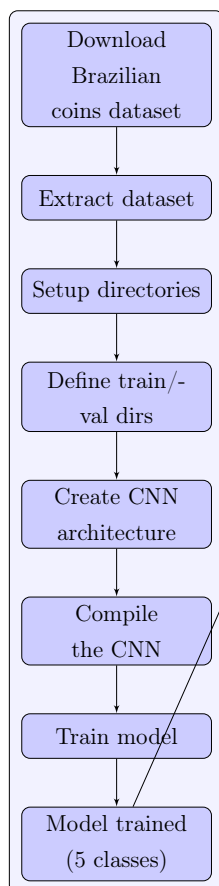
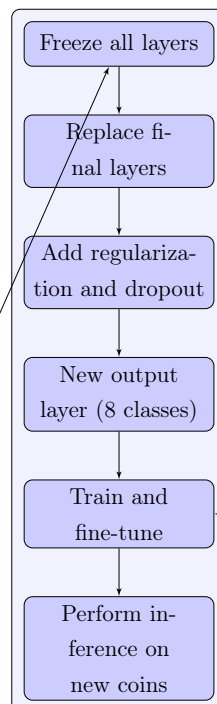


Figure 4.6: System Architecture Diagram

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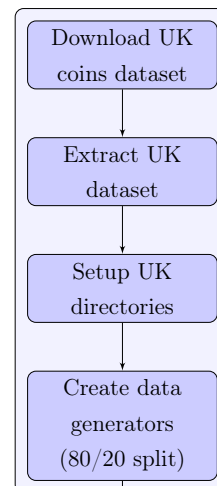


Figure 4.7: System Design Overview Flowchart

#### 4.4.1 Functional Requirements

#### 4.4.2 Design Approach

#### 4.4.3 System Architecture

As shown in Figure 4.7 the system architecture consists of various components.

```
1 # Your code here
```

Listing 4.4: System Architecture Code Example

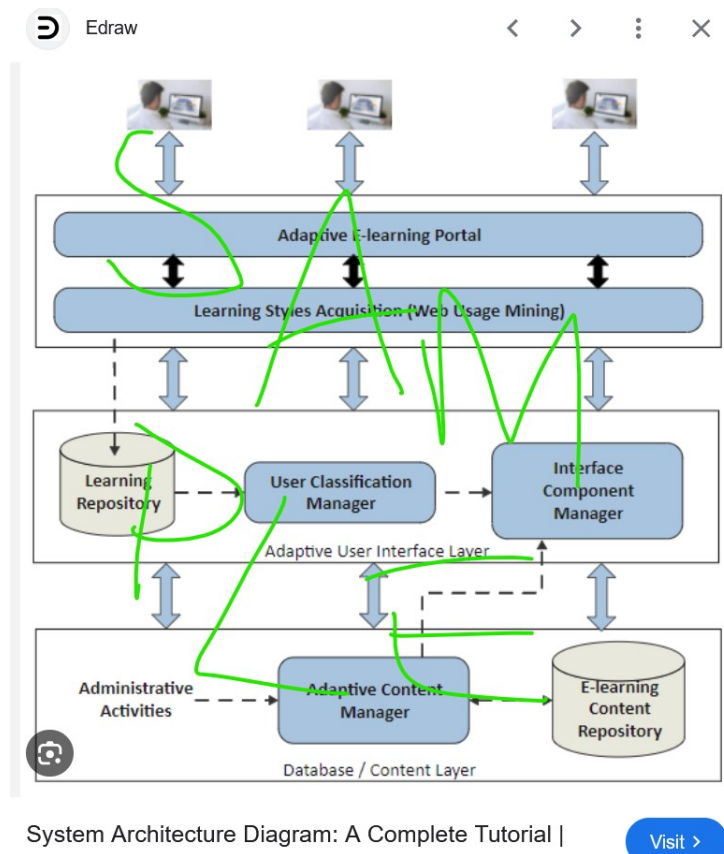


Figure 4.8: System Architecture Diagram

### 4.5 Data Acquisition System Evaluation

This section provides results related to the Arduino DAQ.

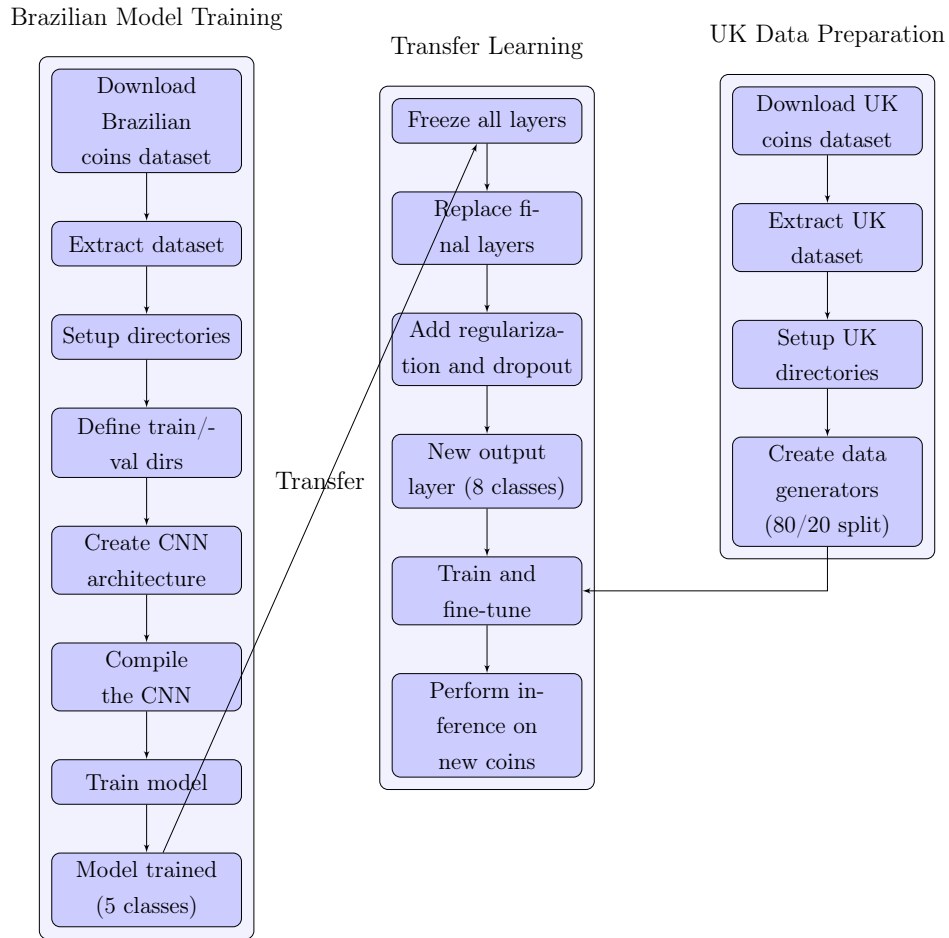


Figure 4.9: System Design Overview Flowchart

### 4.5.1 Functional Requirements

### 4.5.2 Design Approach

### 4.5.3 System Architecture

As shown in Figure 4.9 the system architecture consists of various components.

```
1 # Your code here
```

Listing 4.5: System Architecture Code Example

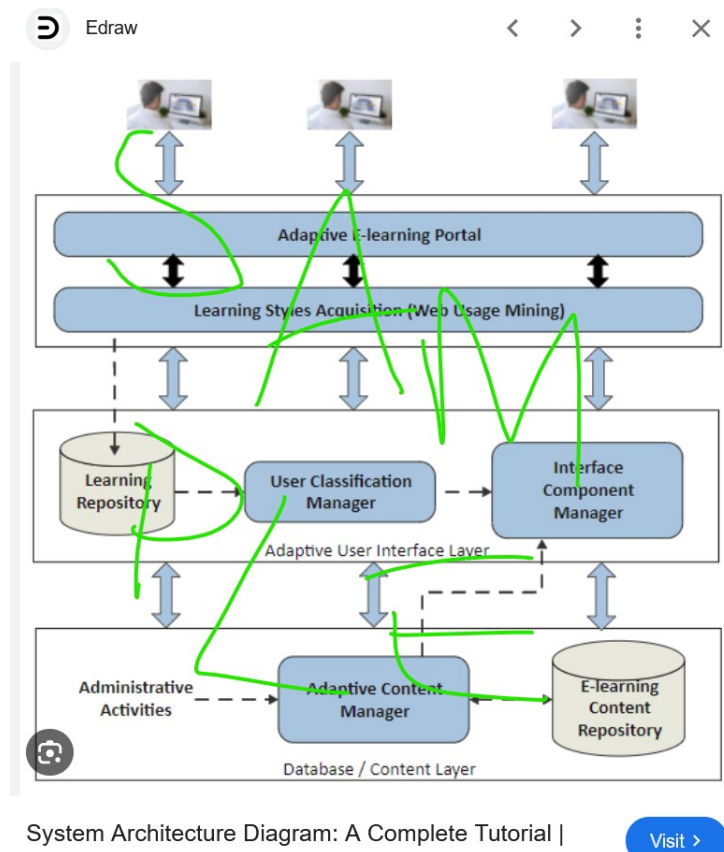


Figure 4.10: System Architecture Diagram

## 4.6 System Performance Analysis

### 4.6.1 Operational Constraints Identified

### 4.6.2 Environmental Factors Impact

```
1 // Environmental test results
2 // Temperature, ambient light, and vibration effects
```

Figure 4.11: Environmental Testing Results

### 4.6.3 System Stability and Repeatability

### 4.6.4 Recommendations for Improvement

## 4.7 Comparative Analysis

This section compares the simulation with the prototype results.

### 4.7.1 Breadboard vs. Stepboard Results

### 4.7.2 Iteration Improvements Analysis

### 4.7.3 Performance Against Design Requirements

The performance ...

### 4.7.4 Design Evolution Assessment

The what now?

## 4.8 System Limitations And Considerations

This section discusses the limitations and future work.

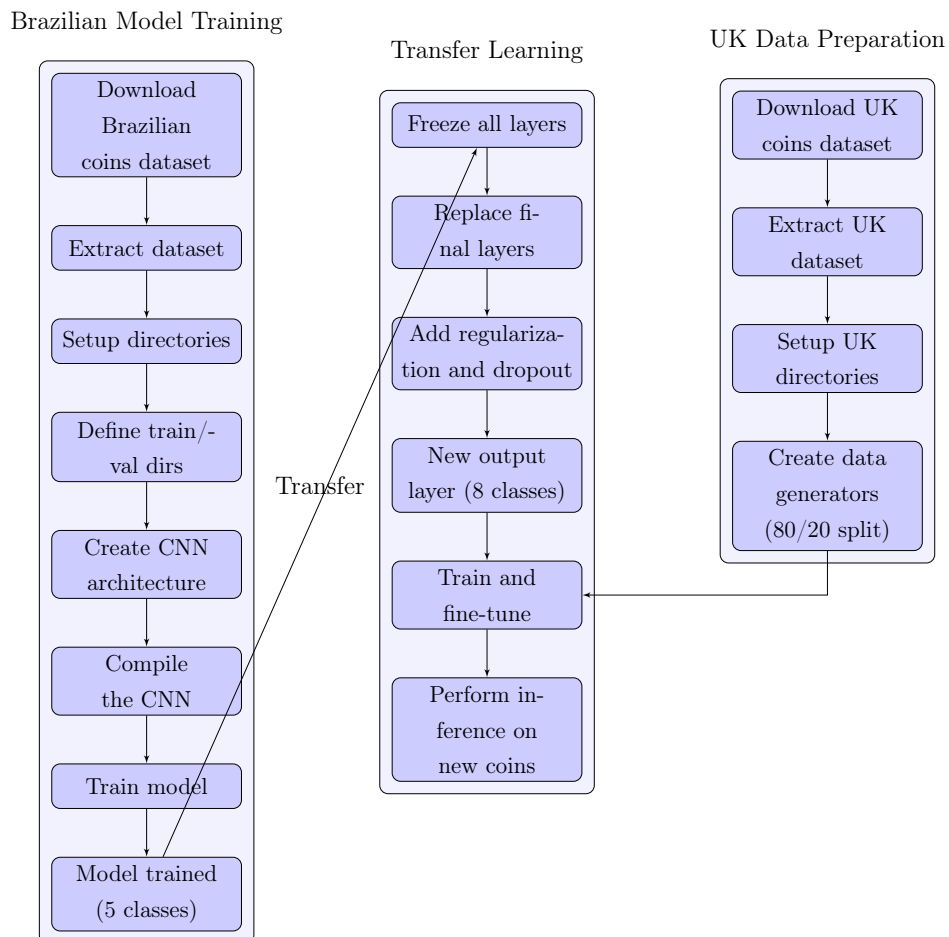


Figure 4.14: System Design Overview Flowchart

### 4.8.1 Functional Requirements

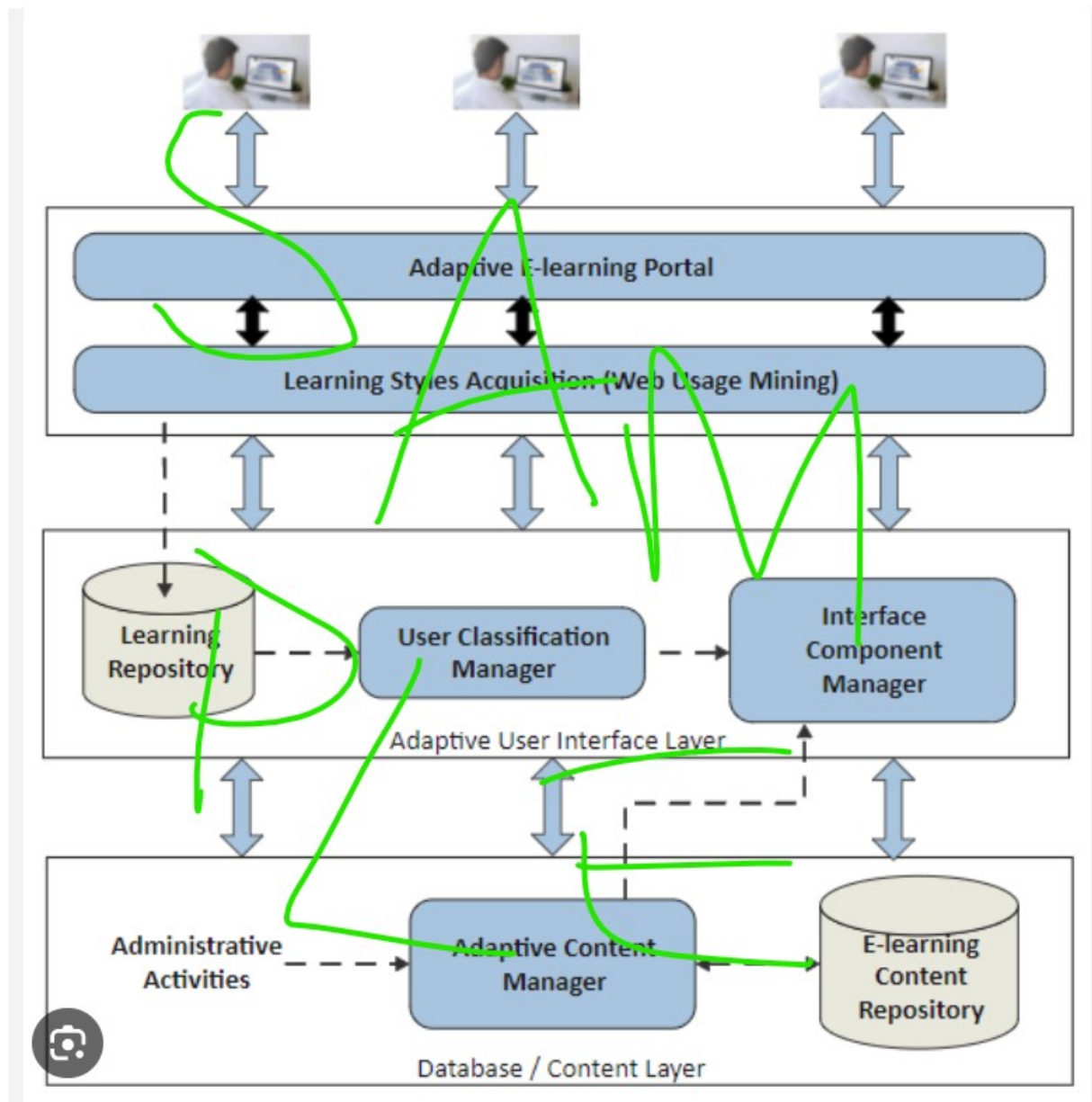
### 4.8.2 Design Approach

### 4.8.3 System Architecture

As shown in Figure 4.14 the system architecture consists of various components.

```
1 # Your code here
```

Listing 4.6: System Architecture Code Example



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Figure 4.12: Overall System Performance Analysis

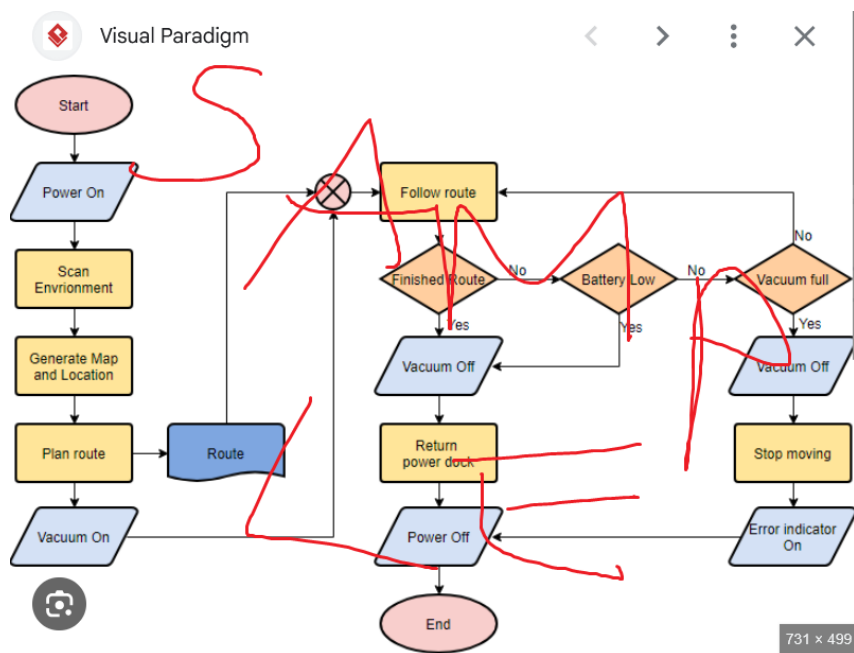
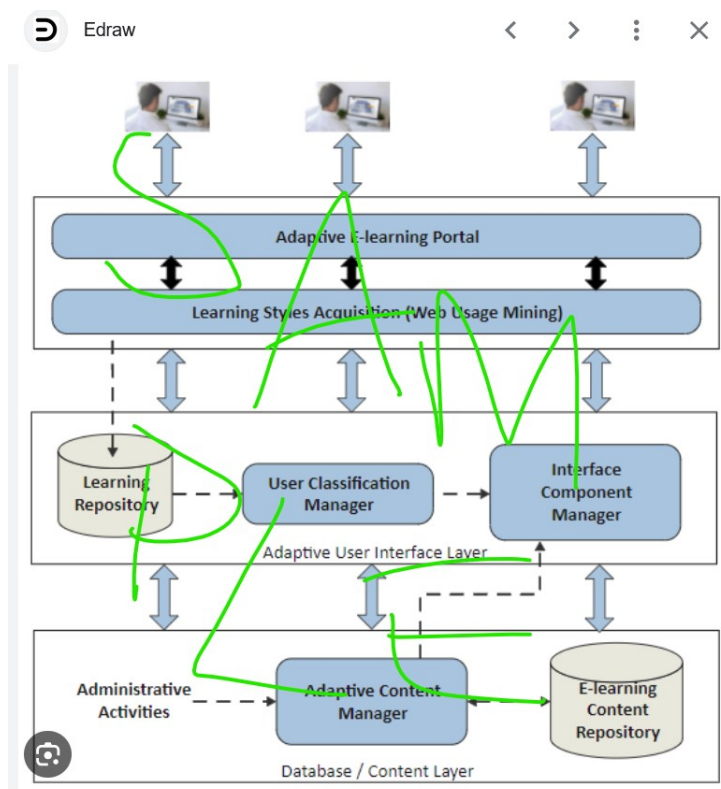


Figure 4.13: Prototype Iteration Comparison



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Figure 4.15: System Architecture Diagram



## 5. Conclusions

# Bibliography

- [1] A. Rosebrock. (2019, 12) Label smoothing with Keras, TensorFlow, and deep learning. [Online]. Available: <https://pyimagesearch.com/2019/12/30/label-smoothing-with-keras-tensorflow-and-deep-learning/>