

**GLASGOW CALEDONIAN UNIVERSITY**

MEng Group Research Project

MMH723842-24-AB-GLAS

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

word count: xxx

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Sebastian Alexander, William Kong, Nassor Salim,

Date: April 6, 2025

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# Abstract

add abstract here

# 1. Acknowledgements

## 2. Introduction

## 3. LiteratureReview

### 3.1 CubeSat Design

Puig-Suari, Turner and Ahlgren published an IEEE paper in 2001 with the help of their students at California Polytechnic State University exploring a need for micro satellites for use by universities in an ever-expanding space programme. They provide as a solution a standard satellite form-factor that will bring down the cost of both manufacture and deployment of satellites by smaller entities: the CubeSat. The paper identifies a key component for the success of this form factor a need for a standard CubeSat deployer mechanism which can deploy several satellites safely and develop such a platform, called Poly Picosatellite Orbital Deployer or P-POD. They point out the need and provide microsatellite size and shape of the CubeSat form factor

## 4. Background



# 5. Methodology

## 5.1 System Design Overview

This section provides an overview of the System Design Overview.

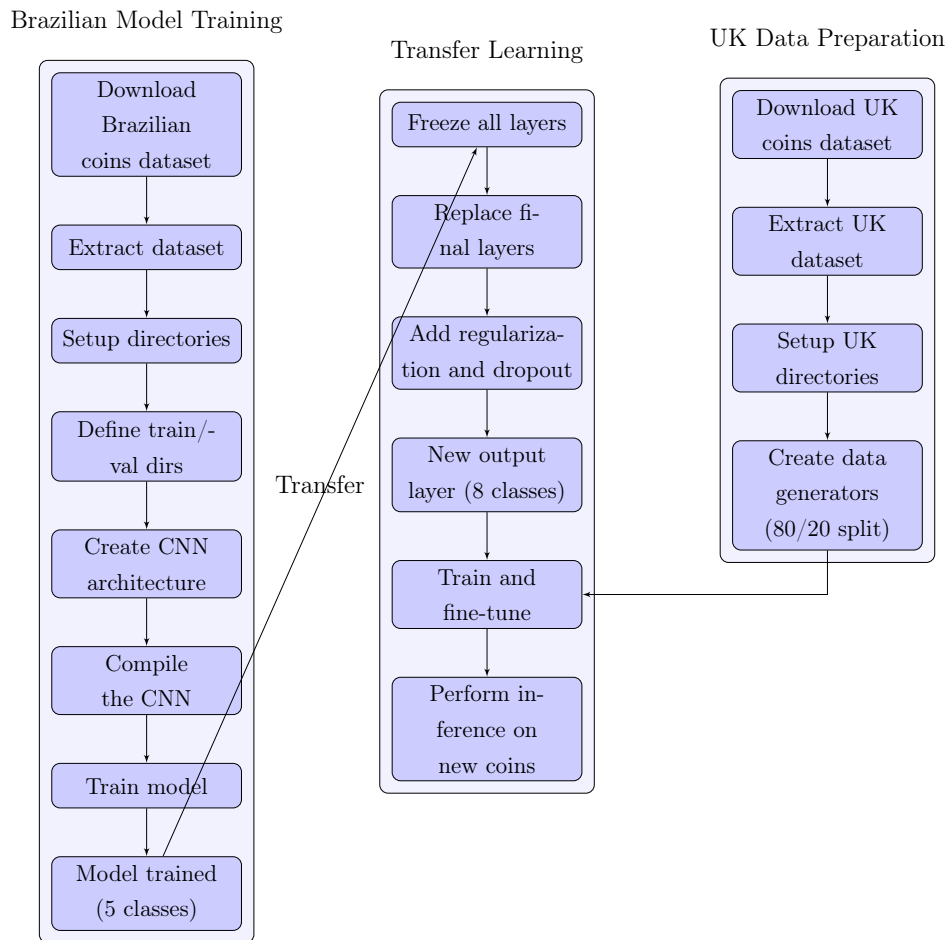


Figure 5.1: System Design Overview Flowchart

### 5.1.1 Functional Requirements

### 5.1.2 Design Approach

### 5.1.3 System Architecture

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

```
1 # Your code here
```

Listing 5.1: System Architecture Code Example

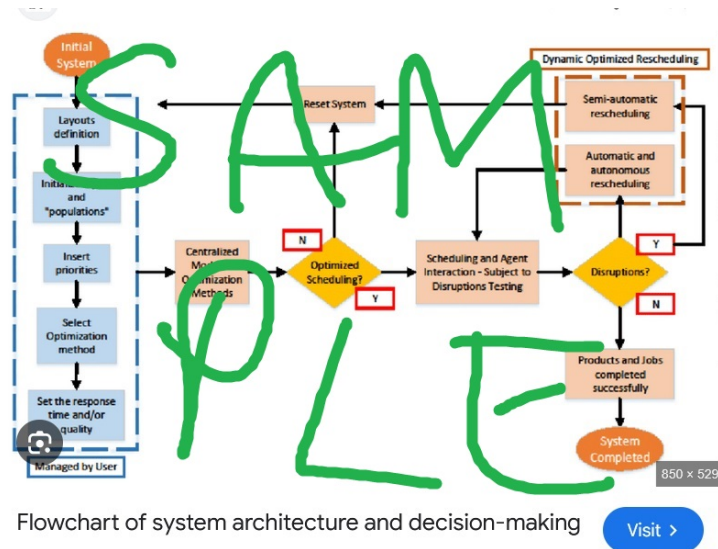


Figure 5.2: System Architecture Diagram

## 5.2 Sensor Array Development

This section provides an overview of the Sensor Array Development.

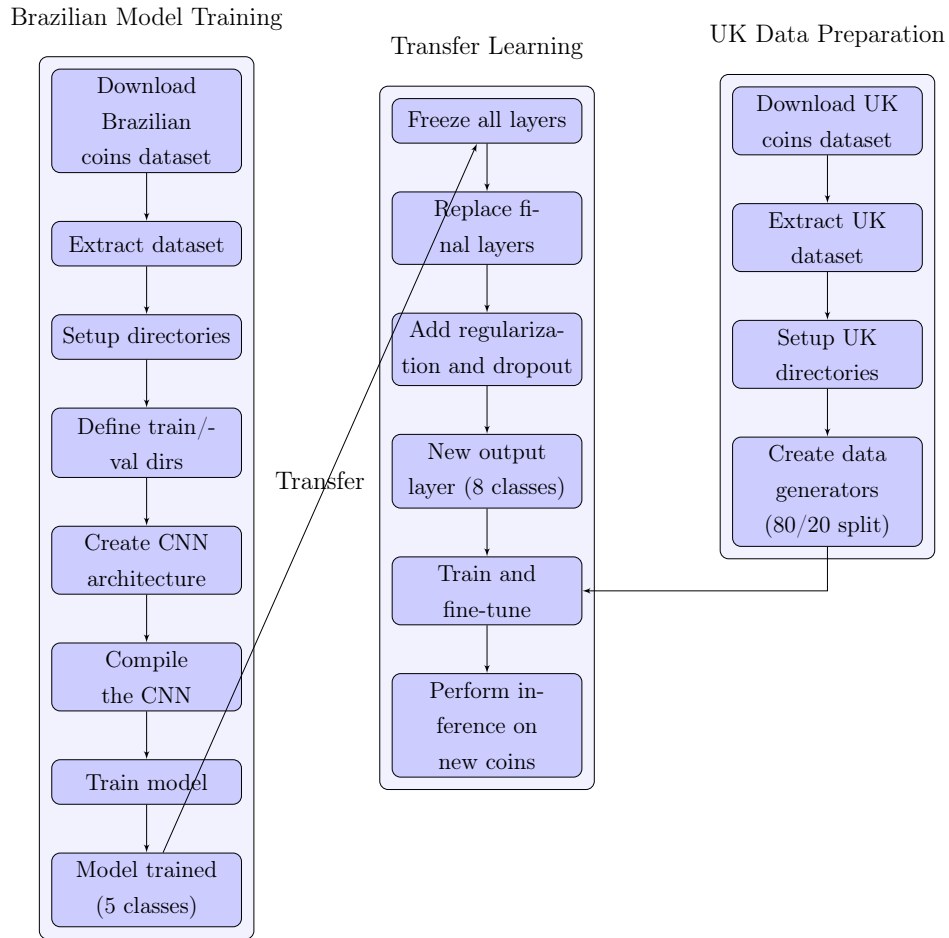


Figure 5.3: System Design Overview Flowchart

### 5.2.1 Functional Requirements

### 5.2.2 Design Approach

### 5.2.3 System Architecture

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

```
1 # Your code here
```

Listing 5.2: System Architecture Code Example

## 5.3 Signal Conditioning Circuitry

This section provides an overview of the Signal Conditioning Circuitry.

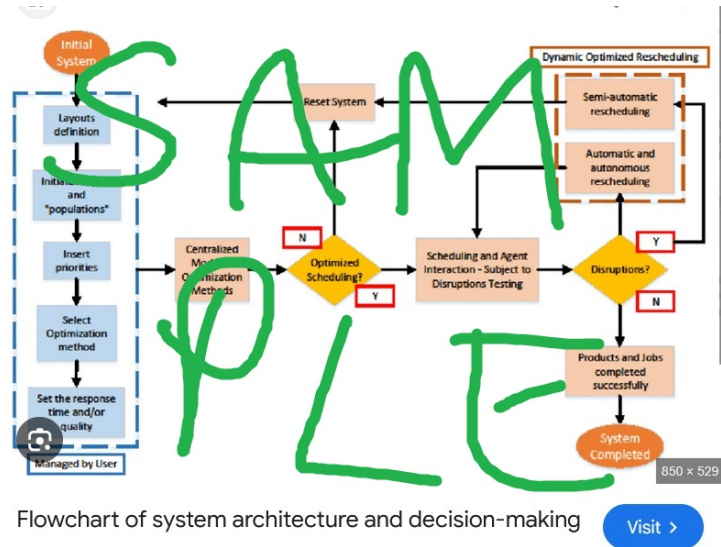
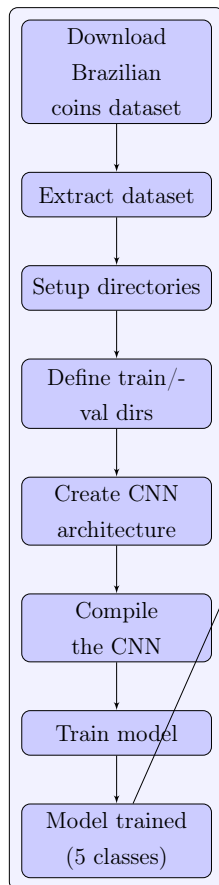
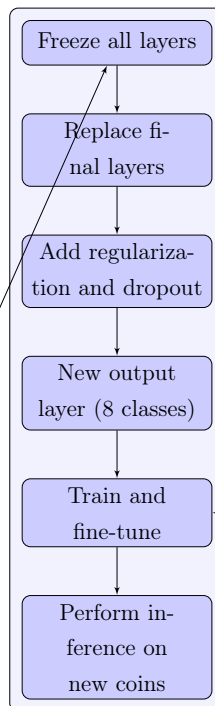


Figure 5.4: System Architecture Diagram

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#### Transfer Learning



#### UK Data Preparation

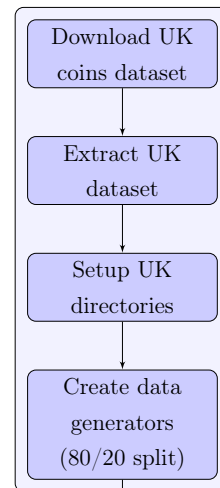


Figure 5.5: System Design Overview Flowchart

### 5.3.1 Functional Requirements

### 5.3.2 Design Approach

### 5.3.3 System Architecture

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

```
1 # Your code here
```

Listing 5.3: System Architecture Code Example

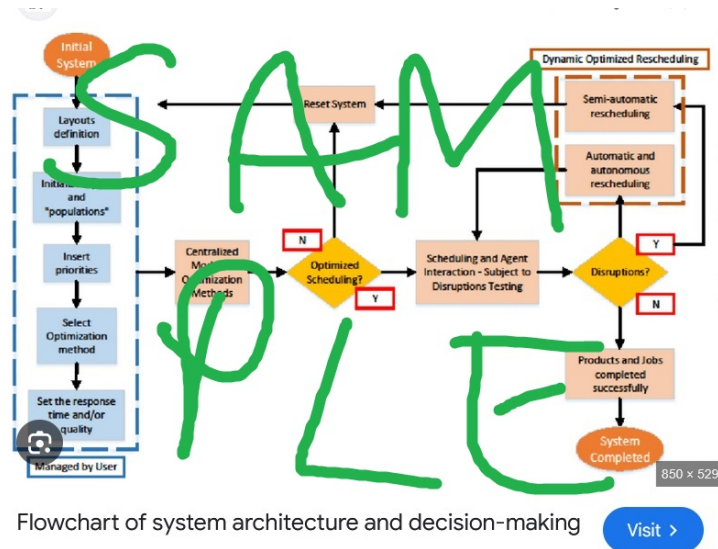


Figure 5.6: System Architecture Diagram

## 5.4 Enclosure Design And Fabrication

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

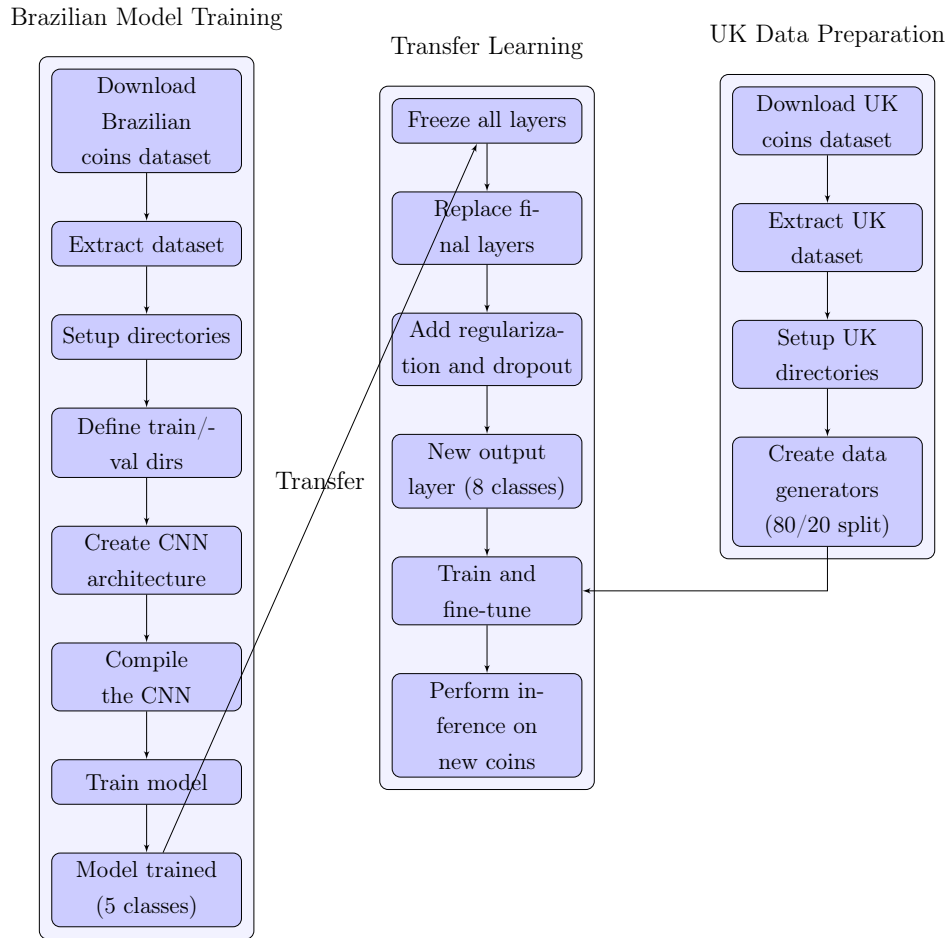


Figure 5.7: System Design Overview Flowchart

### 5.4.1 Functional Requirements

### 5.4.2 Design Approach

### 5.4.3 System Architecture

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

```
1 # Your code here
```

Listing 5.4: System Architecture Code Example

## 5.5 Data Acquisition System

This section provides an overview of the Data Acquisition System.

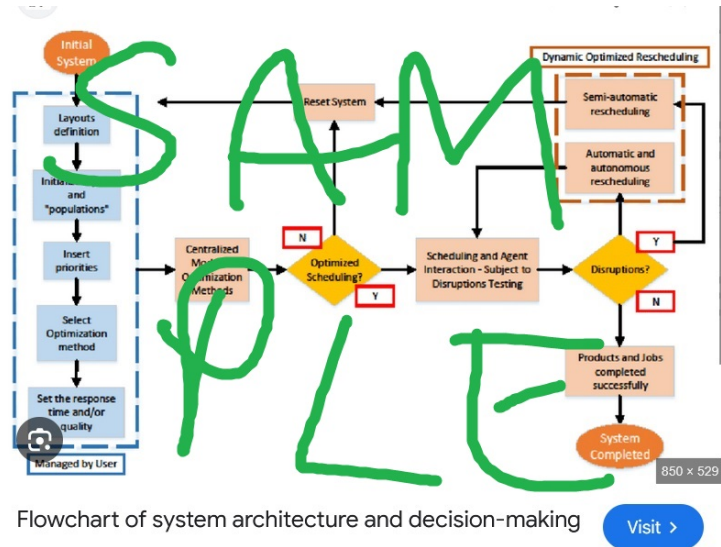
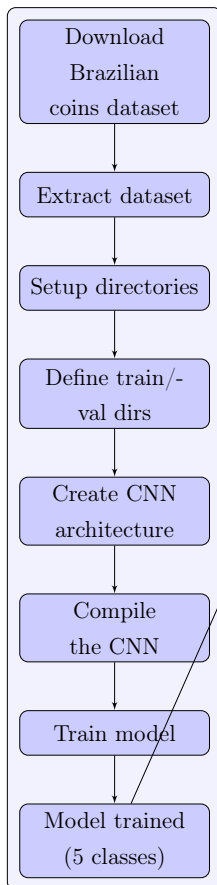
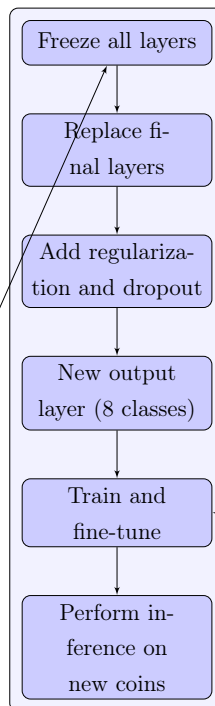


Figure 5.8: System Architecture Diagram

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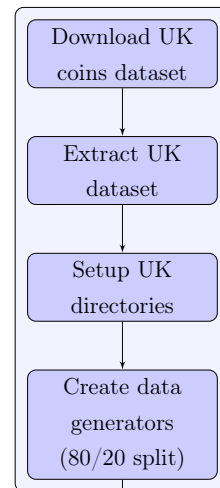


Figure 5.9: System Design Overview Flowchart

### 5.5.1 Functional Requirements

### 5.5.2 Design Approach

### 5.5.3 System Architecture

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

```
1 # Your code here
```

Listing 5.5: System Architecture Code Example

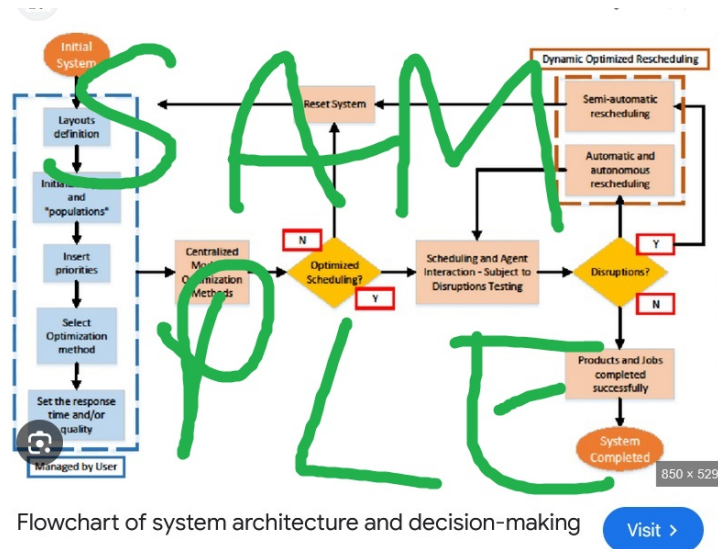


Figure 5.10: System Architecture Diagram

## 5.6 Testing Apparatus

This section provides an overview of the Testing Apparatus.



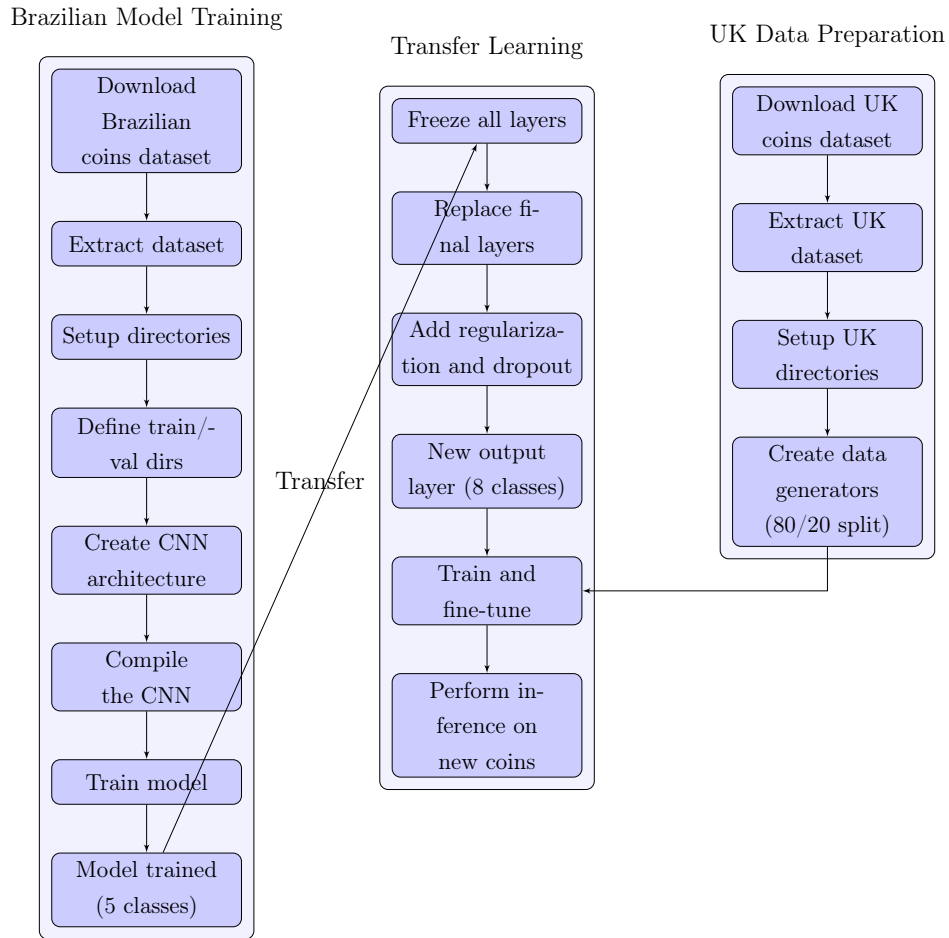


Figure 5.11: System Design Overview Flowchart

### 5.6.1 Functional Requirements

### 5.6.2 Design Approach

### 5.6.3 System Architecture

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

```
1 # Your code here
```

Listing 5.6: System Architecture Code Example

## 5.7 Prototype Development Lifecycle

This section provides an overview of the Prototype Development Lifecycle.

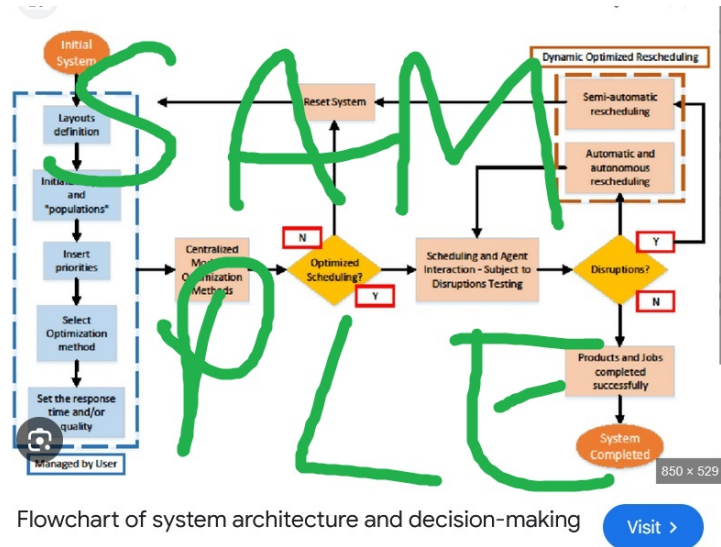
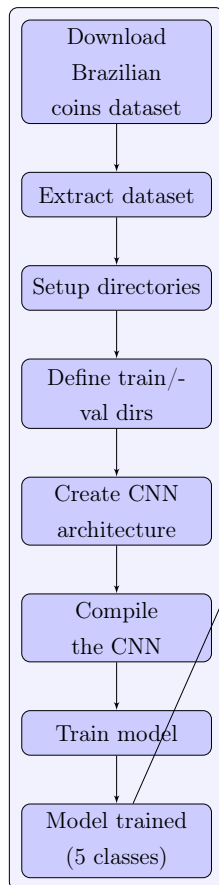
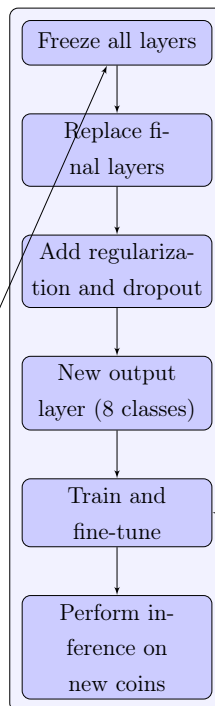


Figure 5.12: System Architecture Diagram

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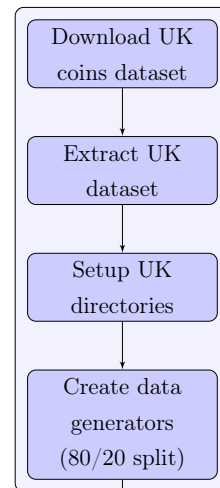


Figure 5.13: System Design Overview Flowchart

### 5.7.1 Functional Requirements

### 5.7.2 Design Approach

### 5.7.3 System Architecture

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

1 # Your code here

Listing 5.7: System Architecture Code Example

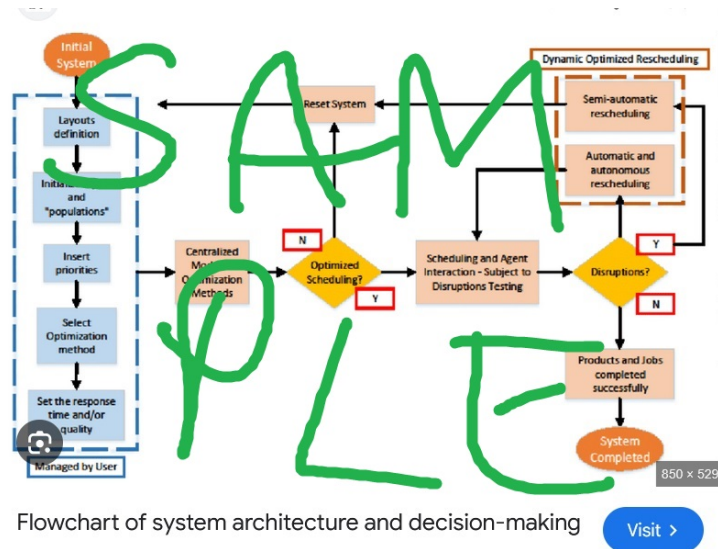


Figure 5.14: System Architecture Diagram

## 6. Results

### 6.1 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.

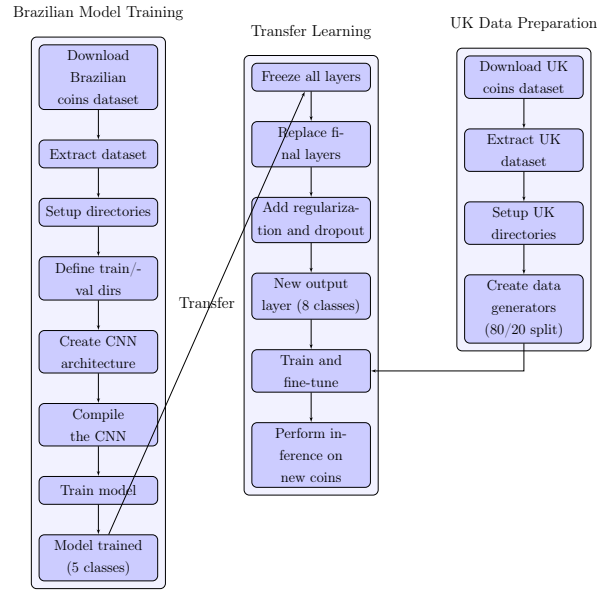


Figure 6.1: System Design Overview Flowchart

### 6.1.1 Functional Requirements

### 6.1.2 Design Approach

### 6.1.3 System Architecture

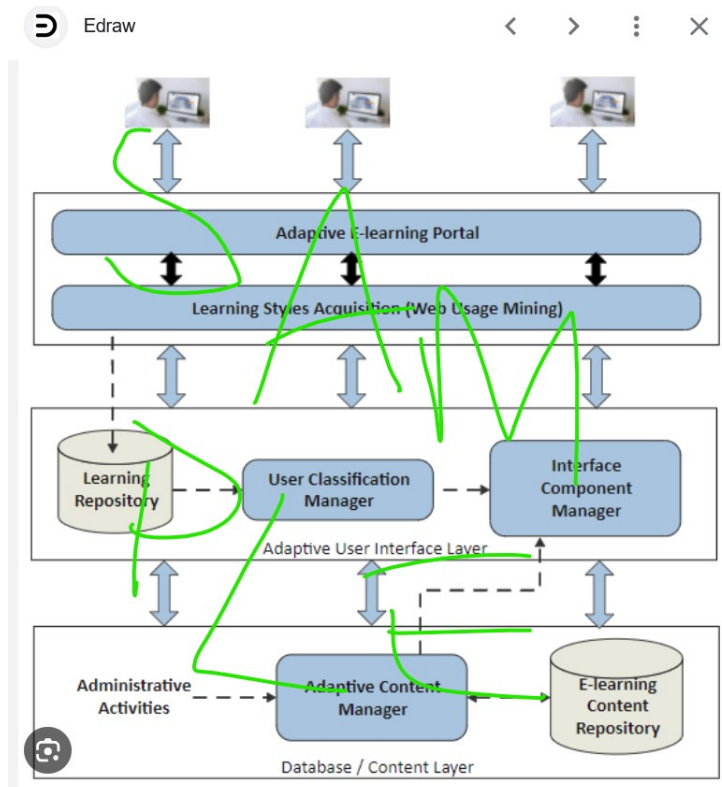
As shown in Figure ?? the system architecture consists of various components.

```
1 # Your code here
```

Listing 6.1: System Architecture Code Example

## 6.2 Amplification Performance

This section provides results of the amplifier performance.



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Figure 6.2: System Architecture Diagram

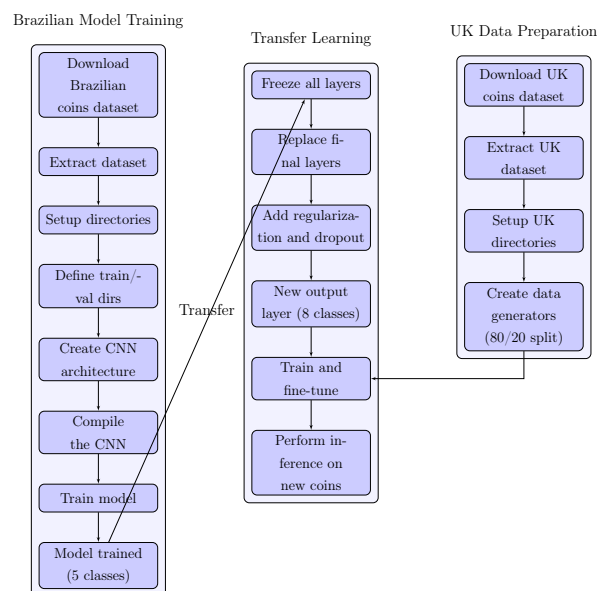


Figure 6.3: System Design Overview Flowchart

### 6.2.1 Functional Requirements

### 6.2.2 Design Approach

### 6.2.3 System Architecture

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

```
1 # Your code here
```

Listing 6.2: System Architecture Code Example

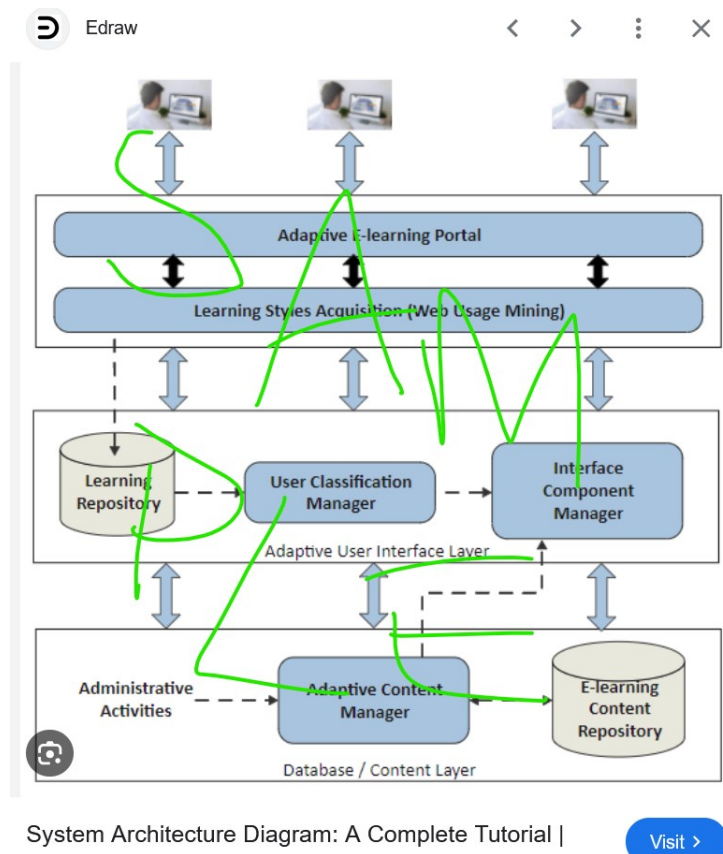


Figure 6.4: System Architecture Diagram

## 6.3 Photodiode Angular Response

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



Figure 6.5: System Design Overview Flowchart

### 6.3.1 Functional Requirements

### 6.3.2 Design Approach

### 6.3.3 System Architecture

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

```
1 # Your code here
```

Listing 6.3: System Architecture Code Example

## 6.4 Enclosure Effectiveness

This section discusses the effectiveness of the Photodiode enclosure.



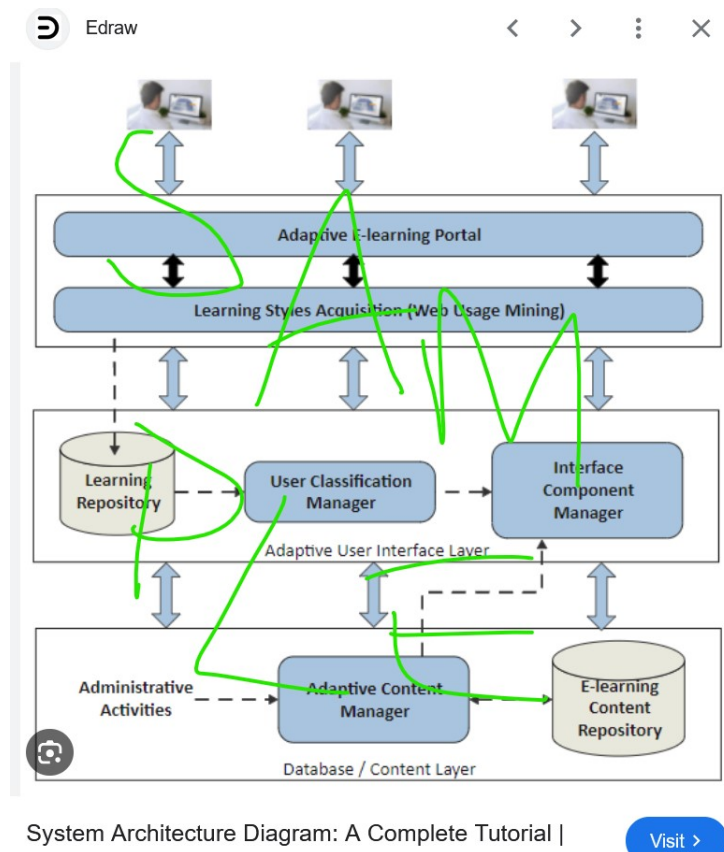
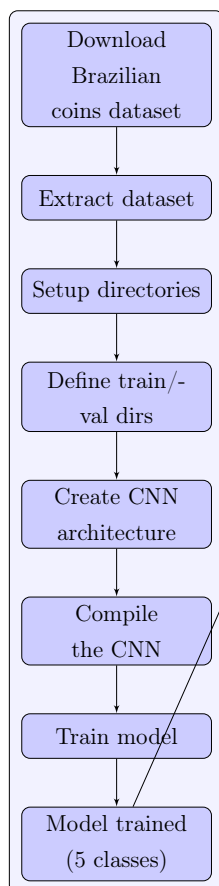
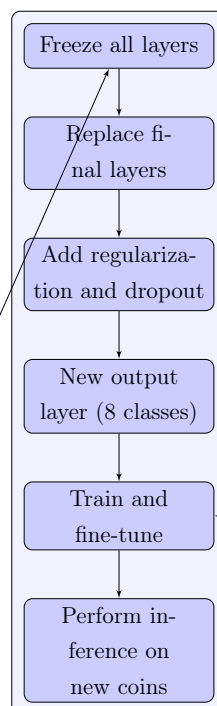


Figure 6.6: System Architecture Diagram

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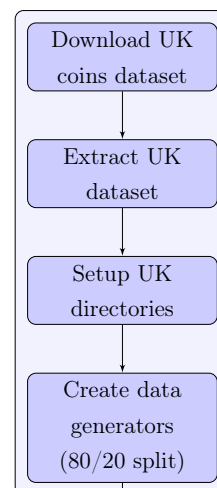


Figure 6.7: System Design Overview Flowchart

### 6.4.1 Functional Requirements

### 6.4.2 Design Approach

### 6.4.3 System Architecture

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

```
1 # Your code here
```

Listing 6.4: System Architecture Code Example

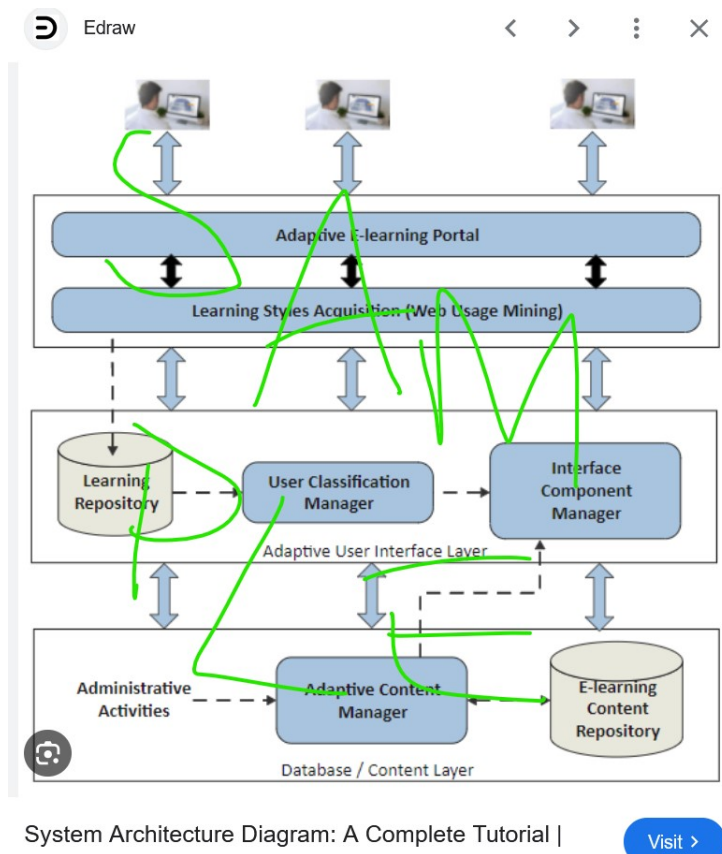


Figure 6.8: System Architecture Diagram

## 6.5 Data Acquisition System Evaluation

This section provides results related to the Arduino DAQ.

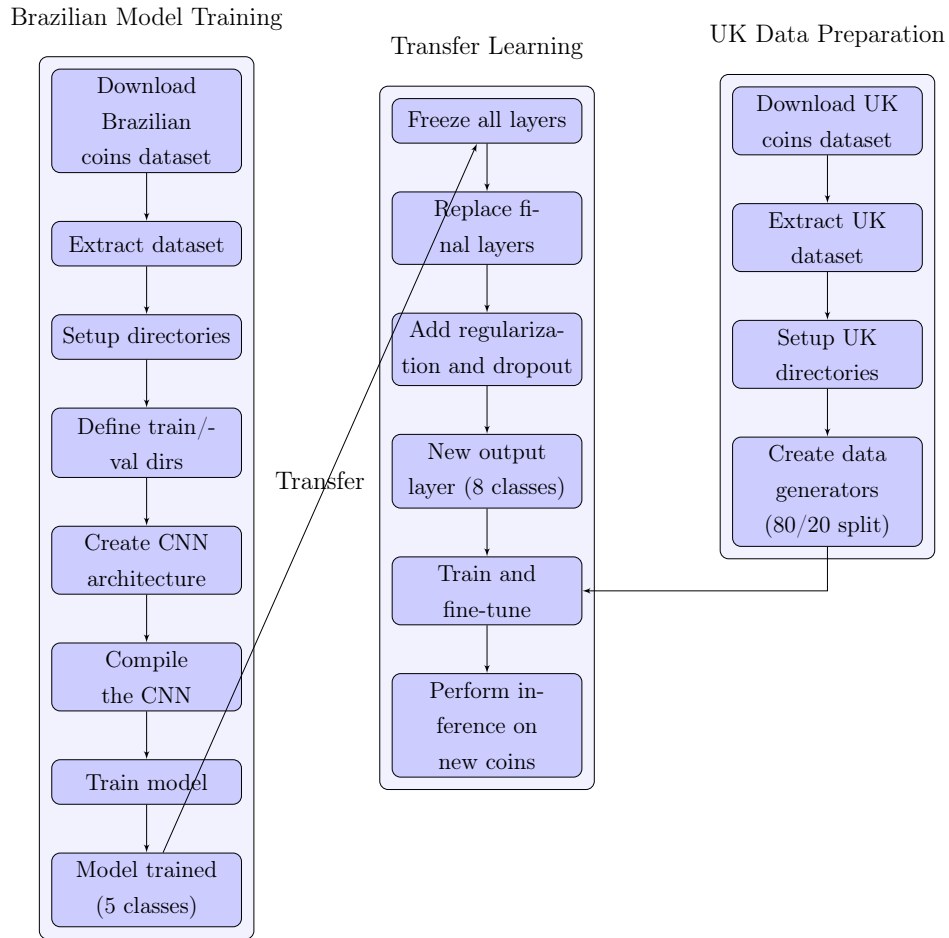


Figure 6.9: System Design Overview Flowchart

### 6.5.1 Functional Requirements

### 6.5.2 Design Approach

### 6.5.3 System Architecture

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

```
1 # Your code here
```

Listing 6.5: System Architecture Code Example

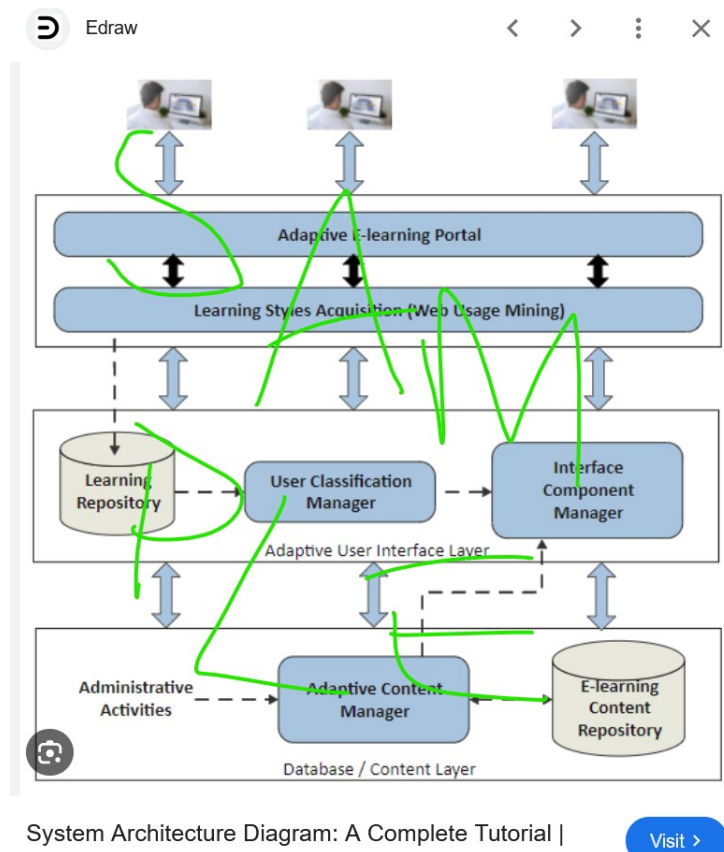


Figure 6.10: System Architecture Diagram

## 6.6 System Performance Analysis

### 6.6.1 Operational Constraints Identified

### 6.6.2 Environmental Factors Impact

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

Figure 6.11: Environmental Testing Results

### 6.6.3 System Stability and Repeatability

### 6.6.4 Recommendations for Improvement

## 6.7 Comparative Analysis

This section compares the simulation with the prototype results.

### 6.7.1 Breadboard vs. Stepboard Results

### 6.7.2 Iteration Improvements Analysis

### 6.7.3 Performance Against Design Requirements

The performance ...

### 6.7.4 Design Evolution Assessment

The what now?

## 6.8 System Limitations And Considerations

This section discusses the limitations and future work.

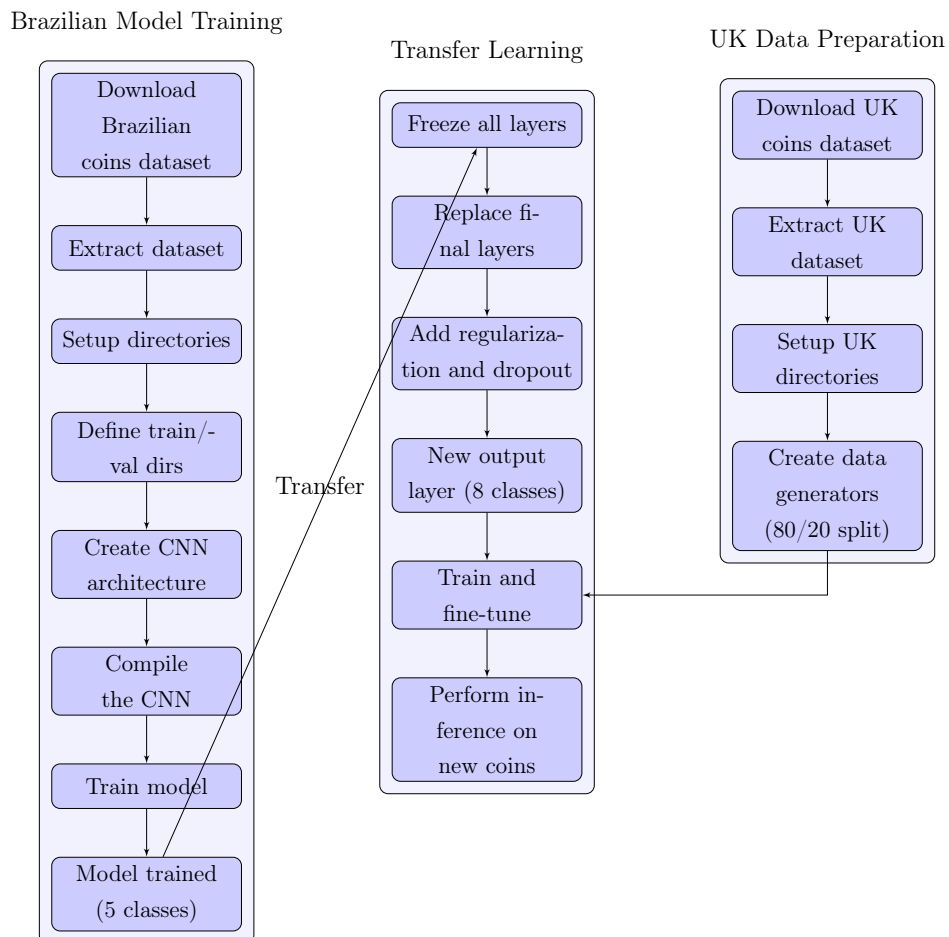


Figure 6.14: System Design Overview Flowchart

### 6.8.1 Functional Requirements

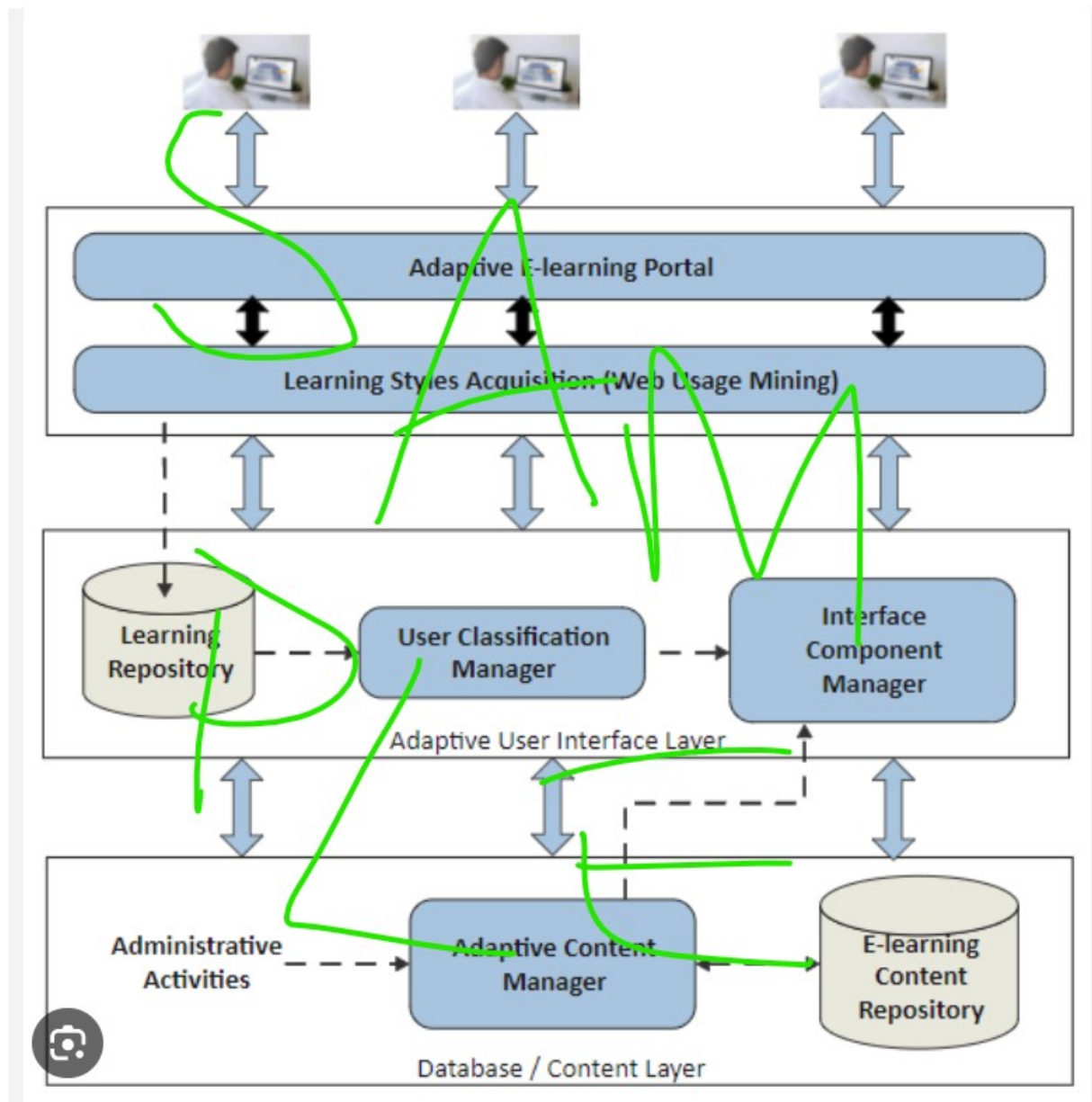
### 6.8.2 Design Approach

### 6.8.3 System Architecture

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

```
1 # Your code here
```

Listing 6.6: System Architecture Code Example



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Figure 6.12: Overall System Performance Analysis

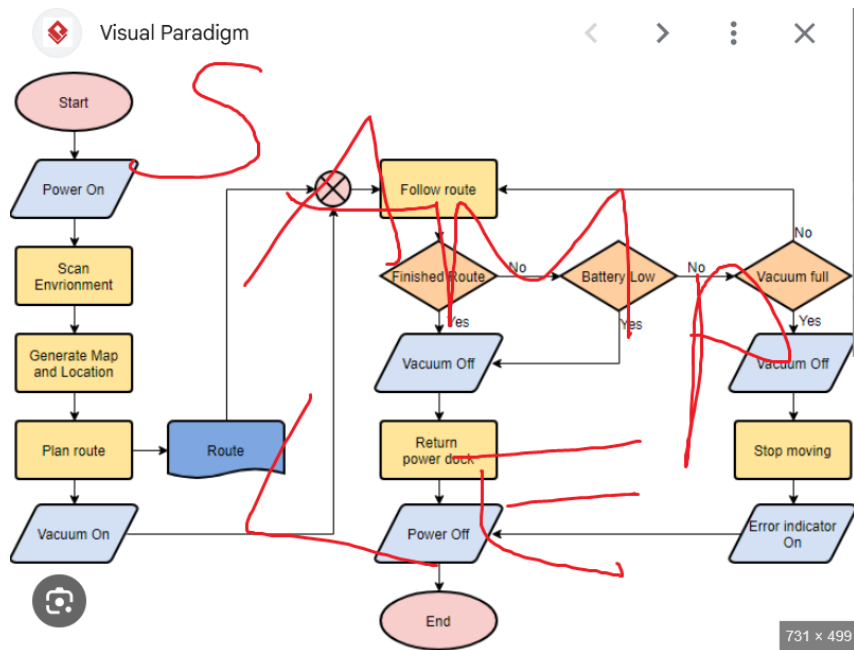
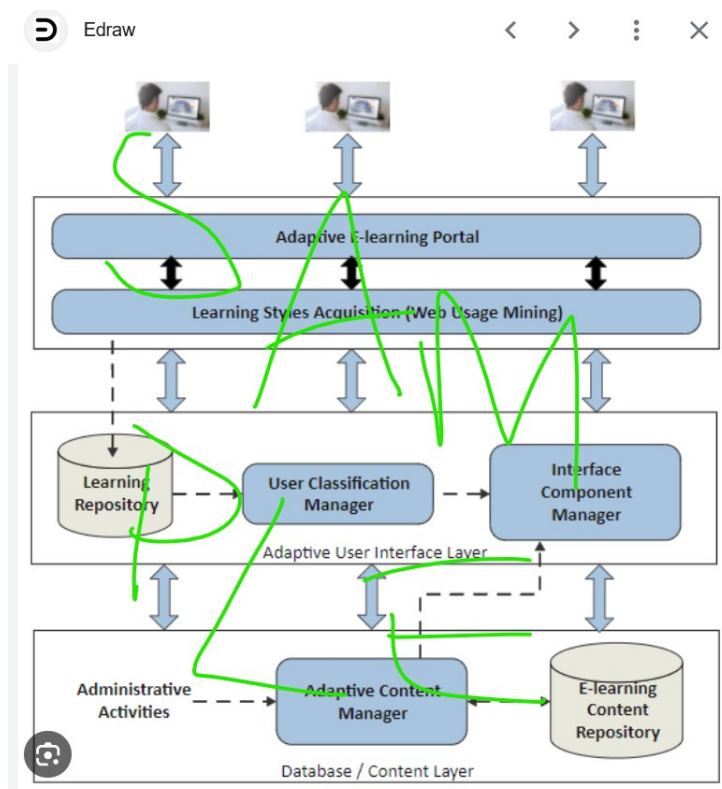


Figure 6.13: Prototype Iteration Comparison



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Figure 6.15: System Architecture Diagram



## 7. Conclusions

## 8. FutureWork