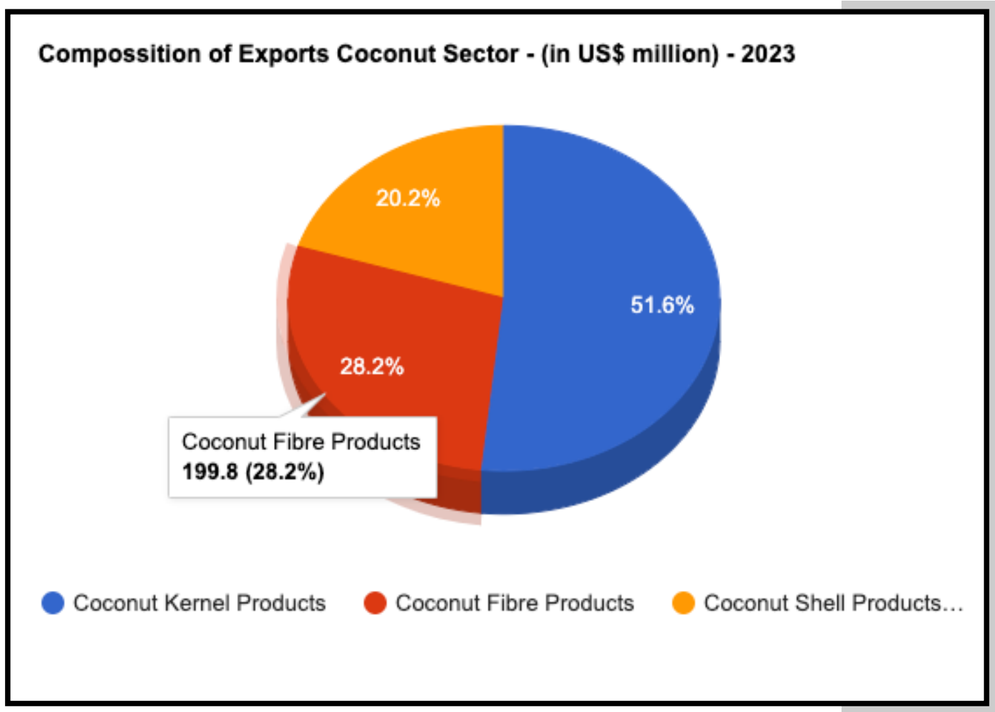
ENHANCING TRANSPARENCY IN THE COCONUT PEAT SUPPLY CHAIN THROUGH A SOFTWARE ENGINEERING APPROACH

Group - 24-25J-313

OUR PROJECT

- 4th largest coconut producer in the world
- The global coco-peat market is valued at USD 2.27 billion (2022) and is projected to reach USD 3.8 billion by 2031 (CAGR of 4.4%).



- Coco-peat, also known as coir pith, is a byproduct of the coconut industry.
- Used extensively in horticulture as a soil substitute and soil conditioner.

Field Visit

CURRENT CHALLENGES

1. Quality Control Issues
2. Inefficiencies in the supply chain
3. Lack of Transparency and Traceability
4. Reluctancy to adopt new technologies

All these information was gathered during the field visit

Research Question

How can transparency be enhanced in the coco-peat supply chain through a software engineering approach integrating blockchain, IoT, and customizable workflow management systems?

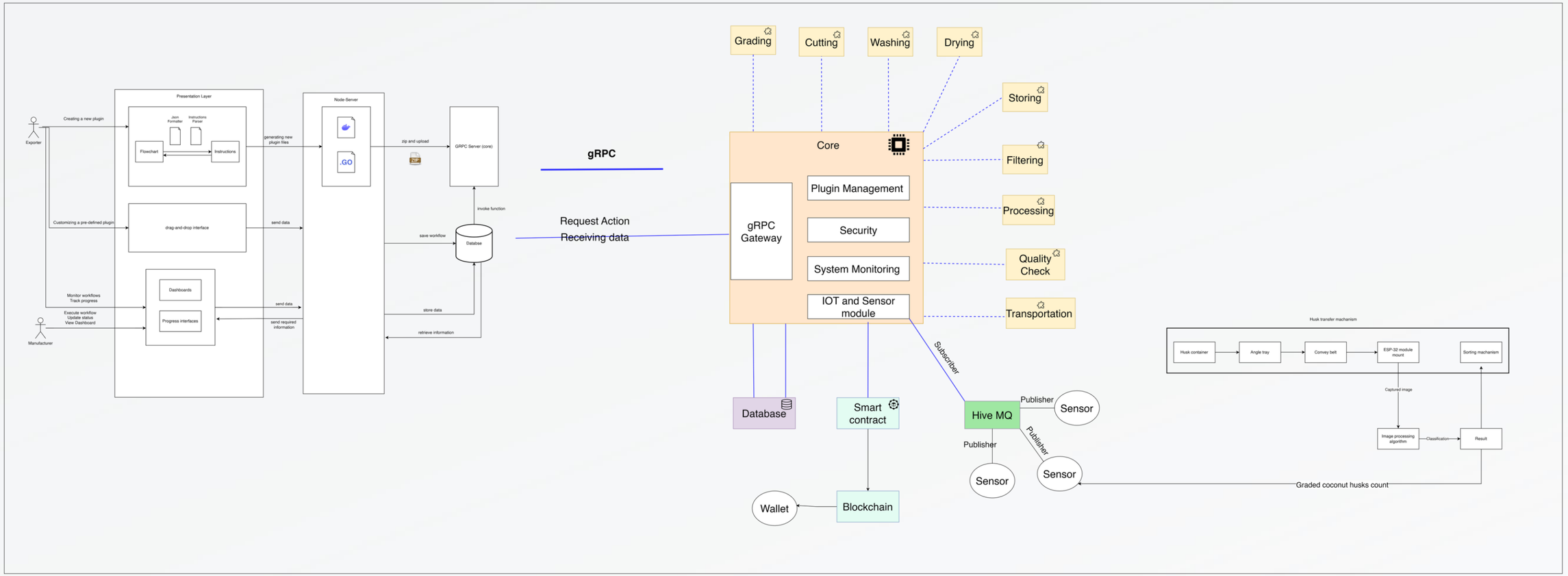
Main Objective

- To develop and implement a comprehensive software engineering solution that enhances transparency in the coco-peat supply chain.

Specific Objectives:

1. Analyze Current Supply Chain
2. Select Appropriate Technologies
3. Design System Architecture
4. Develop Smart Contracts
5. Integrate IoT Devices
6. Customize Workflow Management
7. Test and Validate the System

SYSTEM DIAGRAM



COMMERCIALIZATION

- Sri Lanka Export Development Board (SLEDB)

- Medium to small scale exporters

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A NOVEL ARCHITECTURAL APPROACH FOR ENHANCING SYSTEM AVAILABILITY AND PLUGIN MANAGEMENT IN A MICROKERNEL ARCHITECTURE

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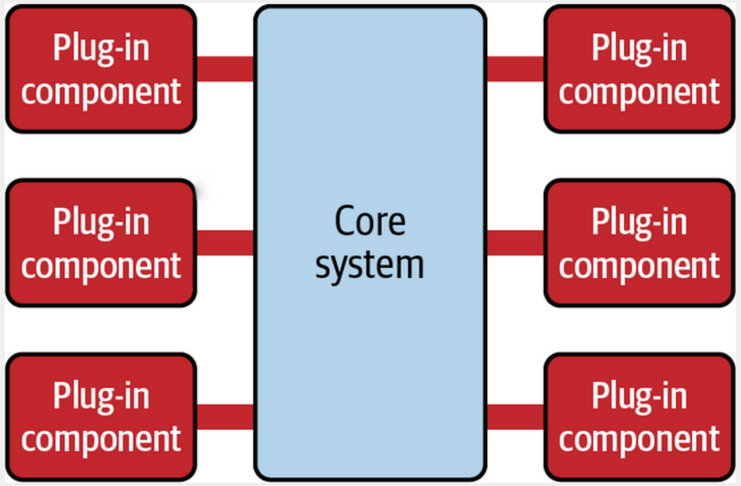
Specialization - Software Engineering

INTRODUCTION

- Importance of an Architecture?
  - Ensures Scalability and Flexibility
  - Improves Maintainability and Extensibility
  - Optimizes Performance
  - Enhances Security
  - Reduces Risk and Technical Debt



- Available architecture
  a. monolithic architecture
  b. microservice architecture
  c. microkernel architecture
  d. service-oriented architecture

RESEARCH GAP

- Integration of Advanced Technologies
  - Most Research focuses on the technologies in isolation rather than as a cohesive system. [2][5][6]
- Case Studies and Practical Implementations
  - Most existing literature focuses on theoretical models or implementation in different contexts. [4][5][6]
- System Stability and Plugin Management
  - lacks of failure recovery methods. [7]

RESEARCH QUESTION

How can a microkernel architecture be designed and implemented to enhance system availability and manage dynamic plugins effectively, while ensuring minimal performance overhead ?

OBJECTIVES

Main Objectives:

Develop a robust core system that integrates Blockchain and IoT technologies

Sub Objectives:

- Design and Development of the core system
- Implementation of Dynamic plugin management
- Integration of Modern technologies
- Evaluation of System performance

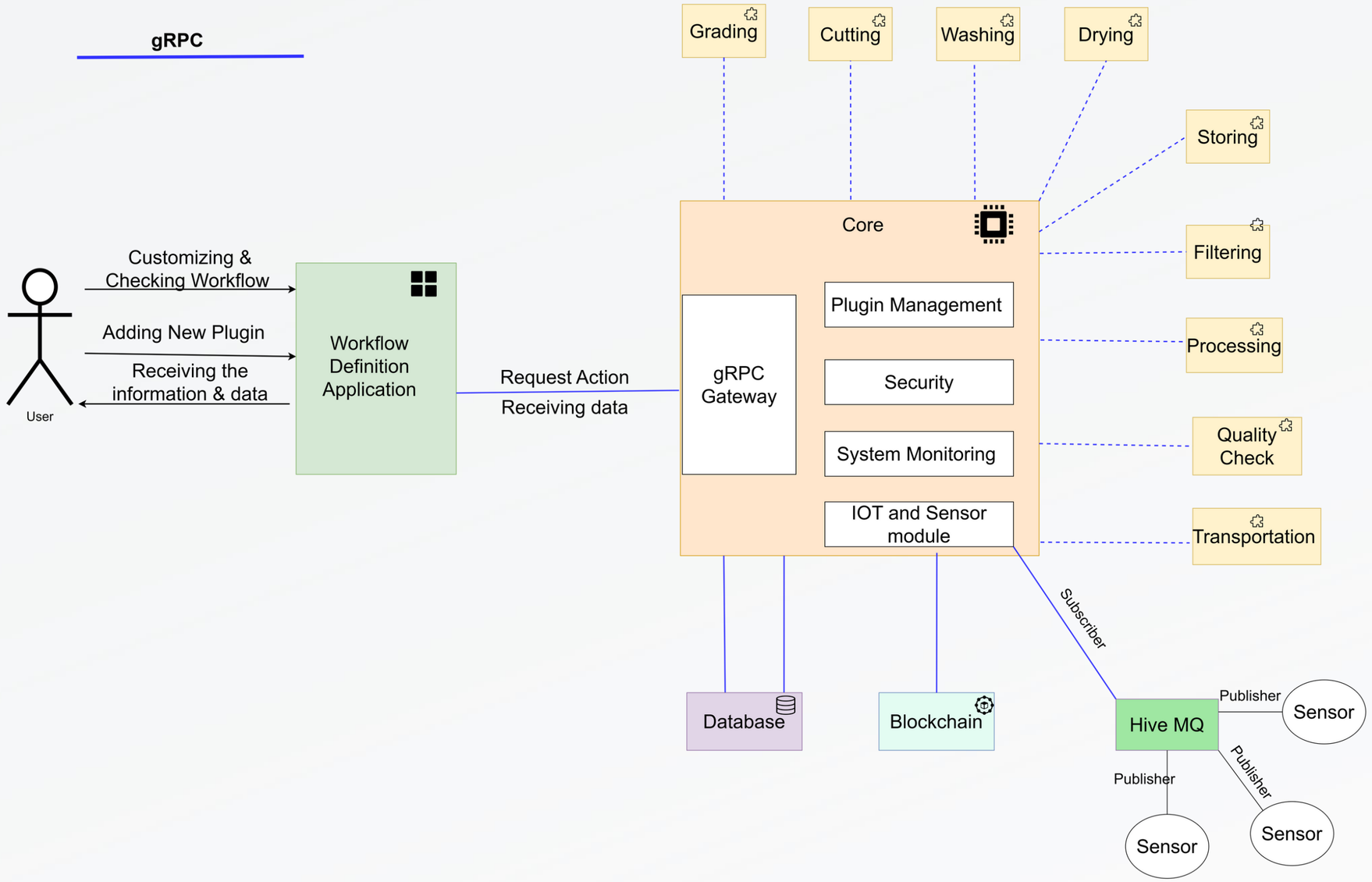
TRADE OFF ANALYSIS

Criteria	Monolithic Architecture	Microservices Architecture	Microkernel Architecture	Service-Oriented Architecture
Modularity	Low	High	High	Moderate
Scalability	Low	High	High	Moderate
Customizability	Limited	High	High	Moderate
Performance	High	Moderate	High	Moderate
Fault Tolerance	Low	High	Moderate	Moderate
Suitability	Small, simple applications	Distributed, large-scale applications	Systems requiring modularity, customizability	Enterprise systems with reusable and loosely coupled services.

[1,8]

METHODOLOGY

Component Diagram



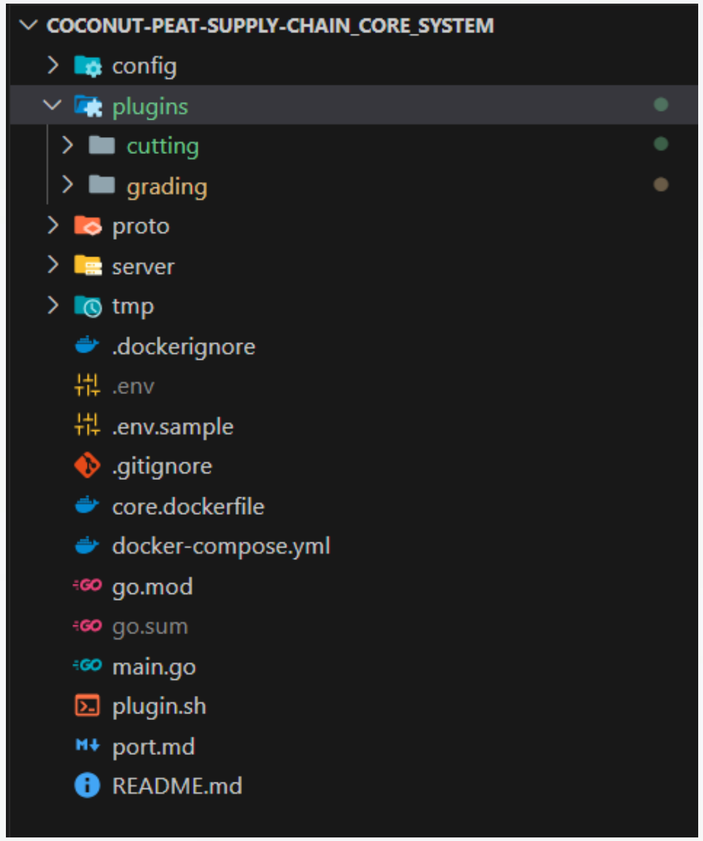
METHODOLOGY

Used Technologies

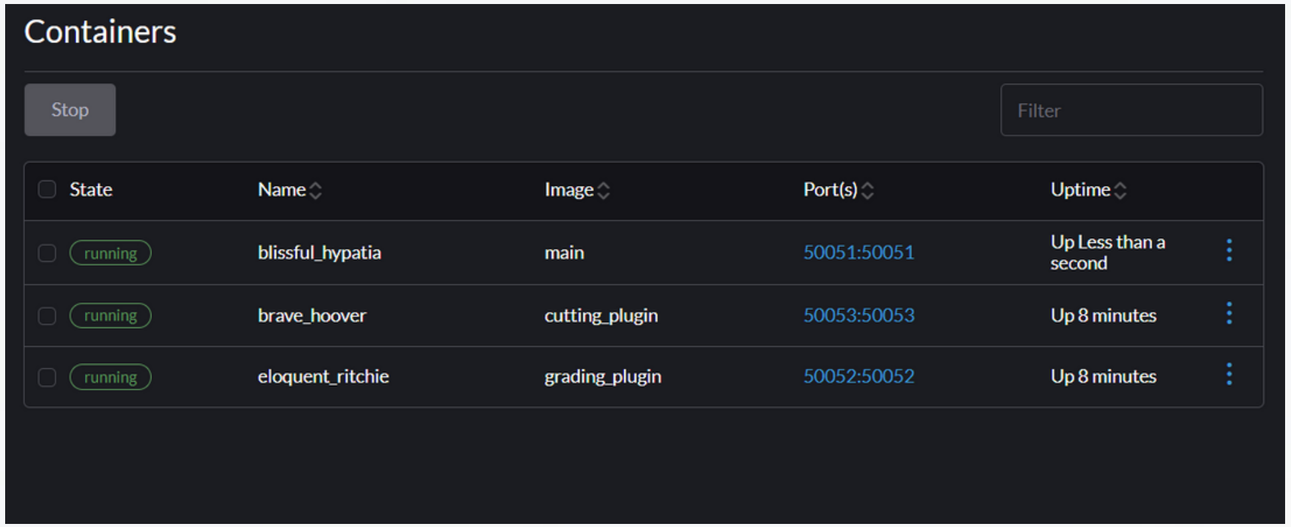
- Go
- GRPC
- MongoDB
- git
- Hive MQ
- GitHub
- BloomRPC
- Postman
- docker
- K3S
- Github Actions
- prometheus
- rancher dekstop

METHODOLOGY

Evidence for Completion



Folder structure



Core and two plugins are running on docker container

METHODOLOGY

Evidence for Completion

```go
//get the plugin name and the plugin port number from the mongodb
collection := mongo.MongoClient.Database("portDB").Collection("port")
filter := bson.D{
    {Key: "plugin", Value: req.PluginName},
    {Key: "status", Value: true},
}
var result bson.M
err := collection.FindOne(context.Background(), filter).Decode(&result)
if err != nil {
    log.Fatalf("Error while fetching the plugin details: %v", err)
}
pluginPort := strconv.Itoa(int(result["port"].(int32)))

//connecting the plugin
address := "0.0.0.0:" + pluginPort
conn, err := grpc.Dial(address, grpc.WithTransportCredentials(insecure.NewCredentials()))
if err != nil {
    log.Fatalf("Failed to connect to backend service: %v", err)
}
defer conn.Close()

// create a gRPC client for the backend service
backendClient := pb.NewPluginClient(conn)
```

Core : Dynamic port fetching and gateway

```go
action := req.Action
if action == "register" {
    backendResp, err := backendClient.RegisterPlugin(ctx, &pb.PluginRequest{
        PluginName:      req.PluginName,
        UserRequirement: req.UserRequirement,
    })
    if err != nil {
        return nil, err
    }
    return &pb.ClientResponse{
        Success: backendResp.Success,
        Message: backendResp.Message,
    }, nil

} else if action == "execute" {
    backendResp, err := backendClient.ExecutePlugin(ctx, &pb.PluginExecute{
        PluginName: req.PluginName,
    })
    if err != nil {
        return nil, err
    }

    // Return the response to the client
    return &pb.ClientResponse{
        Success: backendResp.Success,
        Message: backendResp.Message,
        Results: backendResp.Results,
    }, nil
} else if action == "unregister" {
    backendResp, err := backendClient.UnregisterPlugin(ctx, &pb.PluginUnregister{
        PluginName: req.PluginName,
    })
    if err != nil {
        return nil, err
    }
```

loading , executing and unloading methods

METHODOLOGY

Evidence for Completion

```go
filename := req.FileName
filedata := req.FileData
savePath := filepath.Join("plugins", filename)

// Ensure the directory exists
dir := filepath.Dir(savePath)
err := os.MkdirAll(dir, 0755)
if err != nil {
    log.Printf("Failed to create directory: %v", err)
    return &pbv.NewPluginCreateResponse{
        Success: false,
        Message: "Failed to create directory",
    }, err
}

// Save the file
err = os.WriteFile(savePath, filedata, 0644)
if err != nil {
    log.Printf("Failed to save the file: %v", err)
    return &pbv.NewPluginCreateResponse{
        Success: false,
        Message: "Failed to save the file",
    }, err
}

//run the plugin.sh command file to unzip, install and run docker container
cmd := exec.Command("/bin/bash", "plugin.sh")
cmd.Stdout = os.Stdout
cmd.Stderr = os.Stderr

err = cmd.Run()

if err != nil {
    log.Printf("Failed to execute command file: %v", err)
    return &pbv.NewPluginCreateResponse{
        Success: false,
```

New plugin creation service code

```bash
#!/bin/bash

# Unzip the cutting.zip file from customPlugins directory
echo "Unzipping cutting.zip from Plugins..."
if unzip plugins/cutting.zip -d plugins/unzipped_cutting; then
  echo "Unzip successful."
else
  echo "Failed to unzip cutting.zip. Exiting..."
  exit 1
fi

# Change directory to the unzipped folder
SPECIFIC_FOLDER="plugins/unzipped_cutting/cutting"
echo "Changing directory to $SPECIFIC_FOLDER"
cd "$SPECIFIC_FOLDER" || { echo "Failed to change directory to $SPECIFIC_FOLDER. Exiting..."; exit 1; }

# Check if the Dockerfile exists
DOCKERFILE="cutting.dockerfile"
if [ ! -f "$DOCKERFILE" ]; then
  echo "Dockerfile $DOCKERFILE not found. Exiting..."
  exit 1
fi

# Run go mod tidy
echo "Running go mod tidy..."
if go mod tidy; then
  echo "go mod tidy successful."
else
  echo "Failed to run go mod tidy. Exiting..."
  exit 1
fi

# Build the Docker image
echo "Building Docker image..."
if docker build -t cutting_plugin -f "$DOCKERFILE" .; then
  echo "Docker image build successful."
else
```

New plugin creation command file

COMPLETION AND FUTURE WORKS

1.Implementation of Plugin Architecture

2.Implementation of Docker for containerization.

3.Implementation of Dynamic plugin management.

4.Implementation of New Plugin management.

5.Implementation of the sensor module.

6.Implementation of the blockchain module.

7. Evaluating the system.

PROJECT REQUIRMENTS

Functional Requirements:

- The Core System should be resilient to errors.
- Plugin loading, execution, and unloading should be dynamic.
- A new plugin should be created in the runtime

User Requirements:

- Usability
- Accessibility
- Customization
- Real-time Data
- Security

Non-Functional Requirements:

- The core system shall respond to user requests within [specify time limit, e.g., 2 seconds]
- The plugin shall be able to handle increasing workloads without significant performance degradation.
- The core system shall employ industry-standard encryption techniques to protect data in transit and at rest.

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4. J. LIEDTKE, “ON MICRO-KERNEL CONSTRUCTION,” IN *PROCEEDINGS OF THE FIFTEENTH ACM SYMPOSIUM ON OPERATING SYSTEMS PRINCIPLES*, 1995, PP. 237-250.
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A CUSTOMIZATION TOOL FOR WORKFLOW MANAGEMENT

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INTRODUCTION

- Existing workflow management in coco-peat manufacturing is often rigid and complex.
- Customization of processes requires technical expertise, limiting flexibility for non-technical users.
- Workflows vary significantly across different manufacturing processes, adding complexity.
- Need for an intuitive tool that allows domain experts to easily customize and manage workflows without technical knowledge.

RESEARCH GAP

- Existing workflow tools are static and lack the ability to dynamically adjust workflows in response to changing inputs or conditions.
- Many workflow systems offer limited customization options, and those that do often require users to have technical knowledge to modify workflows. (e.g. scripting or coding skills)
- Many existing tools struggle to manage complex, multi-step workflows that involve multiple dependencies, approvals, and team members.

RESEARCH QUESTION

How can a dynamic and customizable workflow system be developed that is user-friendly for domain-specific users with non-technical expertise?

OBJECTIVES

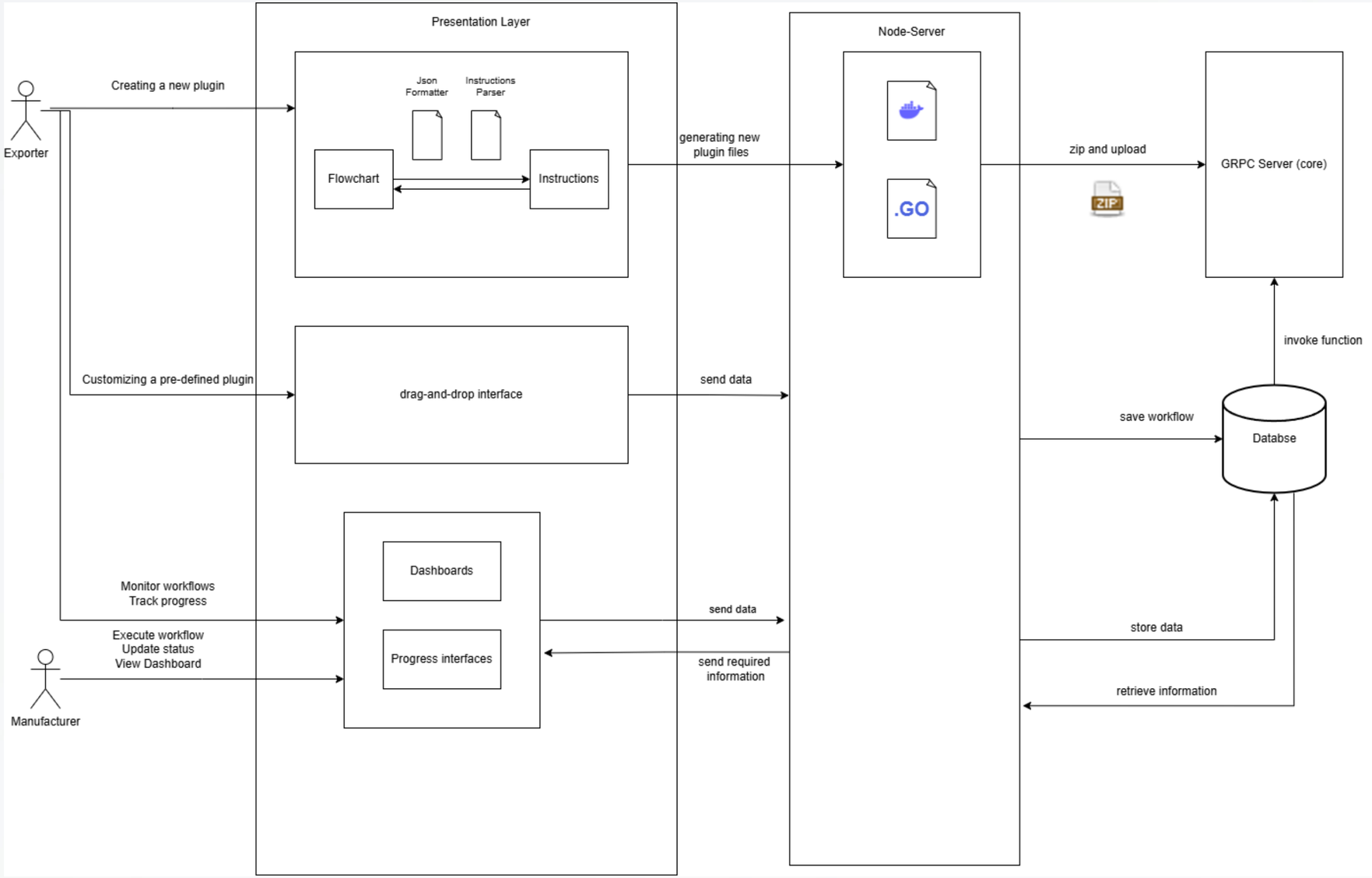
Main Objective: To design and implement a user-friendly, no-code workflow customization interface for domain-specific users (non-programming experts)

Specific Objectives:

- Develop a drag-and-drop interface for workflow customization.
- Create a library of pre-built, domain-specific workflow templates.
- Enable real-time modifications with instant workflow previews.
- Develop a monitoring interface for workflow progress and execution.
- Establish a system for ensuring workflow accuracy and performance.

METHODOLOGY

System Diagram



TECHNICAL DECISIONS

REST API for internal communication

- Easy to implement, stateless communication

JWT (JSON Web Tokens):

- No need for server-side session storage.
- Signed and encrypted tokens ensure integrity.

Role-Based Access Control (RBAC):

- Roles (Exporter, Manufacturer) control access to resources.
- Ensures appropriate user access, preventing unauthorized actions.

TECHNICAL DECISIONS

Flowchart for Plugin Creation

- Simplifies complex workflows for non-technical users.
- Ensures consistency in the plugin creation process.

Converting Flowchart to JSON format

- Allows programmatic parsing and logic execution.
- Easily integrates with different systems and platforms.
- Easy to modify and extend the flowchart logic.

Role-Based Access Control (RBAC):

- Roles (Exporter, Manufacturer) control access to resources.
- Ensures appropriate user access, preventing unauthorized actions.

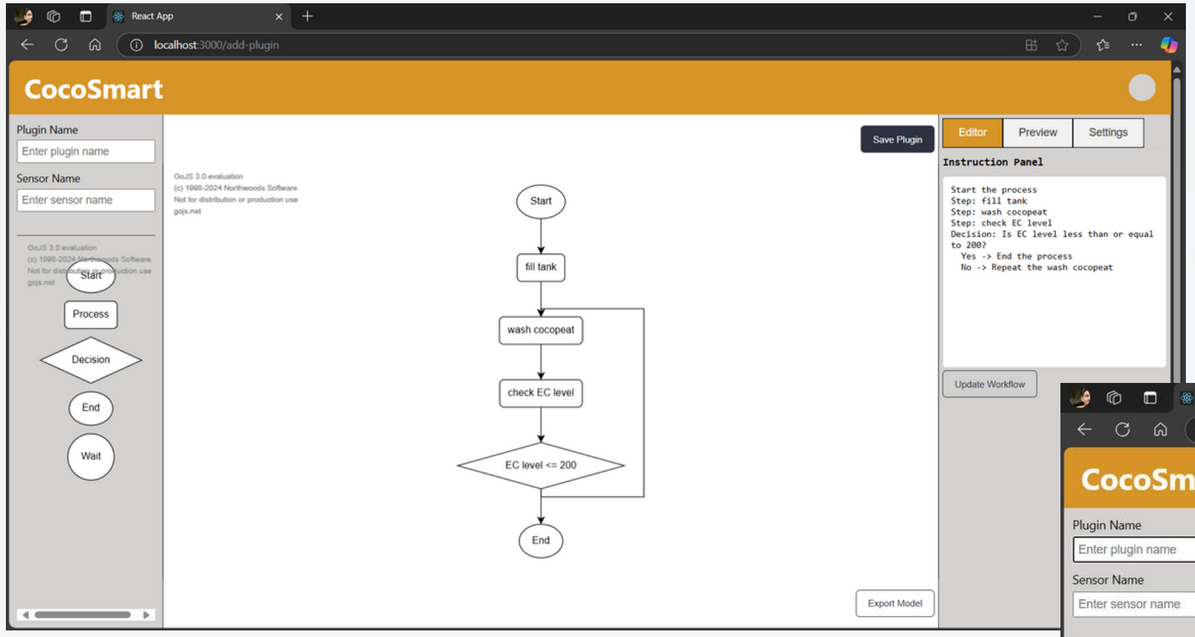
TECHNICAL DECISIONS

Zipped Plugin Files

- Reduces bandwidth and storage requirements.
- Consolidates multiple files into a single, manageable package.
- Ensures integrity and prevents incomplete uploads.

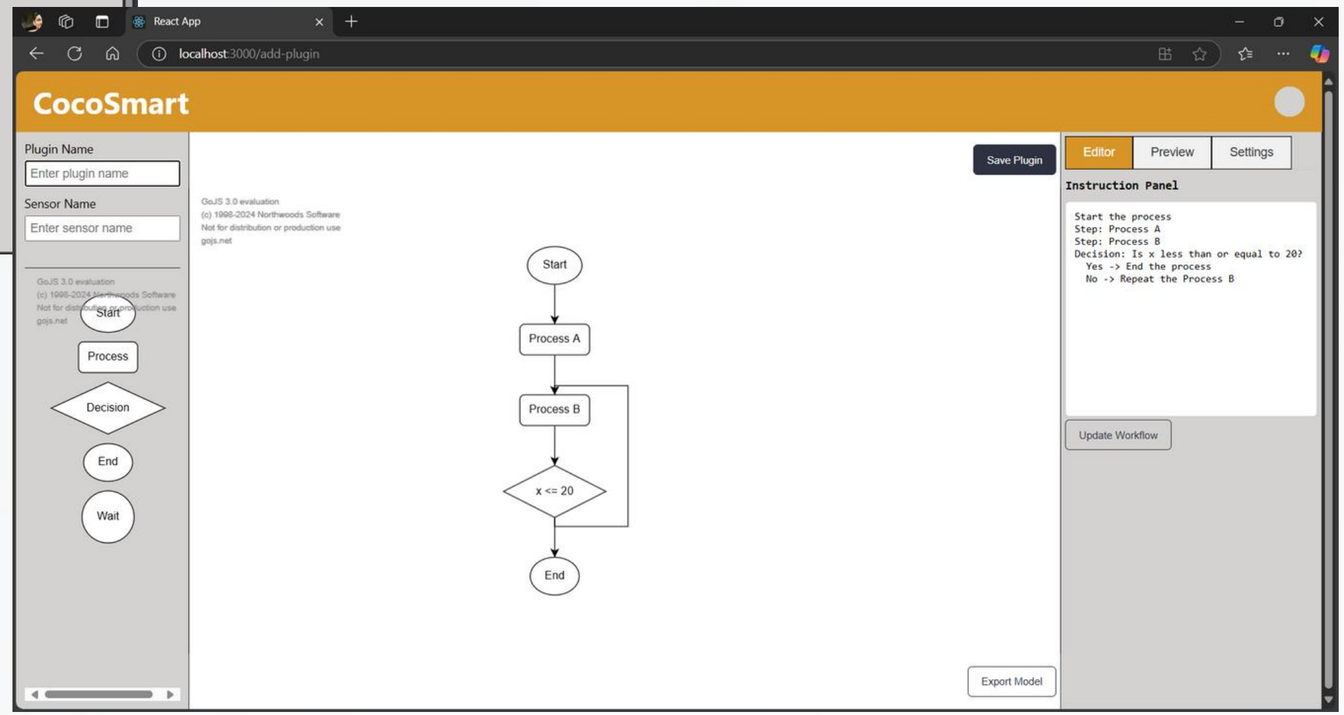
METHODOLOGY

Evidence for Completion



Converting flowchart to instructions

Converting instructions to flowchart



METHODOLOGY

Evidence for Completion

dslGenerator.js

frontend > src > utils > dslGenerator.js > generateDSL

```
export function generateDSL(json) {
  const { nodes, links } = json;
  let instructions = "";

  // Validation Step 1: Check that 'nodes' and 'links' are valid arrays
  if (!Array.isArray(nodes)) {
    throw new Error("Invalid input: 'nodes' must be an array.");
  }
  if (!Array.isArray(links)) {
    throw new Error("Invalid input: 'links' must be an array.");
  }

  // Validation Step 2: Validate nodes
  const nodeKeys = new Set();
  nodes.forEach((node) => {
    if (!node.key) throw new Error(`Node with missing 'key' found.`);
    if (nodeKeys.has(node.key))
      throw new Error(`Duplicate node key found: ${node.key}`);
    nodeKeys.add(node.key);

    // Check for valid category and text
    if (
      !node.category ||
      !["Start", "Process", "Decision", "End"].includes(node.category)
    ) {
      throw new Error(`Invalid node category found: ${node.category}`);
    }
    if (!node.text)
      throw new Error(
        `Node with key ${node.key} is missing 'text' description.`
      );
  });

  // Validation Step 3: Validate links
  links.forEach((link) => {
    if (!link.from || !link.to) {
      throw new Error(
```

Code snippet of instructions generating function

Code snippet of json format generating function

jsonGenerator.js

frontend > src > utils > jsonGenerator.js > generateJSON > lines.forEach() callback

```
export function generateJSON(instructions) {

  const lines = instructions.split("\n");
  const json = { nodes: [], links: [] };

  let lastNode = null;
  let decisionNode = null;
  let yesNode = null;
  let noNode = null;
  let actionNodes = {}; // To track action nodes by label

  lines.forEach((line, index) => {
    if (line.startsWith("Start the process")) {
      json.nodes.push({
        id: 1,
        key: 1,
        type: "Start",
        category: "Start",
        label: "Start",
        text: "Start",
      });
      lastNode = 1;
    } else if (line.startsWith("Step")) {
      const label = line.match(/Step: (.+)/)[1];
      const id = json.nodes.length + 1;
      json.nodes.push({
        id,
        key: id,
        type: "Action",
        category: "Process",
        label,
        text: label,
      });
      if (lastNode) json.links.push({ from: lastNode, to: id });
      lastNode = id;
      actionNodes[label] = id; // Store the action node with its label
    } else if (line.startsWith("Decision")) {
```

METHODOLOGY

Evidence for Completion

Code snippets of new plugin creation function

pluginController.js

backend > controllers > pluginController.js > processAll > processAll

```
const fs = require("fs");
const path = require("path");
const archiver = require("archiver");
const grpc = require("@grpc/grpc-js");
const protoLoader = require("@grpc/proto-loader");
const axios = require("axios");
const { updateFile } = require("../controllers/fileWriter");
const { generateFile } = require("../controllers/fileWriter");

// Load the protobuf
const PROTO_PATH = path.join(
  __dirname,
  "../grpc-node-server/file_service.proto"
);
const packageDefinition = protoLoader.loadSync(PROTO_PATH, {
  keepCase: true,
  longs: String,
  enums: String,
  defaults: true,
  oneofs: true,
});

const fileServiceProto =
  grpc.loadPackageDefinition(packageDefinition).fileservice;

// Create a client
const client = new fileServiceProto.FileService(
  "localhost:50051",
  grpc.credentials.createInsecure()
);

exports.processAll = async (req, res) => {
  try {
    const {
      updateContent,
      goFileContent,
      plugin_name,
```

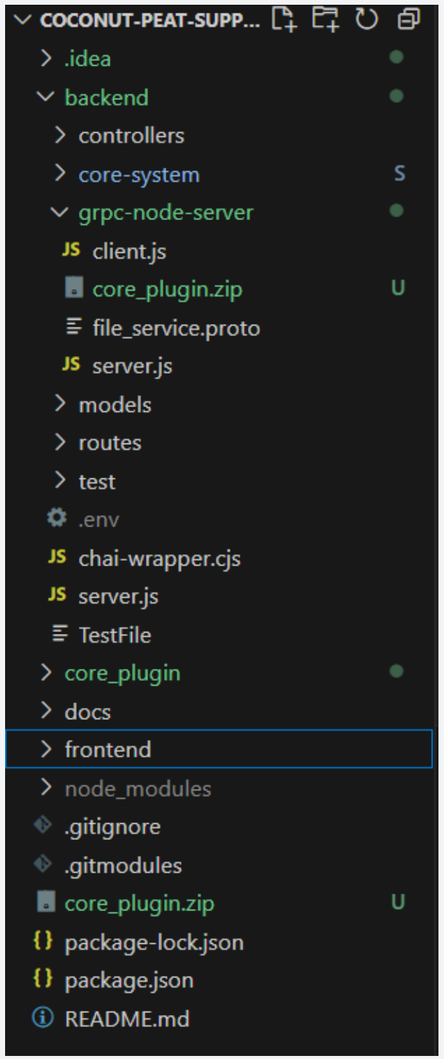
pluginController.js

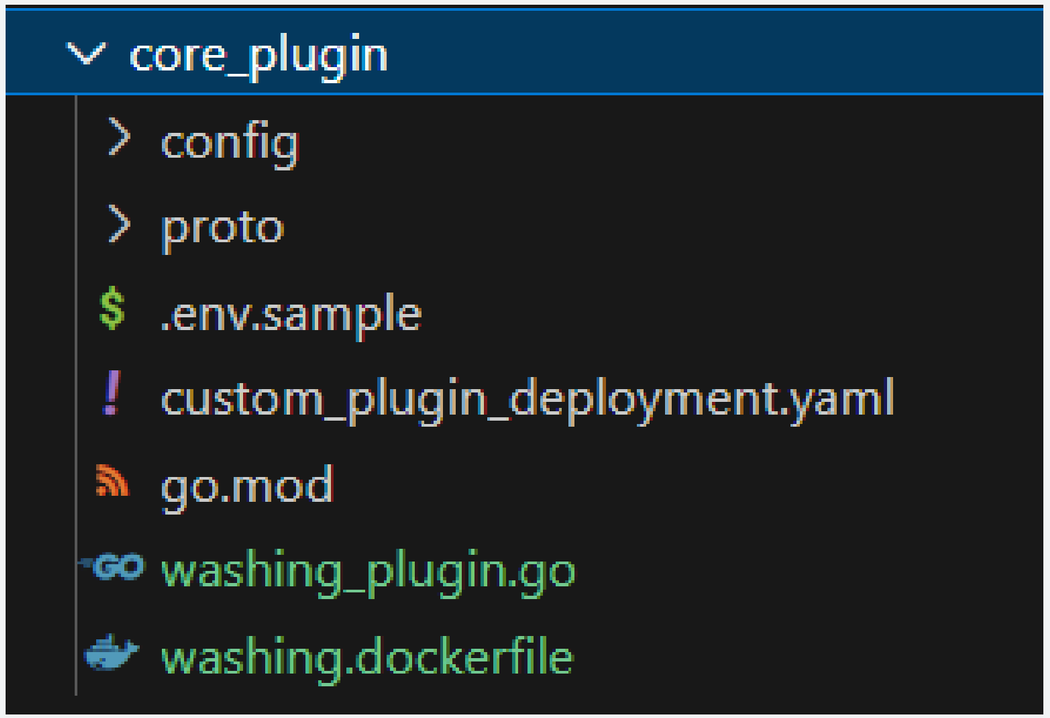
backend > controllers > pluginController.js > processAll > processAll

```
exports.processAll = async (req, res) => {
      .then(() => {
      });
    })
    .catch((err) => console.error("Error zipping folder:", err));
} catch (err) {
  console.error("Error processing all steps:", err);
  res
    .status(500)
    .json({ message: "Error processing all steps", error: err.message });
}
};

// Folder Zip method
function zipFolder(folderPath, outputZipPath) {
  return new Promise((resolve, reject) => {
    // Create a file to stream the archive data to.
    const output = fs.createWriteStream(outputZipPath);
    const archive = archiver("zip", { zlib: { level: 9 } }); // Best compression level

    // Listen for events
    output.on("close", () => {
      console.log(`Zipped ${archive.pointer()} total bytes`);
      resolve();
    });

    archive.on("error", (err) => reject(err));

    // Pipe archive data to the output file
    archive.pipe(output);

    // Append the folder to the archive
    archive.directory(folderPath, false); // `false` prevents nesting in a subfolder

    // Finalize the archive
    archive.finalize();
  });
```

METHODOLOGY

Evidence for Completion





- Folder directory after uploading the zipped file to the grpc server(core)
- Includes new docker file and go file

Completion of Tasks

60%

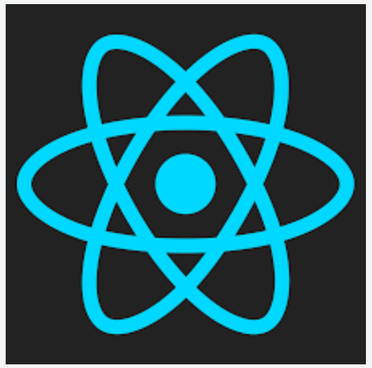
- **Drag-and-drop interface for workflow customization completed.**
- **Sidebar with predefined plugins and real-time DSL preview implemented.**
- **Refined bidirectional DSL and flowchart mapping.**
- **Structural validation for workflow nodes.**
- **Login page and basic styling applied.**
- **Workflow serialization and core system communication via gRPC implemented.**
- **User authentication API (JWT) and role-based access implemented.**

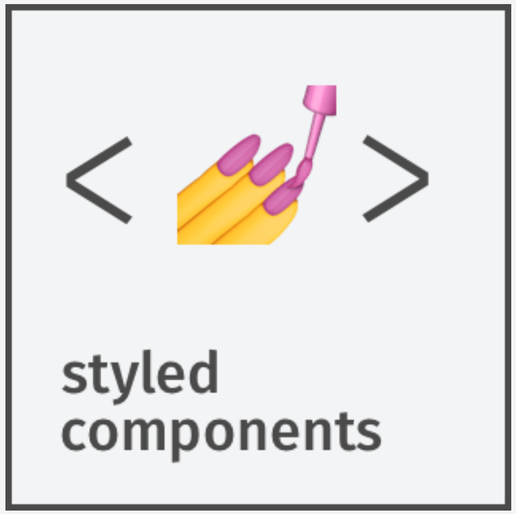
Future Works

- Finalize signup page, dashboard, status update and progress tracker styling.
- Implement version control for database integration.
- Implement cycle detection and property validation.
- Perform unit, integration, security and performance testing.
- Complete user documentations.

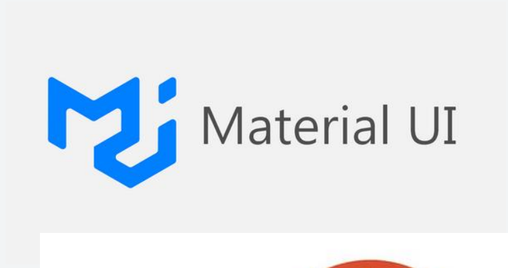
40%

Technologies

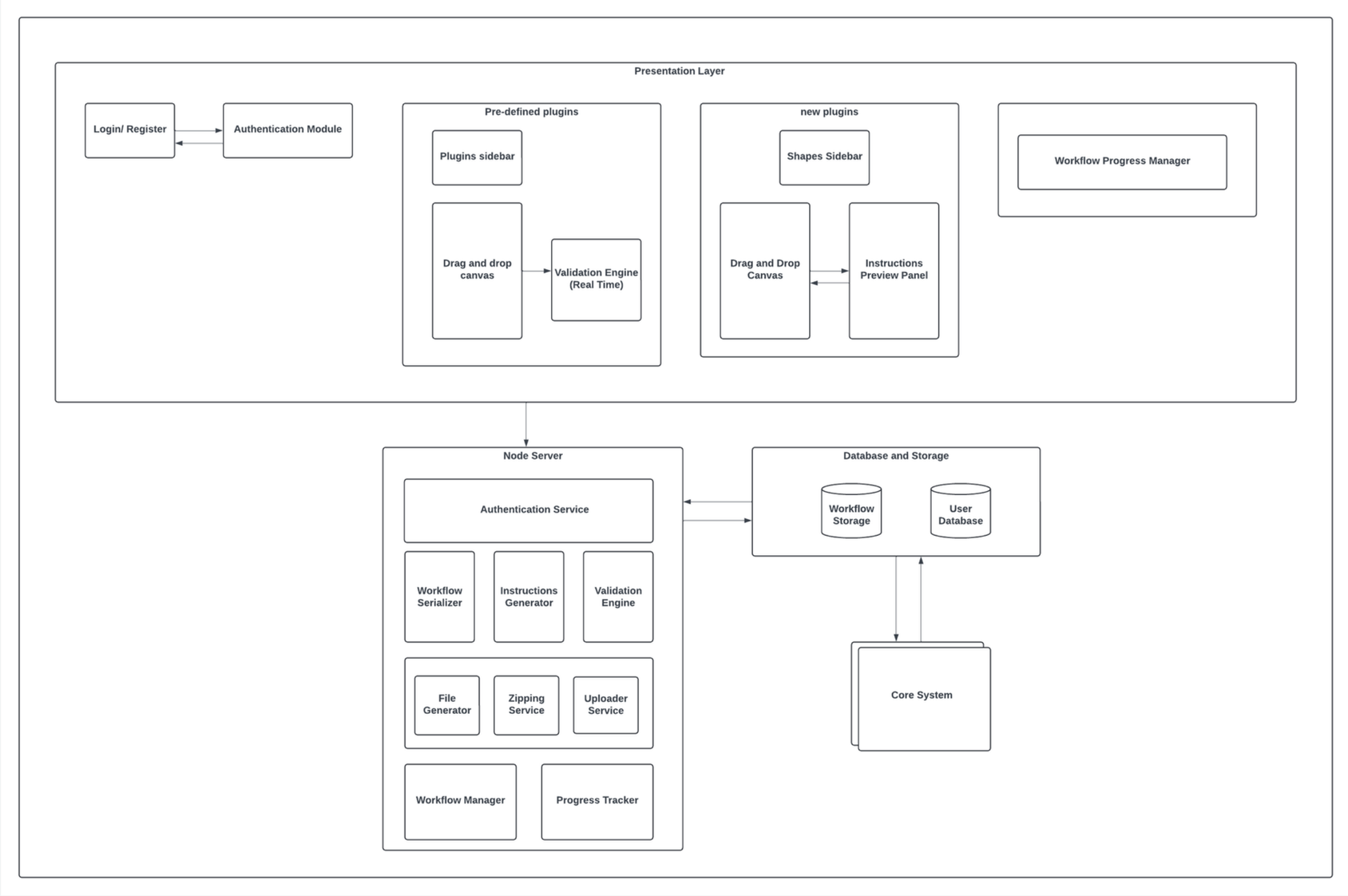




gRPC



Component Diagram



SIMILAR TOOLS

PROJECT REQUIREMENTS

Functional Requirements:

- Customizable workflows for different manufacturing processes.
- Drag-and-drop interface for easy workflow setup.
- Real-time updates and monitoring of workflows.
- Role-based access control.

Non-Functional Requirements:

- Fast response time (under 1 second for most actions).
- Strong encryption for sensitive data (in transit and at rest).
- 99.9% system uptime and high availability.

PROJECT REQUIREMENTS

User Requirements:

- Non-technical users must be able to customize workflows easily.
- Users should be able to generate reports and analytics.
- Intuitive interface with minimal learning curve.

System Requirements:

- Compatibility with existing manufacturing hardware and software.
- Scalability to handle multiple concurrent users and large datasets.
- Secure storage of workflow configurations.

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INTEGRATION OF BLOCKCHAIN

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CURRENT SUPPLY CHAIN CHALLENGES

- Lack of transparency.
- Issues with traceability.
- Quality control problems.
- Inefficiencies and fraud risks.

RESEARCH GAP

While existing studies and best practices address gas efficiency in Solidity smart contracts, there is limited focus on systematically analyzing how code complexity in **common design patterns** directly affects gas usage.

RESEARCH PROBLEM

- Lack of transparency and traceability in the coco-peat supply chain.
- Traditional approaches fail to ensure data integrity and real-time visibility.
- How to effectively integrate blockchain to enhance transparency and traceability in the coco-peat supply chain.

How can the application of techniques to reduce code complexity in existing smart contract design patterns enhance gas efficiency without compromising functionality and security in Solidity-based blockchain applications?

OBJECTIVES

Main Objective: To develop and evaluate techniques for reducing code complexity in Solidity smart contract design patterns, thereby enhancing gas efficiency while maintaining functionality and security.

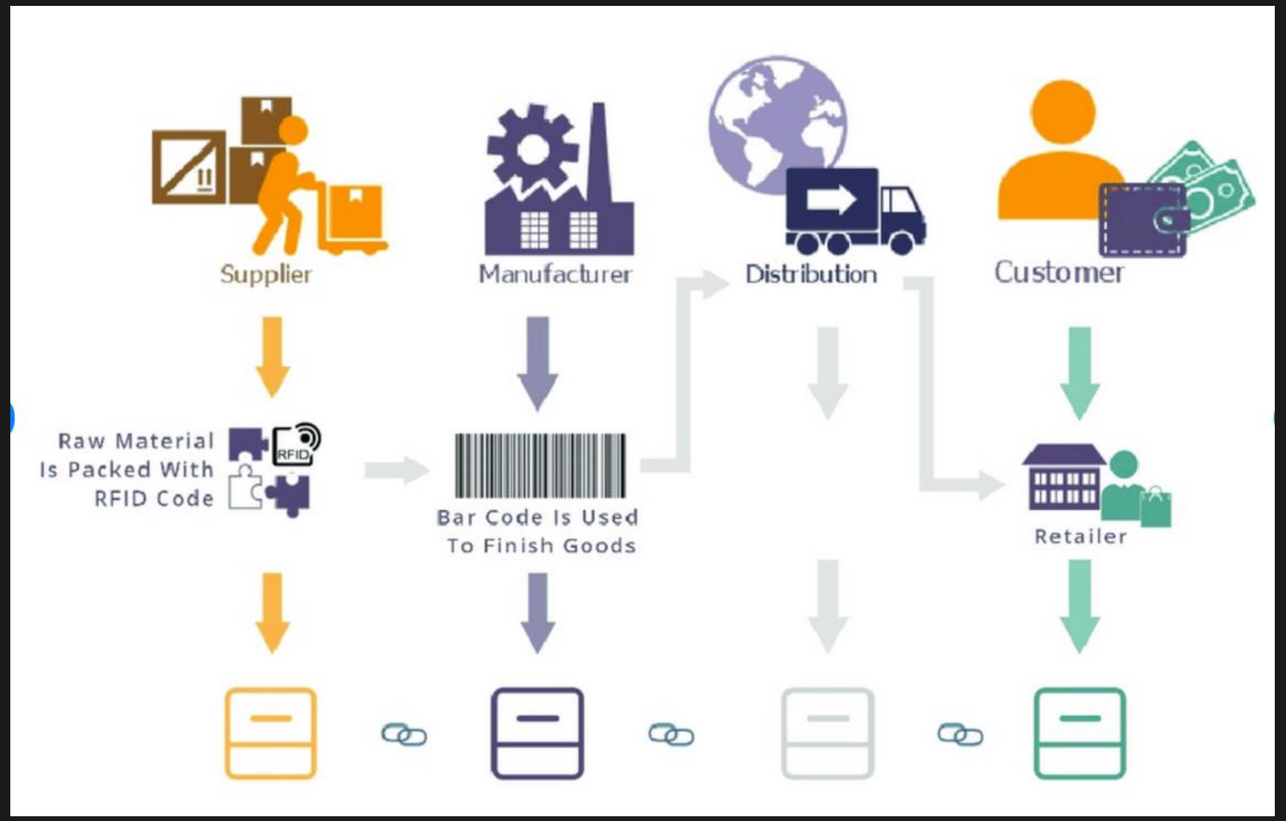
Specific Objectives:

1. Identify key pain points in the current supply chain.
2. Select an appropriate blockchain platform.
3. Design smart contracts.
4. Implementing blockchain.
5. Test and validate the system.

What is Blockchain ?

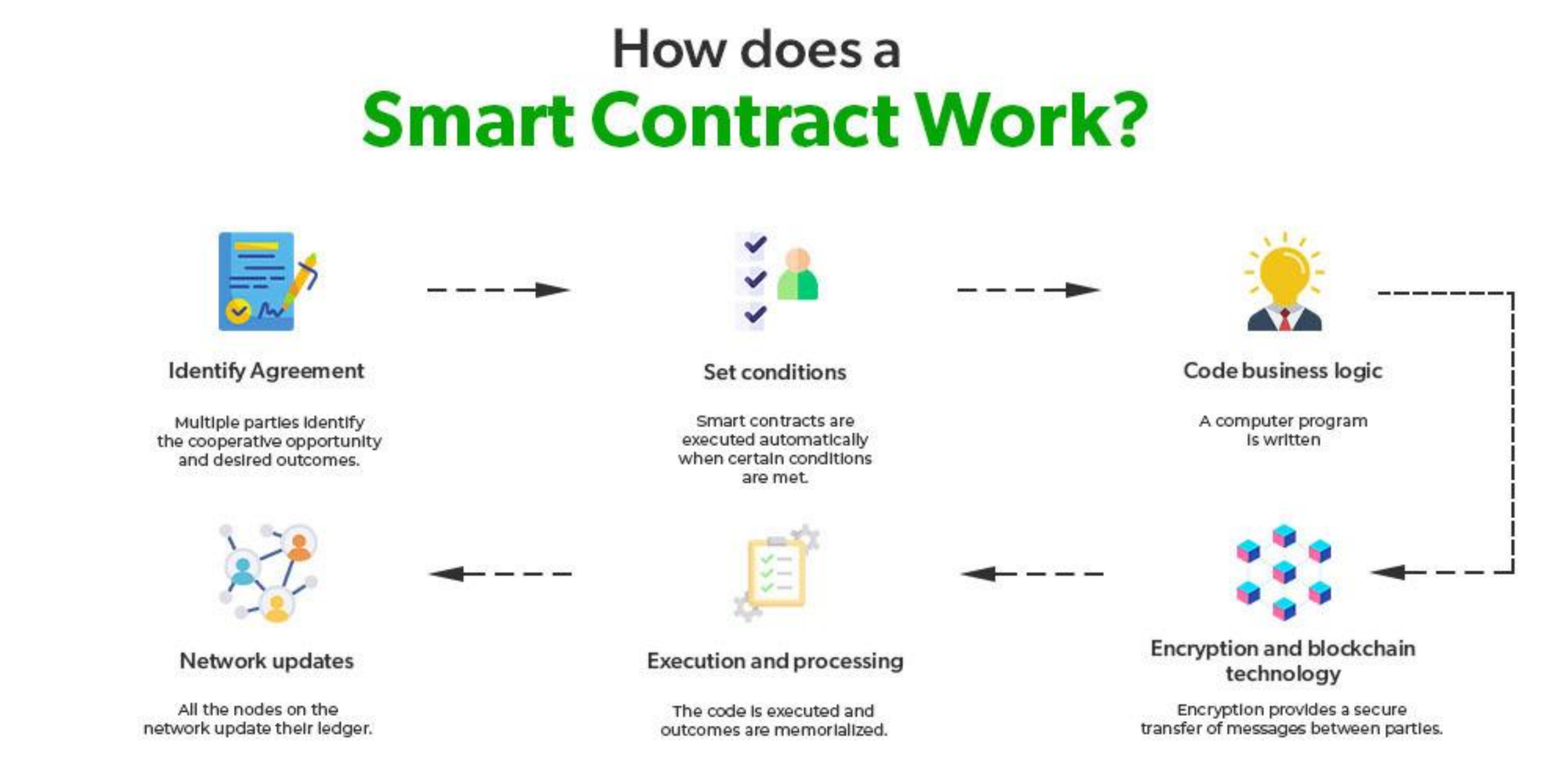
Blockchain is a type of digital ledger that records transactions across multiple computers in a way that ensures the data cannot be altered

1. Decentralized
2. Immutable
3. Transparency



What is a Smart Contract ?

A smart contract is a program that exists on the blockchain that run when some predetermined conditions are met.



Overview of Blockchain Technologies

Platform	Features	Pros	Cons
Ethereum	Decentralized, smart contracts, public blockchain	Wide adoption, robust smart contract functionality	Scalability issues, **high transaction fees**
Hyperledger Fabric	Permissioned blockchain, modular architecture	High scalability, privacy features, enterprise-focused	More complex setup, less decentralized
Corda	Permissioned blockchain, designed for financial institutions	High privacy, efficient for bilateral transactions	Limited to financial use cases, less flexibility

Smart Contract Testing

```solidity
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;

contract ProductFactoryComplex {
    address public owner;
    mapping(address => bool) public admins;
    mapping(address => bool) public productsRegistry;

    struct Product {
        string name;
        uint256 state; // 0: Created, 1: Shipped, 2: Delivered
        address owner;
    }

    mapping(address => Product) public products;

    event ProductCreated(address indexed productAddress, string name);
    event StateUpdated(address indexed productAddress, uint256 newState);

    modifier onlyAdmin() {
        require(admins[msg.sender], "Not an admin");
        _;
    }

    modifier onlyOwnerOrAdmin() {
        require(msg.sender == owner || admins[msg.sender], "Not authorized");
        _;
    }

    constructor() {    947081 gas 895400 gas
        owner = msg.sender;
        admins[owner] = true;
    }

    function addAdmin(address _admin) external onlyOwnerOrAdmin {    29258 gas
        admins[_admin] = true;
    }

    function createProduct(string memory _name, address _productAddress) external onlyAdmin {    infinite gas
        require(!productsRegistry[_productAddress], "Product already exists");
        products[_productAddress] = Product(_name, 0, msg.sender);
        productsRegistry[_productAddress] = true;
        emit ProductCreated(_productAddress, _name);
    }

    function updateState(address _productAddress, uint256 _newState) external onlyAdmin {    infinite gas
        require(productsRegistry[_productAddress], "Product not registered");
        require(_newState > products[_productAddress].state, "Invalid state transition");
```

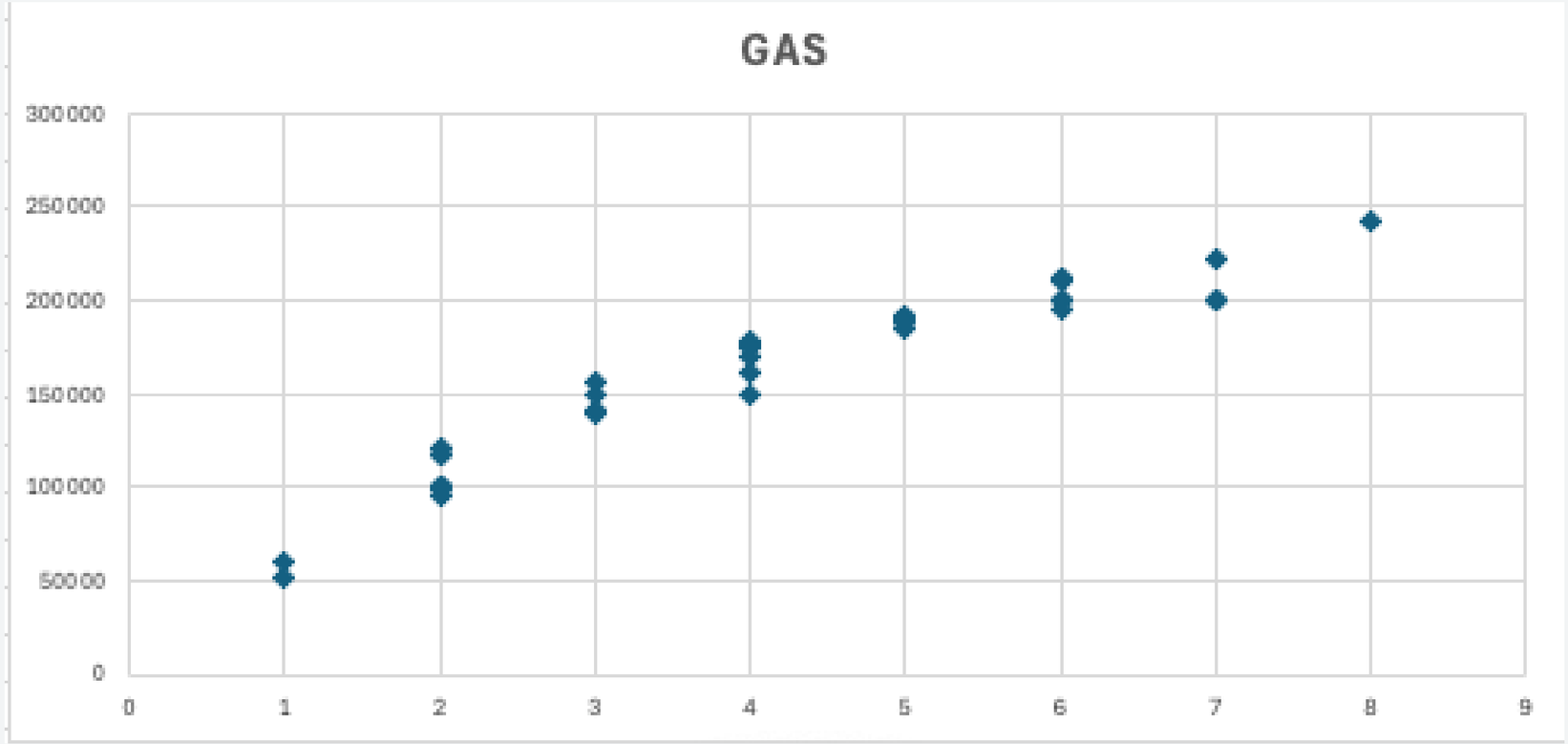
A product creation contract

Calculating the Code Complexity

$$\text{Cyclomatic Complexity} = E - N + 2P$$

Where:

- E = Number of edges in the control flow graph.
- N = Number of nodes in the control flow graph.
- P = Number of connected components (usually 1 for a single function).



	A	B
1	Complexity	Gas
2	3	156032
3	2	120444
4	4	178478
5	5	190901
6	6	212456
7	2	99567
8	4	160834
9	2	117879
10	5	188976
11	2	95787
12	4	175432
13	6	200874
14	5	191754
15	2	100437
16	7	222054
17	1	50921
18	4	169239
19	8	241753
20	5	189634
21	3	149765
22	4	176909
23	2	118076
24	6	210897
25	7	200342
26	3	139654
27	7	200898
28	4	149004
29	5	185798
30	6	199987
31	2	100898
32	5	188432
33	6	195043
34	3	141233
35	1	60921

With this,

Code Complexity $\propto$ Gas amount

Techniques to reduce the cyclomatic complexity

1. Calling outer contract functions
2. Avoiding deep nesting
3. Reducing data structure
   complexity
4. Minimizing data types
5. Eleminating validation logics
6. Bulk operations
7. Refactoring repeated logic
8. Leveraging libraries (Solidity)

Efficiency

With the implementation of multiple techniques
The gas amount went from
1,224,933 to 880,161

28% decrease the gas amount spent for the deployment of this contract

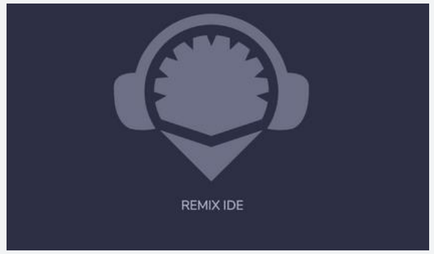
Methodology

Technology used

The selected Blockchain technology

Etherium development environment

Smart contract writing language



Solidity deployment Environment

Digital wallet

Version Controlling

COMPLETION AND FUTURE WORKS

1.Deploying the test blockchain network

2.Deployment and testing of techniques to reduce code complexity

3.Deployment of smart contracts

4.Implementing the gas efficient smart contracts

5.Implementation Blockchain network to the coco peat supplychain.

6.Implementation of the test network

7. Evaluating the system.

Functional Requirents

- Real-time data capture.
- Immutable ledger.
- Smart contract automation.
- User access control.
- Traceability interface.

Non-Functional Requirements

- The application should process at least 100 transactions per second during peak usage
- The system should have a recovery time objective (RTO) of 15 minutes.

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COCONUT HUSK GRADING SYSTEM USING IMAGE PROCESSING AND COMPUTER VISION. IOT AUTOMATION FOR COCO PEAT QUALITY ASSURANCE

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BACKGROUND

- Using qualified husks is necessary to produce high-quality cocopeat products.
- Finding quality coconut husks is a challenge

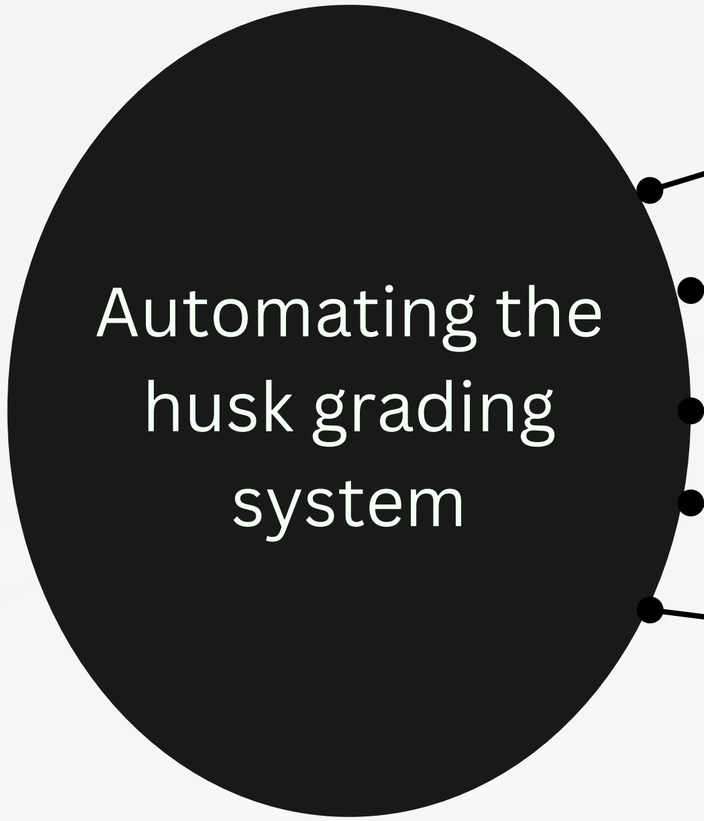
RESEARCH QUESTION

Identifying which technology is suitable for this husk grading system?

Computer vision **Or** **Image processing**

OBJECTIVES

Main Objectives:



Sub Objectives:

- Computer vision model training and image processing algorithm designing
- Tracking and comparing performances of the models and algorithms
- identifying which technology is suitable for this system
- Implement algorithem in the hardware
- IOT automation system for coco peat quality assurance system

METHODOLOGY
COMPUTER VISION

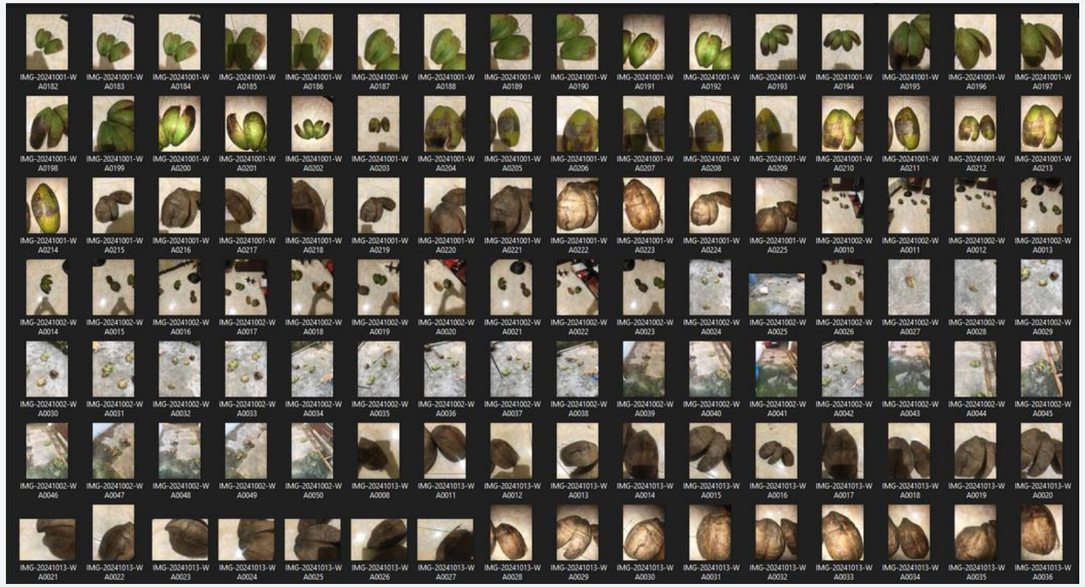
YOLOv5

SSD

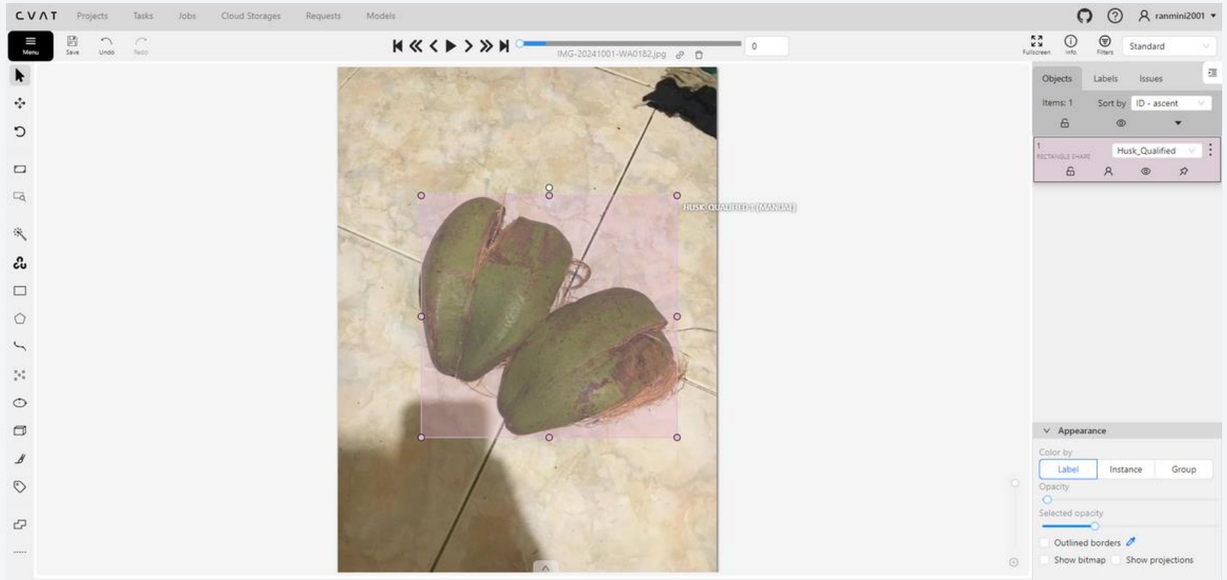
CNN

METHODOLOGY
DATA COLLECTION AND PREPARATION FOR COMPUTER VISION

YOLOv5



Dataset

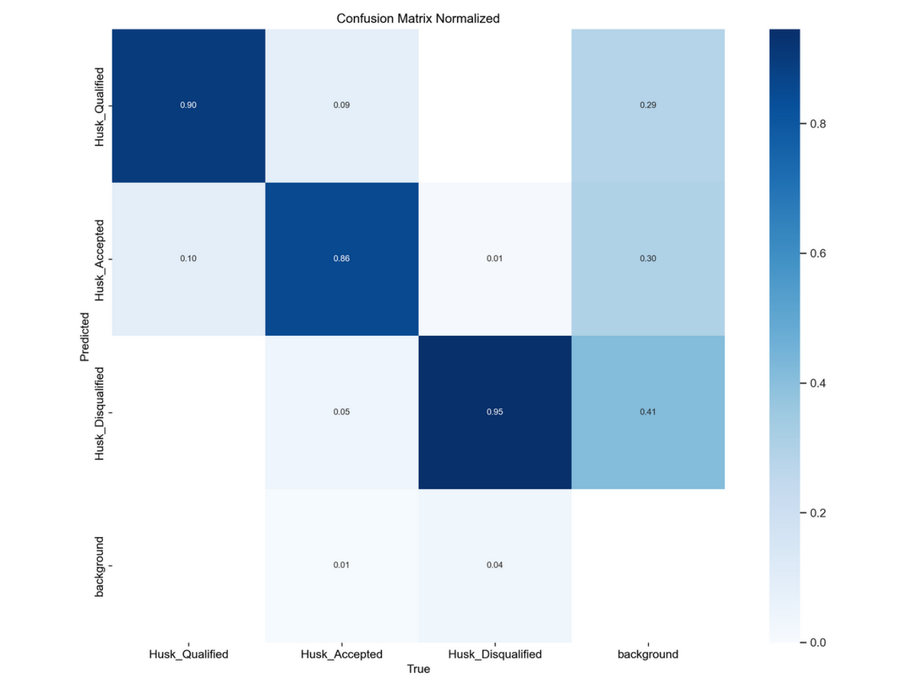


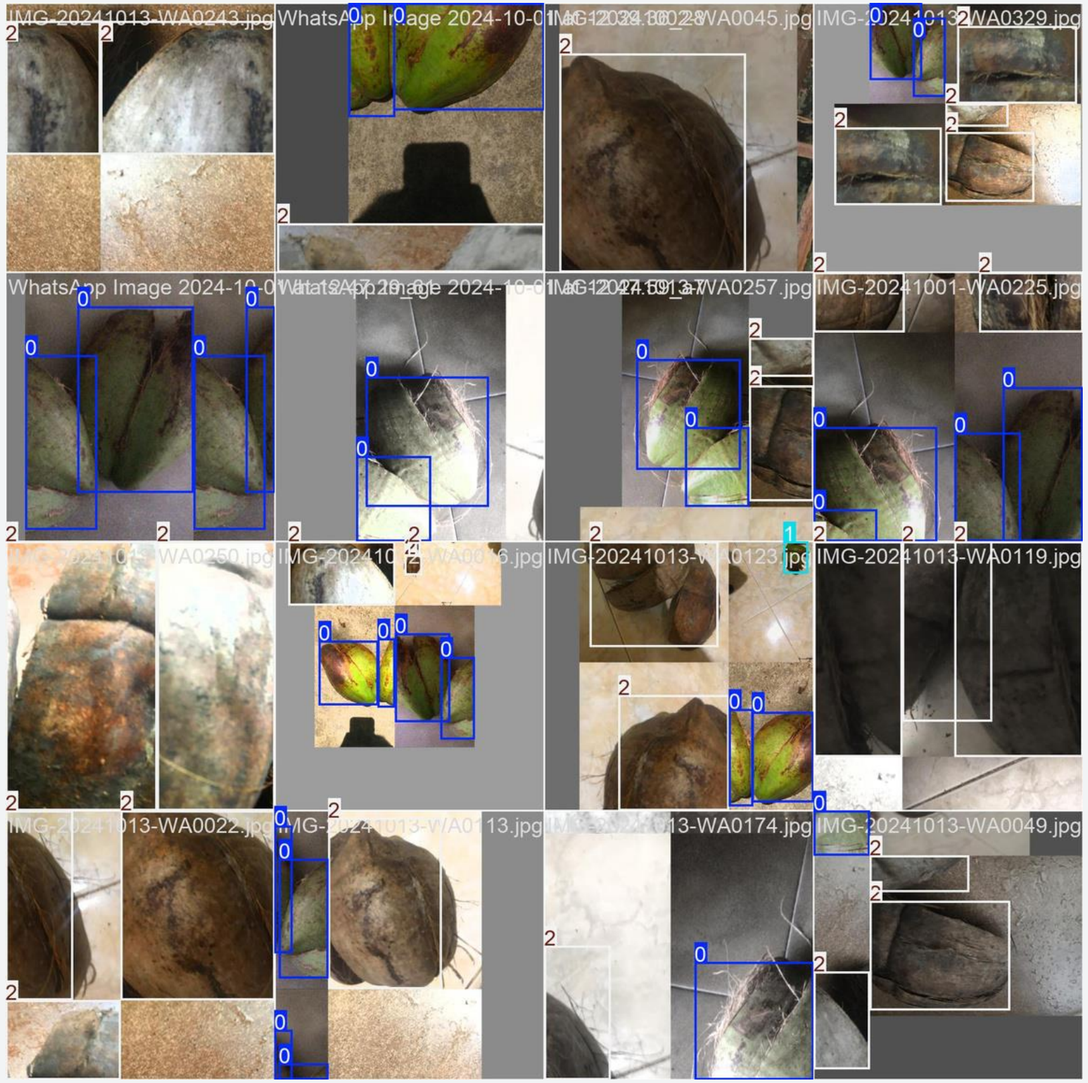
Data annotation

METHODOLOGY

DATA COLLECTION AND PREPARATION FOR COMPUTER VISION

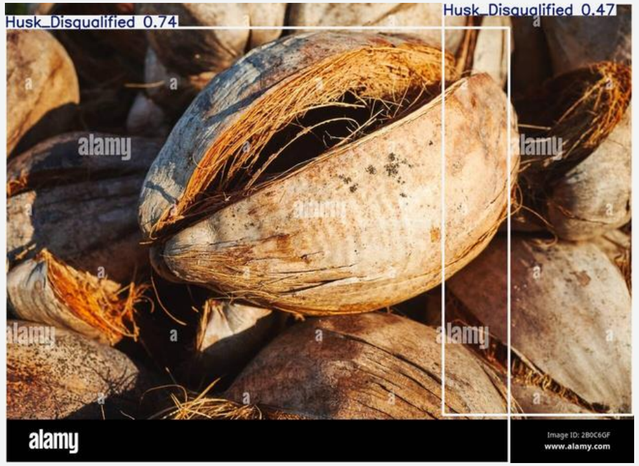
```python
from ultralytics import YOLO

# Load a model
model = YOLO("yolo11n.pt")

# Train the model
train_results = model.train(
    data="config.yaml",  # path to dataset YAML
    epochs=20,  # number of training epochs
    imgsz=640,  # training image size
    device="cpu",  # device to run on, i.e. device=0 or device=0,1,2,3 or device=cpu
)
```

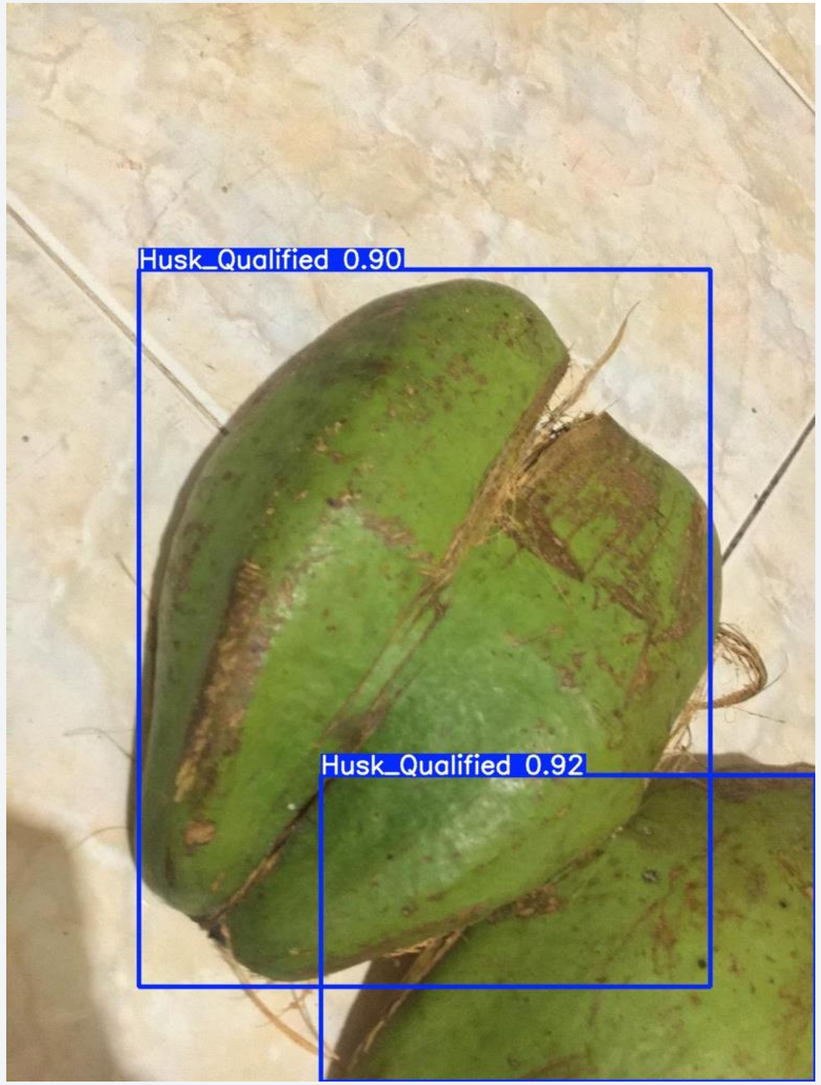




METHODOLOGY
MODEL TESTING

YOLOv5





METHODOLOGY
IMAGE PROCESSING TECHNIQUES

- **Basic color thresholding**

```
qualified_hue_min, qualified_hue_max = 35, 85
qualified_sat_min, qualified_val_min = 50, 50

# Accepted (Yellowish/Brownish)
accepted_hue_min, accepted_hue_max = 15, 35
accepted_sat_min, accepted_val_min = 80, 80

# Disqualified (Dark/Brownish)
disqualified_sat_max = 45  # Low saturation
disqualified_val_max = 85  # Low value (dark)
```

HSV color ranges

checks if pixel values fall within a specified range

- **Color thresholding with edge detection(Canny edge detection)**

```
qualified_hsv_range = [(40, 60, 60), (75, 255, 255)]  # Greenish (Qualified)
accepted_hsv_range = [(20, 60, 60), (30, 200, 200)]   # Narrowed Yellowish/Brownish (Accepted)
disqualified_hsv_range = [(0, 0, 0), (20, 50, 85)]    # Dark brownish tones (Disqualified)
```

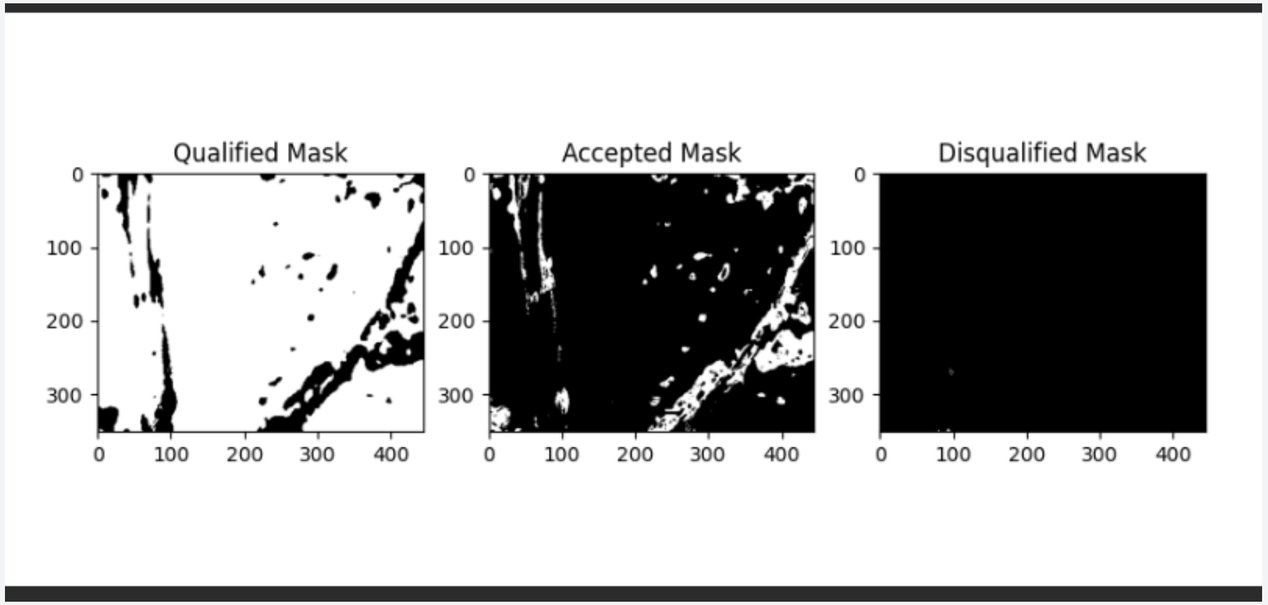
HSV color ranges

finding areas in an image where the intensity changes sharply

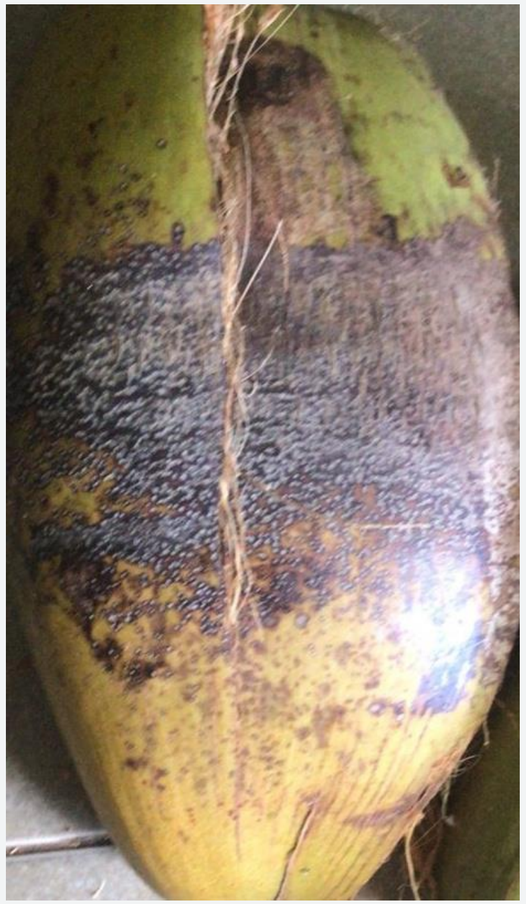
METHODOLOGY

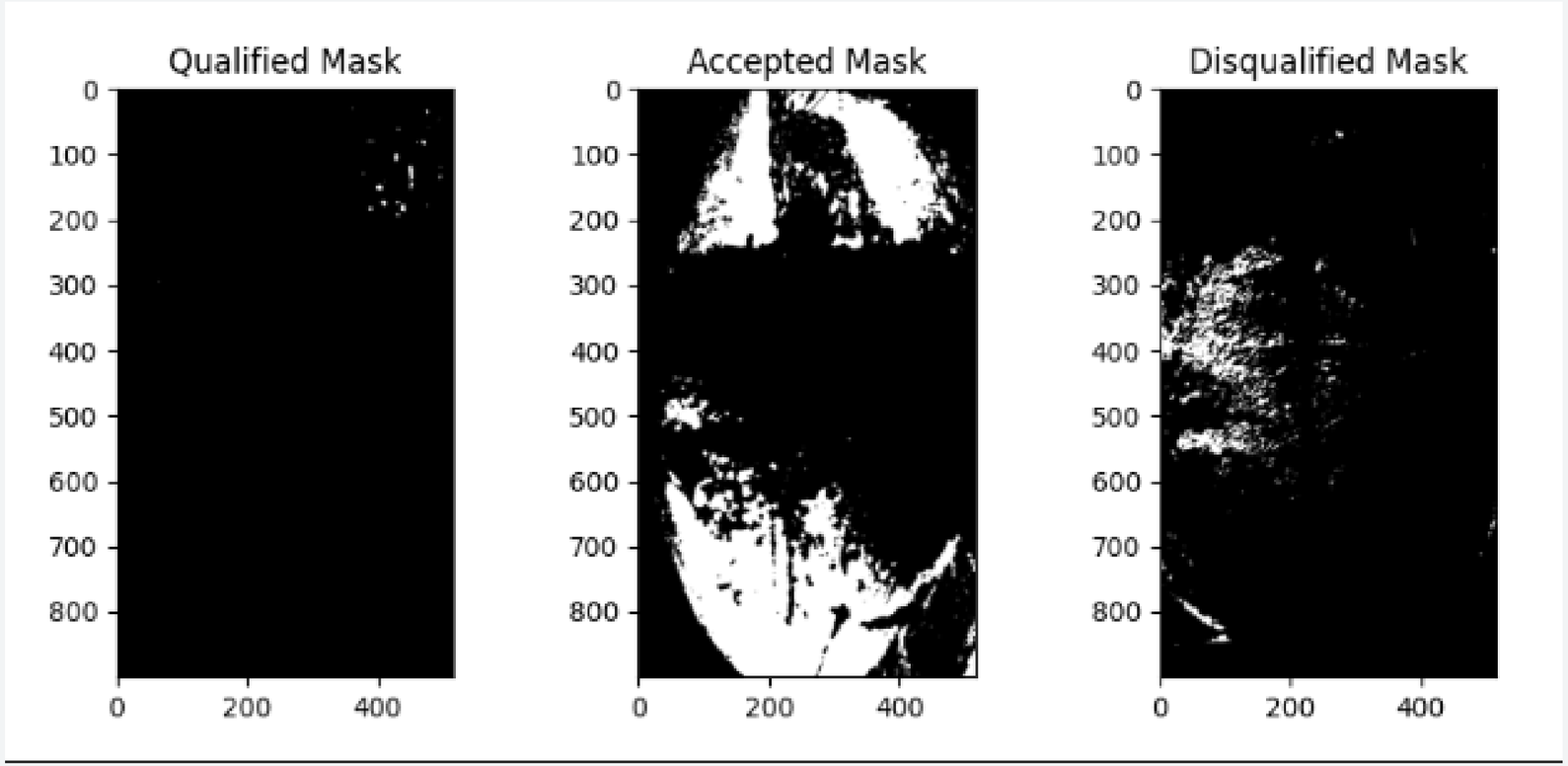
TESTING COLOR THRESHOLDING WITH EDGE DETECTION

original image



METHODOLOGY
TESTING BASIC COLOR THRESHOLDINGS





METHODOLOGY
TRACKING PERFORMANCES

Yolo model

- **Initial time -** 6.5631 seconds
- **Initial memory usage -** 255.53 MB
- **Initial CPU Usage -** 40.00%

Color thresholding with edge detection

- **Initial time -** 0.0148 seconds
- **Initial memory usage -** 967.06 KB
- **Initial CPU Usage -** 25.00%

Basic color thresholding

- **Initial time -** 1.771138 seconds
- **Initial memory usage -** 4158.83 KB
- **Initial CPU Usage -** 45.60%

METHODOLOGY
HARDWARE SOLUTION

ESP -

32

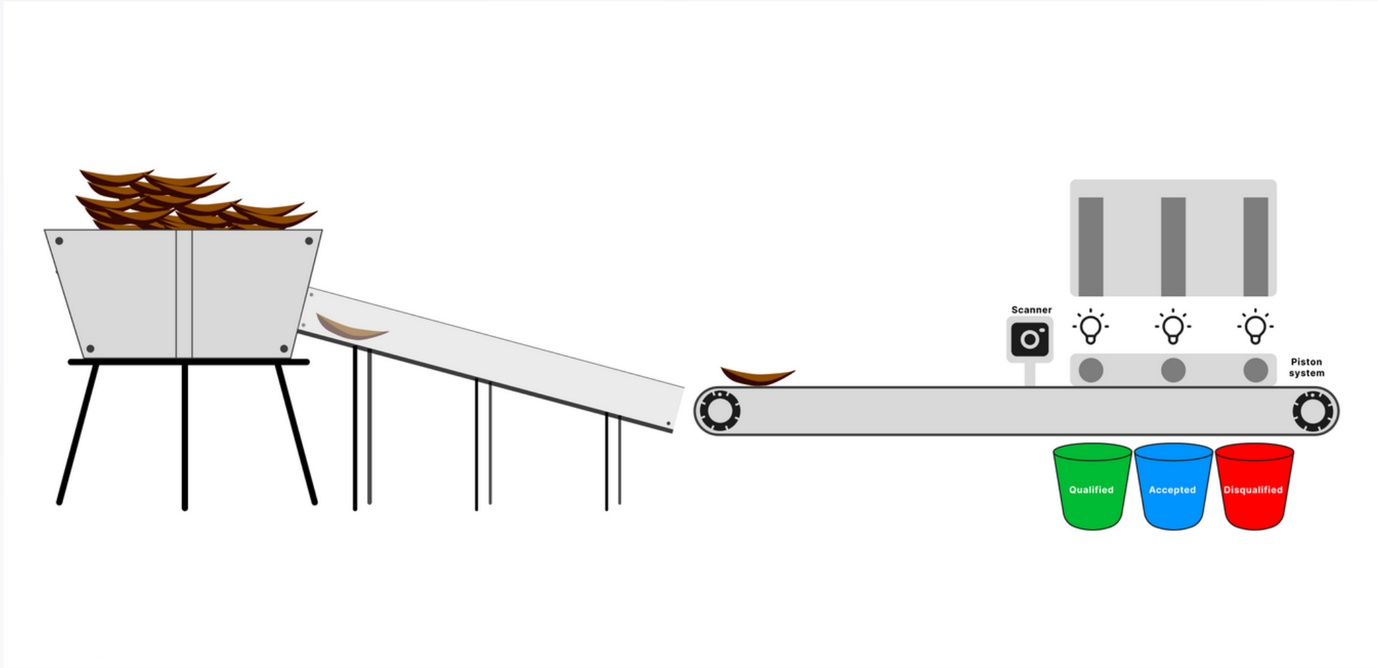
Raspberry pi

METHODOLOGY
COMPATIBILITY WITH ESP-32

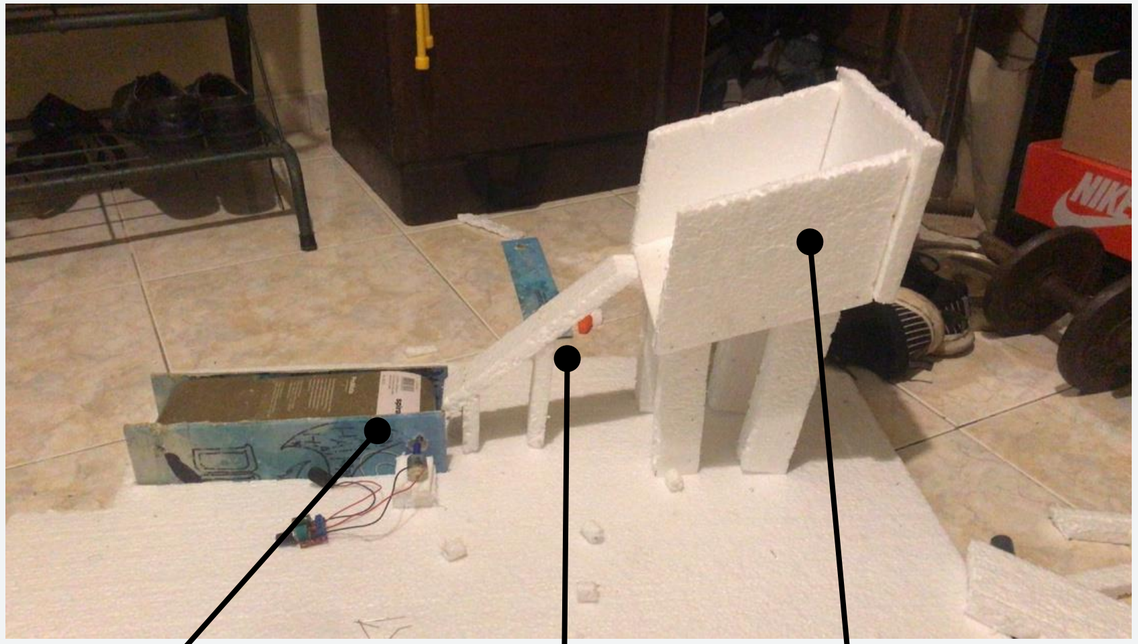
	Yolo model	Basic Thresholding	Thresholding with edge detection
Initial time	High	Moderate	Low
CPU usage	Moderate	Moderate	Low
Memory Usage	High	Moderate	Low
Compatibility with ESP 32	Not directly compatible	Fully compatible	Compatible
Accuracy	High	Moderate	High

METHODOLOGY
HUSK TRANSFER MACHANISM

- Husk container
- Angle tray
- Convey belt
- ESP 32 hardware component with the sensor
- Sorting mechanism



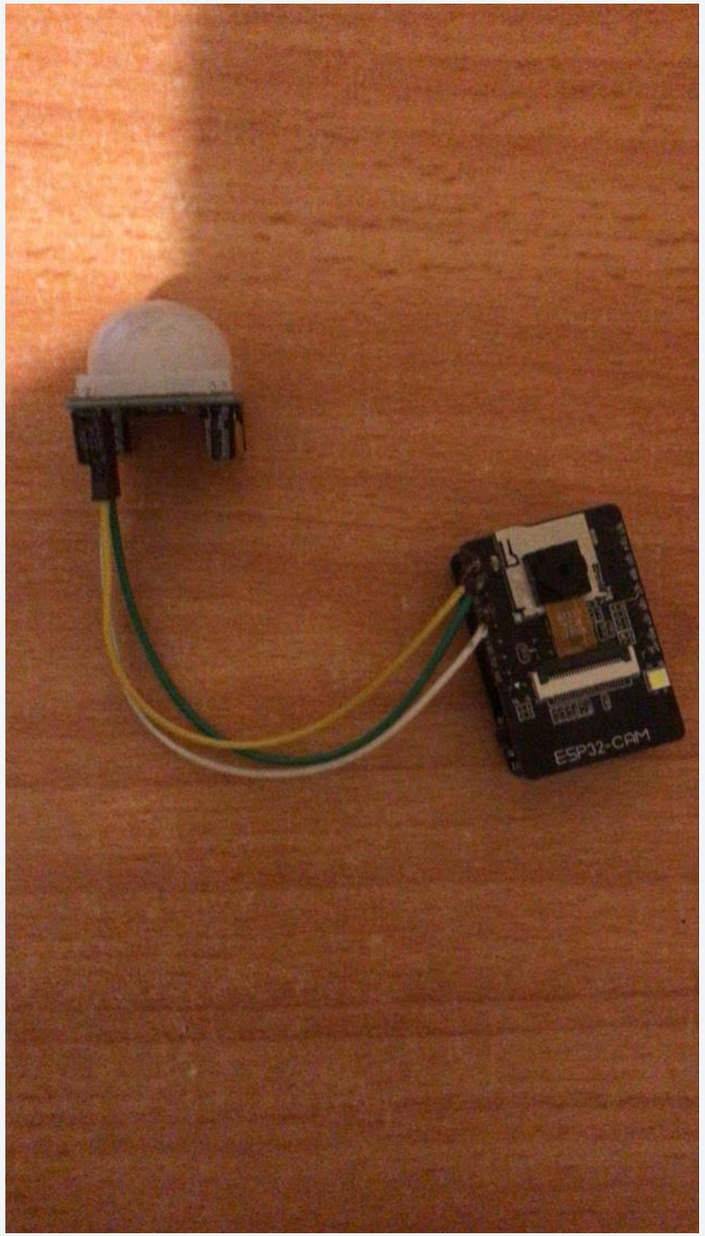
METHODOLOGY
HUSK TRANSFER MACHANISM



Convey belt

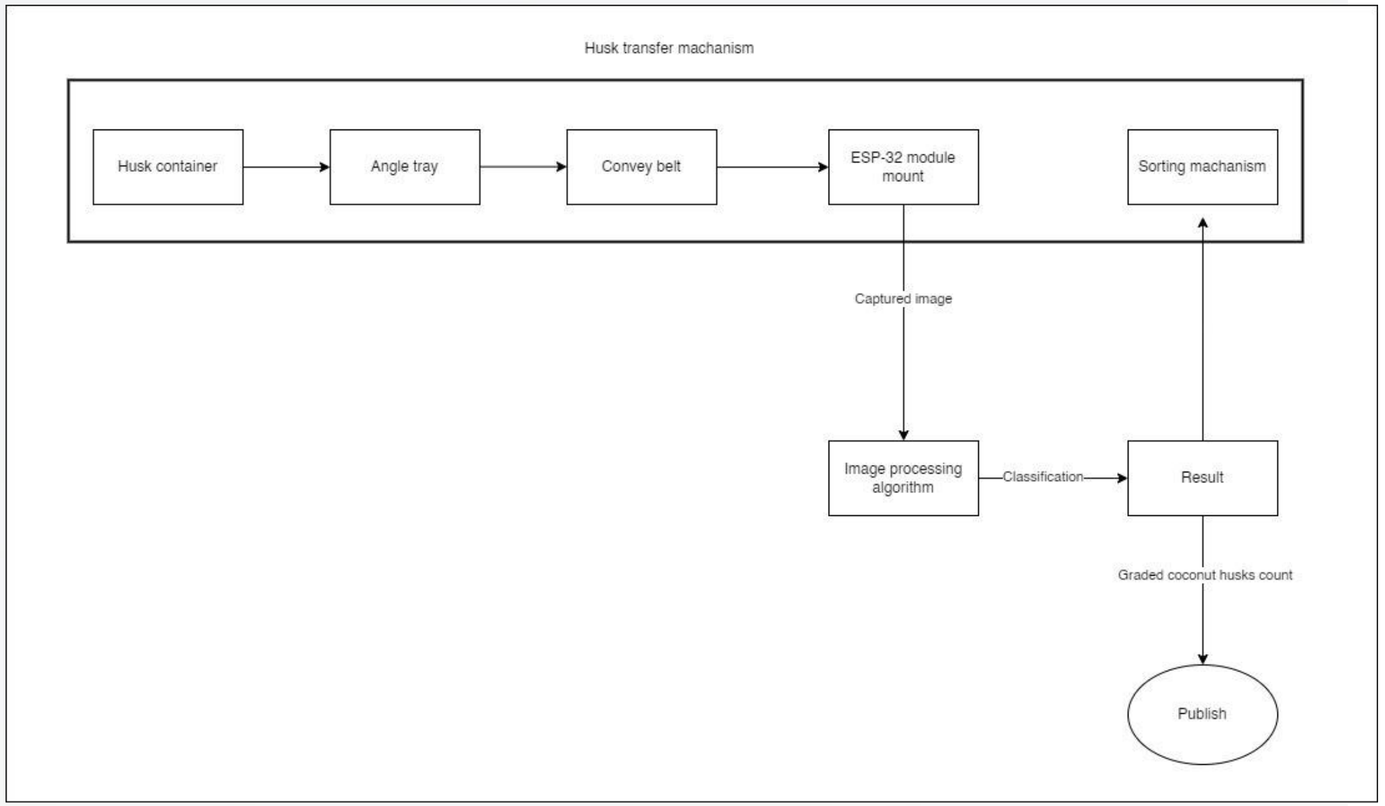
Angle tray

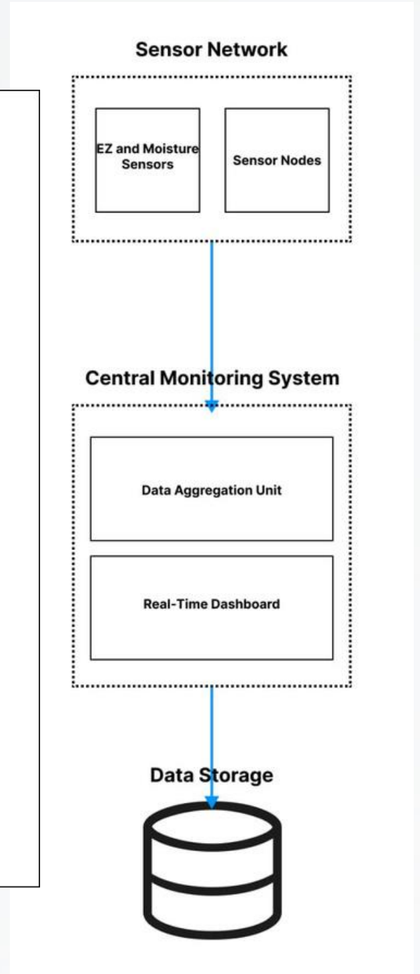
Container



ESP 32 hardware component with sensor

SYSTEM DIAGRAM





TECHNIQUES AND TECHNOLOGIES

TECHNIQUES

- YOLO
- Image segmentation
- Basic color thresholdings

TECHNOLOGIES

- ESP 32 cam
- Open CV
- Matplotlib
- Pytorch

FUNCTIONAL AND NON FUNCTIONAL REQUIREMENTS

FUNCTIONAL

- Image capturing
- Image processing and classification
- Real time processing

NON - FUNCTIONAL

- Accuracy
- Reliability
- Scalability
- Compatibility

COMPLETION AND FUTURE WORKS

- Computer vision model training.
- Image processing algorithm designing
- Tracking and comparing performance matrices
- Husk container, ladder, and convey belt deployment.
- Optimize the algorithem to be compatible with the ESP-32
- Publish the husk grading count.
- Finalize the husk grading mechanism
- Implement IoT systems for real-time monitoring of coco peat conditions

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THANK YOU !