Smart Agro –
An integrated platform for identification of suitable lands and soil conditions for remunerative crops in Sri Lanka

TMP-23-236

Team Members

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Overall Project Description

- Sri Lanka is experiencing an economic crisis stemming from an unsustainable debt load and perennial deficits on both the international balance of payments and government budget, resulting in a severe shortage of foreign currency exchange.
- Agriculture is one of the most important sectors in Sri Lanka, both in terms of its contribution to the economy and its role in providing livelihoods for a significant proportion of the population.
- Our research project fundamentally focuses on import and export of commercially demanding crops such as perilla, patchouli and saffron.
- The aim of the project is to develop an integrated platform for identification of suitable lands and soil conditions for remunerative crops in Sri Lanka.

Research Problem

- Sri Lanka's agricultural sector has the potential to significantly contribute to the country's economic development, but identifying suitable lands and soil conditions for remunerative crops remains a challenge.

- Currently, there is no integrated platform that provides comprehensive information on soil quality, land use, and crop suitability in Sri Lanka.

- This lack of information makes it difficult for farmers and policymakers to make informed decisions on crop selection and land use, which can lead to reduced agricultural productivity and profitability.

Research Objectives

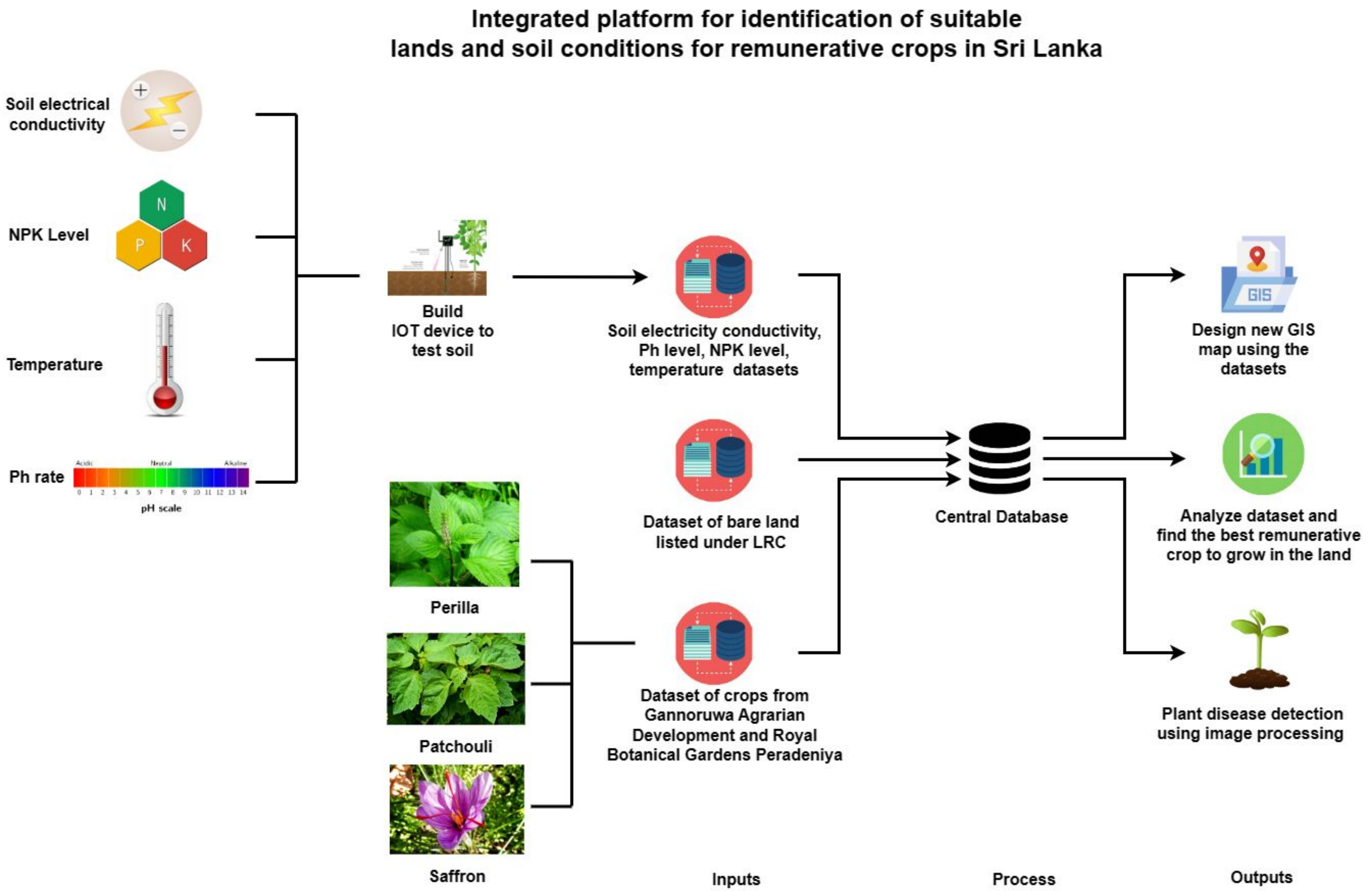
Main Objective:

- Develop an integrated platform for identification of suitable lands and soil conditions for growing remunerative crops in Sri Lanka.

Sub Objectives:

- Monitor and maintain healthy growth of crops by plant disease detection.
- Prediction and analysis to determine whether the selected crop can be grown in given soil condition.
- Soil testing and identification of soil conditions using IOT device.
- Identification of bare lands using GIS map and remote sensing approach.

Overall System Diagram



References

[1]“Sri Lanka: Issues and priority for the agriculture sector | Daily FT,” www.ft.lk. https://www.ft.lk/columns/Sri-Lanka-Issues-and-priority-for-the-agriculture-sector/4-713634

[2]“Are Sri Lanka’s agricultural policies starving our farmers?,” Advocata Institute | Sri Lanka | Independent Policy Think Tank. https://www.advocata.org/commentary-archives/2019/10/20/are-sri-lankas-agricultural-policies-starving-our-farmers#:~:text=The%20Ministry%20of%20Agriculture%20itself%20has%20identified%20the (accessed Feb. 13, 2023).

[3] Author links open overlay panelJagadeesh D. Pujari a *et al.* (2015) *Image processing based detection of fungal diseases in plants*, *Procedia Computer Science*. Elsevier. Available at: https://www.sciencedirect.com/science/article/pii/S187705091500201X (Accessed: March 27, 2023).

IT20096748 | MANCHALEE R.R.N

Information Technology

INTRODUCTION

This Research component is about plant disease identification,

- Plant diseases can have a significant impact on crop yield and quality.
- It is important to identify the plant diseases at an early stage to prevent their spread and minimize damage.
- Image processing techniques can be used to analyze digital images of plants and identify signs of disease.
- Image processing offers a promising approach for rapid and accurate detection of plant diseases, which can help to support more effective disease management and control strategies.

Research Gap

Features	Research A [1]	Research B [2]	Research C [3]	Proposed solution
Provide sustainable solutions to plant diseases	NO	NO	No	YES
Identify diseases in commercially viable plants	NO	NO	Yes	YES
Report Generation	NO	NO	NO	YES
ML techniques	YES	YES	YES	YES
Image processing techniques	YES	YES	YES	YES

Research Problem

- Reduced crop yield
- Quality degradation and low marketability
- Higher production costs
- Crop loss due to reduced shelf life
- Economic losses

Specific and Sub Objectives

Specific Objectives :

- Monitor and maintain healthy growth of commercially viable plants by plant disease detection.

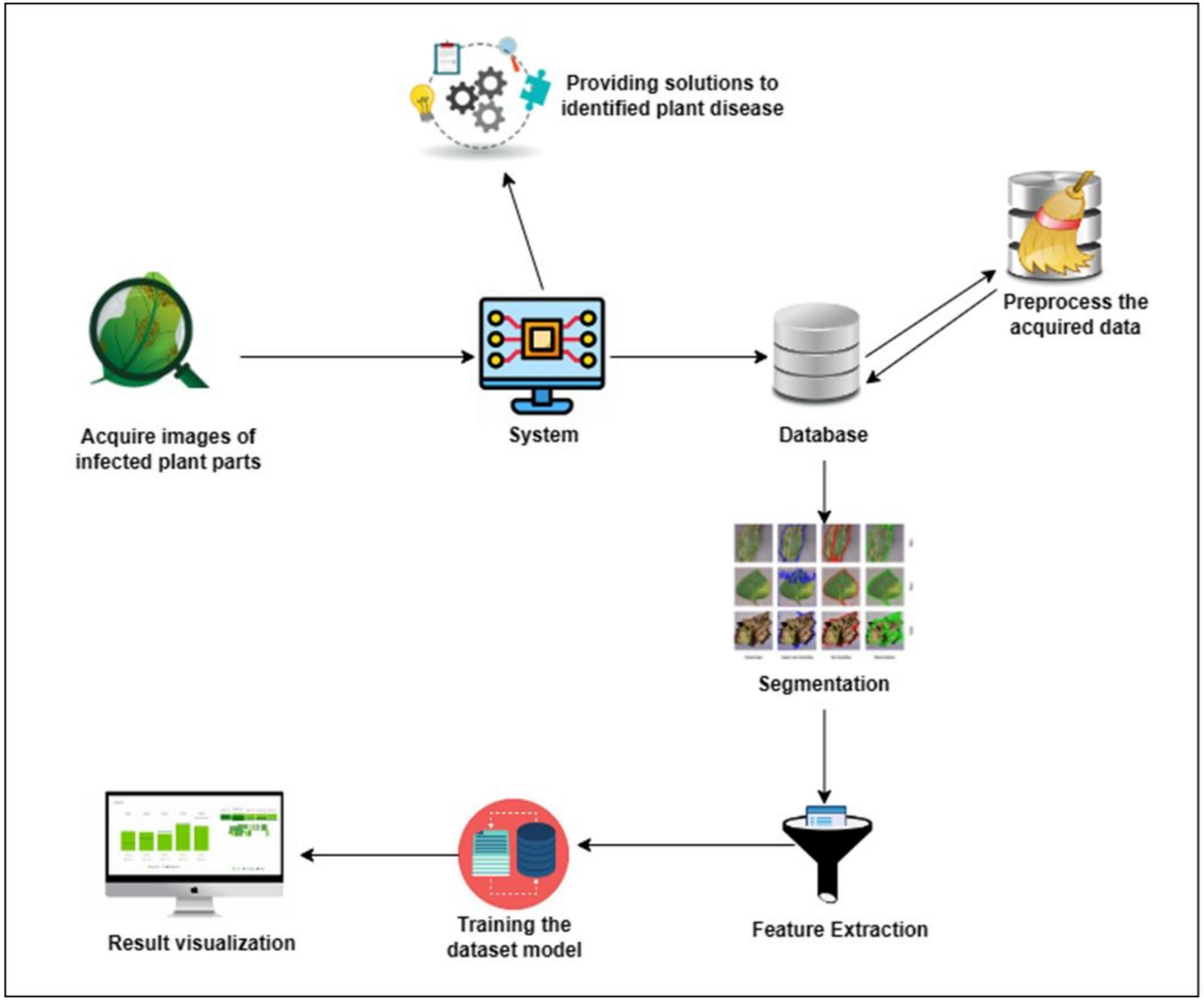
Sub Objectives :

- Provide sustainable solutions for plant diseases
- Generate report of plant diseases

Methodology

- **Image Acquisition:** capturing high quality images of plants using digital cameras.
- **Pre-processing :** captured images are preprocessed to improve image quality
- **Segmentation:** separating the plant parts from the background and isolating the region of interest.
- **Feature Extraction :** Features are extracted from image ,these features may include color, texture, shape, or any other relevant features that can help distinguish between healthy and diseased plants.
- **Classification :** classifying the plant as either healthy or diseased. This involves using machine learning algorithms to train a model that can accurately predict the presence of disease in a given plant.
- **Visualization:** The results are visualized to provide a clear and concise output to the user. This includes highlighting the infected area in the image.
- **Diagnosis :** The system identifies the type of plant disease and suggests appropriate treatment measures, Based on the classification results.

System Diagram



Technologies

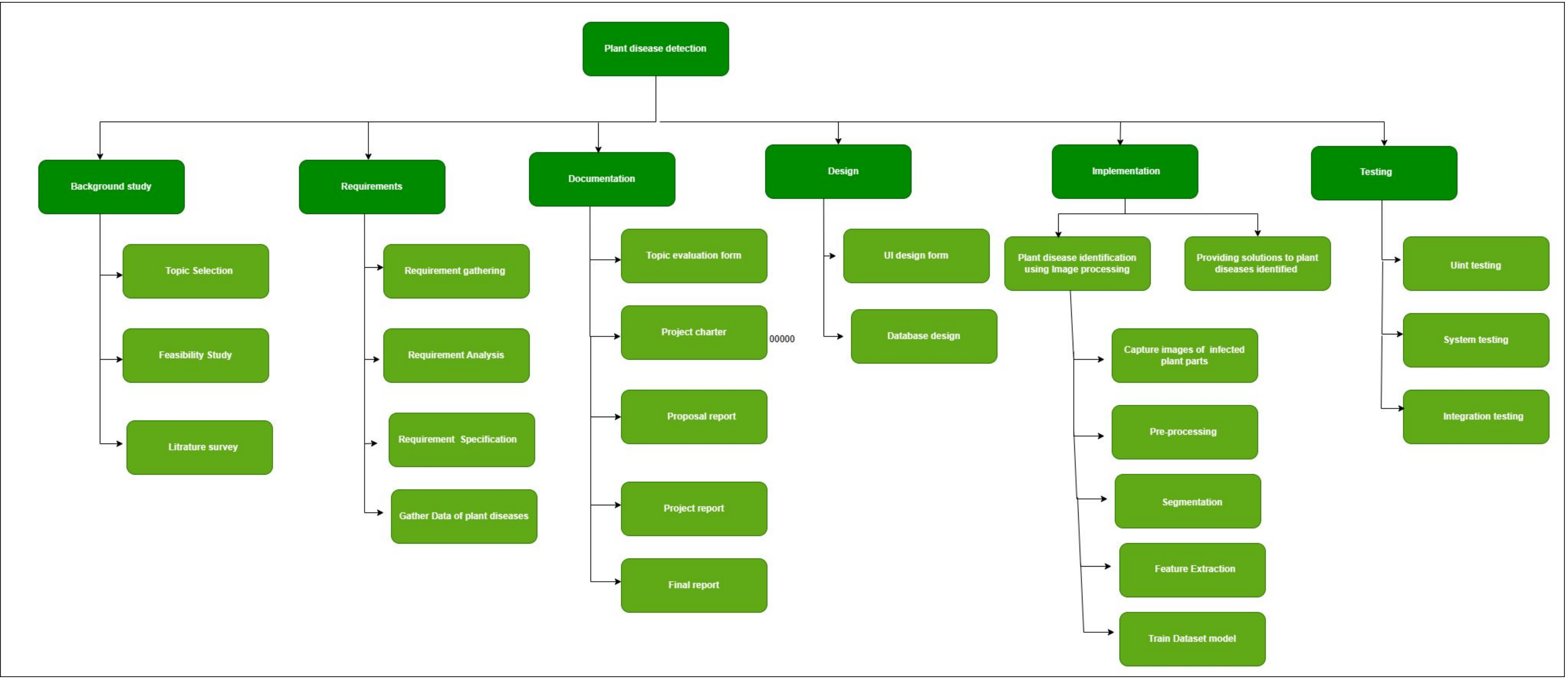
- Python (Back end)
- Tensor Flow (Framework)
- ML (Classifications)
- ReactJS (Front end)
- HTML (Front end)
- CSS (Front end)
- Bootstrap (Front end)
- Jupitor notebook
- Git Hub (Version control system)
- Jira (Project Management)

Requirements

- Non-functional requirements
  - Availability
  - Reliability
  - Performance
  - Usability

- Functional requirements
  - Ability to identify plant diseases
  - Ability to suggest solutions to diseases

Work Breakdown Structure



Gantt chart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Software requirements specification
Identify functions
Preparing SRS document
Software design
Implementation
Testing
Unit testing
Integration testing
Final Document & Viva
Final Documentation
Final Presentation and viva

References

[1] Kumar, R. *et al.* (2022) *A systematic analysis of machine learning and deep learning based approaches for Plant Leaf Disease Classification: A Review*, *Journal of Sensors*. Hindawi. Available at: https://doi.org/10.1155/2022/3287561 (Accessed: March 27, 2023).

[2] Kumar, R. *et al.* (2022) *A systematic analysis of machine learning and deep learning based approaches for Plant Leaf Disease Classification: A Review*, *Journal of Sensors*. Hindawi. Available at: https://doi.org/10.1155/2022/3287561 (Accessed: March 27, 2023).

IT20122928 | MADHUSHIKA A.H.D.

Information Technology

INTRODUCTION

This Research component is t,

- Extract data from relevant places (Gannoruwa department of agrarian development and Peradeniya Botanical Garden).
- Develop a predictive model that can accurately determine the suitability of a selected plant species for growth in a given soil condition.

Research Gap

- We mainly focus on growing plants like perilla, Patchouli and Saffron in bare lands, since those plants can be grown in Sri Lanka but a proper research has not be done till now.
- As well as Growing such plants will be economically beneficial for Sri Lanka.

Research Problem

- What is the predictive relationship between the selected plant species and the given soil condition, and how can this relationship be analyzed to determine the plant's ability to grow in the given soil.

Specific and Sub Objectives

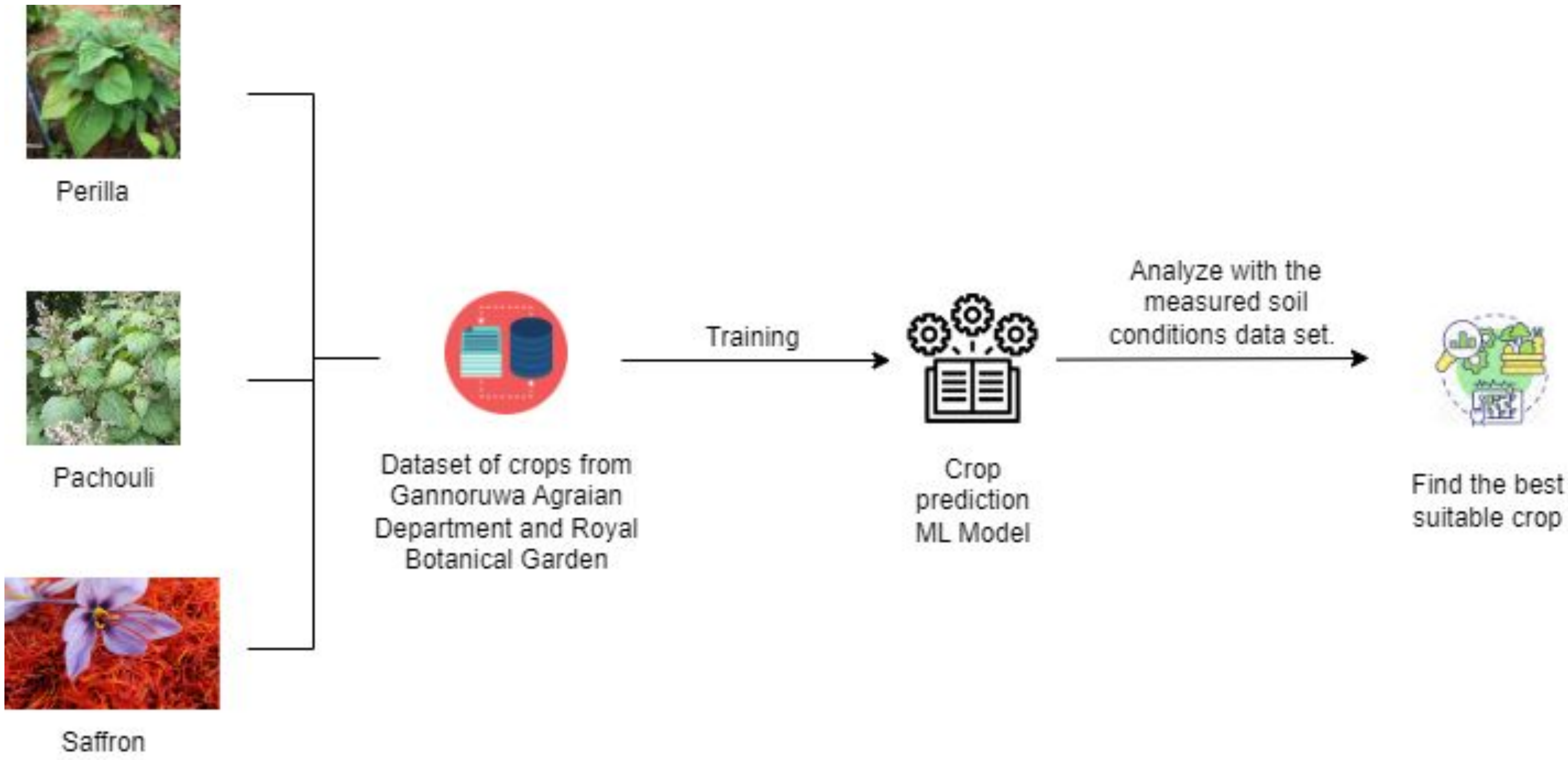
- **Specific Objectives :**
  - Prediction and analysis to determine whether the selected crop can be grown in given soil condition.

- **Sub Objectives :**
  - Analyse the data set with given soil conditions.

Methodology

- Collect dataset (temperature, NPK level, PH rate, Soil conductivity, soil moisture) of perilla, pachouli and saffron from Gannoruwa department of agrarian development and Peradeniya Botanical Garden.
- Analyze the dataset and the measured soil conditions of land.
  - Identify the soil type
  - Determine the soil pH
  - Test soil nutrient levels
  - Assess soil moisture
- Find the best suitable crop to grow in selected land.

System Diagram



Technologies

- Power BI (Data visualization)
- Python (Back end)
- Tensor Flow (Framework)
- ML (Classifications)
- ReactJS (Front end)
- HTML (Front end)
- CSS (Front end)
- Bootstrap (Front end)
- Jupyter notebook
- Github (Version control system)
- Jira (Project Management)

Requirements

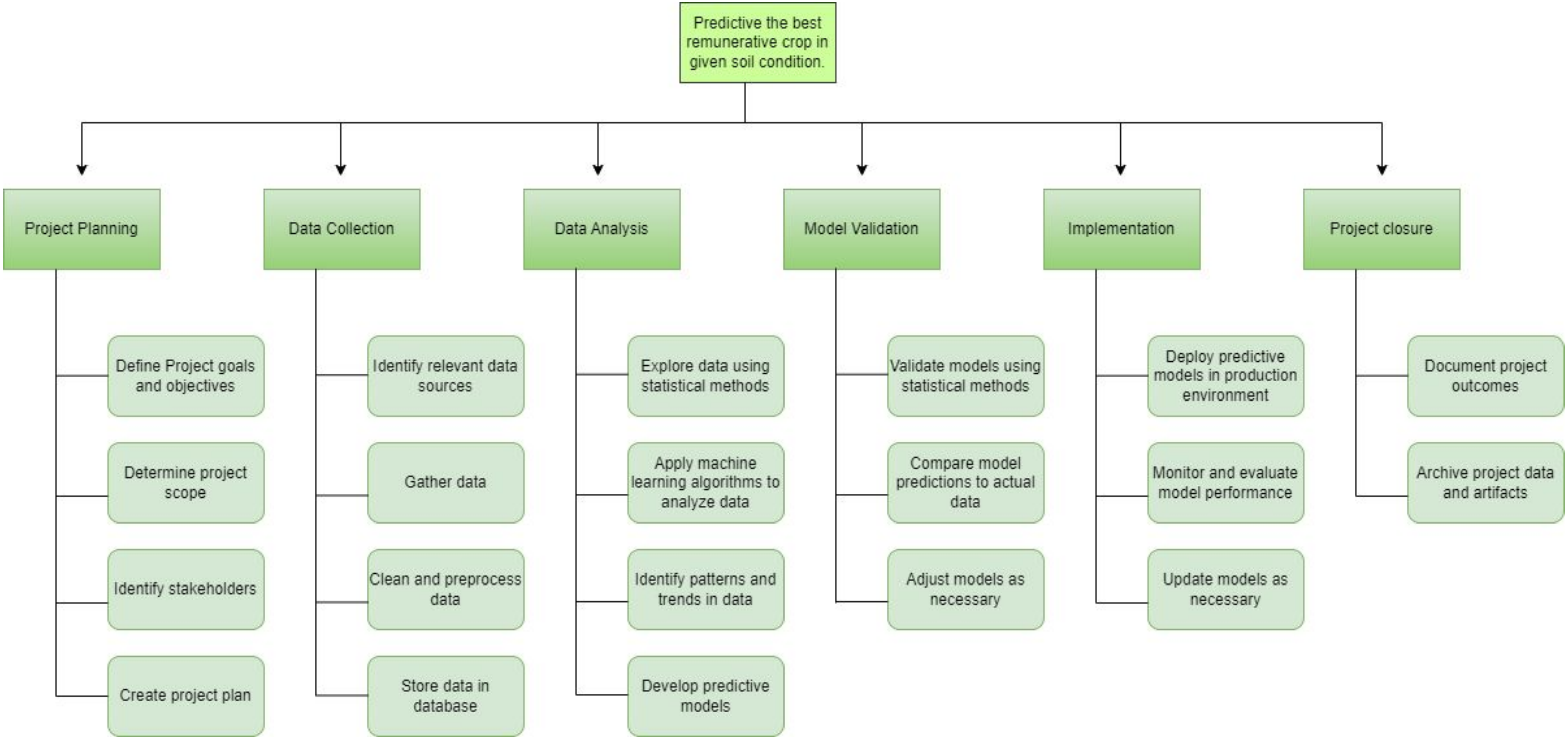
- Non-functional requirements

  - ➢ Accessibility
  - ➢ Reliability
  - ➢ Performance
  - ➢ Usability

- Functional requirements

  - ➢ Ability to analyze crop data set.
  - ➢ Ability to predict best crop to grow in land.

WBS


Predictive the best remunerative crop in given soil condition.
Project Planning
Data Collection
Data Analysis
Model Validation
Implementation
Project closure
Define Project goals and objectives
Determine project scope
Identify stakeholders
Create project plan
Identify relevant data sources
Gather data
Clean and preprocess data
Store data in database
Explore data using statistical methods
Apply machine learning algorithms to analyze data
Identify patterns and trends in data
Develop predictive models
Validate models using statistical methods
Compare model predictions to actual data
Adjust models as necessary
Deploy predictive models in production environment
Monitor and evaluate model performance
Update models as necessary
Document project outcomes
Archive project data and artifacts

Gantt chart

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References

[1]Author links open overlay panel Thomas van Klompenburg a et al. (2020) Crop yield prediction using Machine Learning: A Systematic Literature Review, Computers and Electronics in Agriculture. Elsevier. Available at: https://www.sciencedirect.com/science/article/pii/S0168169920302301 (Accessed: March 27, 2023).

[2]Additional information Funding This work was jointly supported by the Natural Science Basic Research Program of Shaanxi [2020JM-514] (no date) Autumn crop yield prediction using data-driven approaches:- support vector machines, Random Forest, and deep neural network methods, Taylor & Francis. Available at: https://www.tandfonline.com/doi/abs/10.1080/07038992.2020.1833186 (Accessed: March 27, 2023).

[3]Analysis of soil behaviour and prediction of crop yield using data ... (no date). Available at: https://ieeexplore.ieee.org/abstract/document/7546199 (Accessed: March 27, 2023).

IT19045290 | JANADEEPA W.H.G

Information Technology

INTRODUCTION

This Research component is to ,

- Build an IoT device which can measure important soil parameters.
  - Soil moisture
  - pH rate
  - Temperature
  - Soil conductivity
  - Nutrient levels
- This data can be transmitted to a central database for real-time analysis and interpretation.
- This IoT device can also help agricultural professionals to achieve better crop yields while minimizing environmental impact.
- Overall, the use of IoT device for soil testing and identification of soil conditions can lead to more efficient and sustainable agricultural practices.

Research Gap

Feature/System	Sensors to measure the amount of moisture in the soil	sensors to measure the acidity or alkalinity of the soil	Sensors to measure the temperature of the soil	Sensors to measure the nutrient content of the soil	Sensors for measuring soil conductivity
[1]"Wireless Sensor Networks for Soil Moisture Monitoring: A Review." by M. V. C. Goncalves, et al. in IEEE Communications Surveys and Tutorials, 2016.	Yes	No	No	No	No
[2]"Internet of Things for Agriculture: A Comprehensive Survey." by M. Banerjee, et al. in IEEE Access, 2017.	No	No	Yes	No	No
[3]"Design and Implementation of IoT-Based Soil Monitoring System." by Y. Zhang, et al. in IEEE Access, 2018.	Yes	No	Yes	No	No
[4]"Development of a Low-Cost IoT-Based Soil Moisture Sensor." by A. C. Basu and S. P. Mukherjee in Journal of Sensors, 2020.	Yes	No	No	No	No
Proposed System	Yes	Yes	Yes	Yes	Yes

Research Problem

- What is the effectiveness of using IoT device for soil testing and identification of soil conditions, and how can this technology be used to improve soil management practices and crop yields?

Specific and Sub Objectives

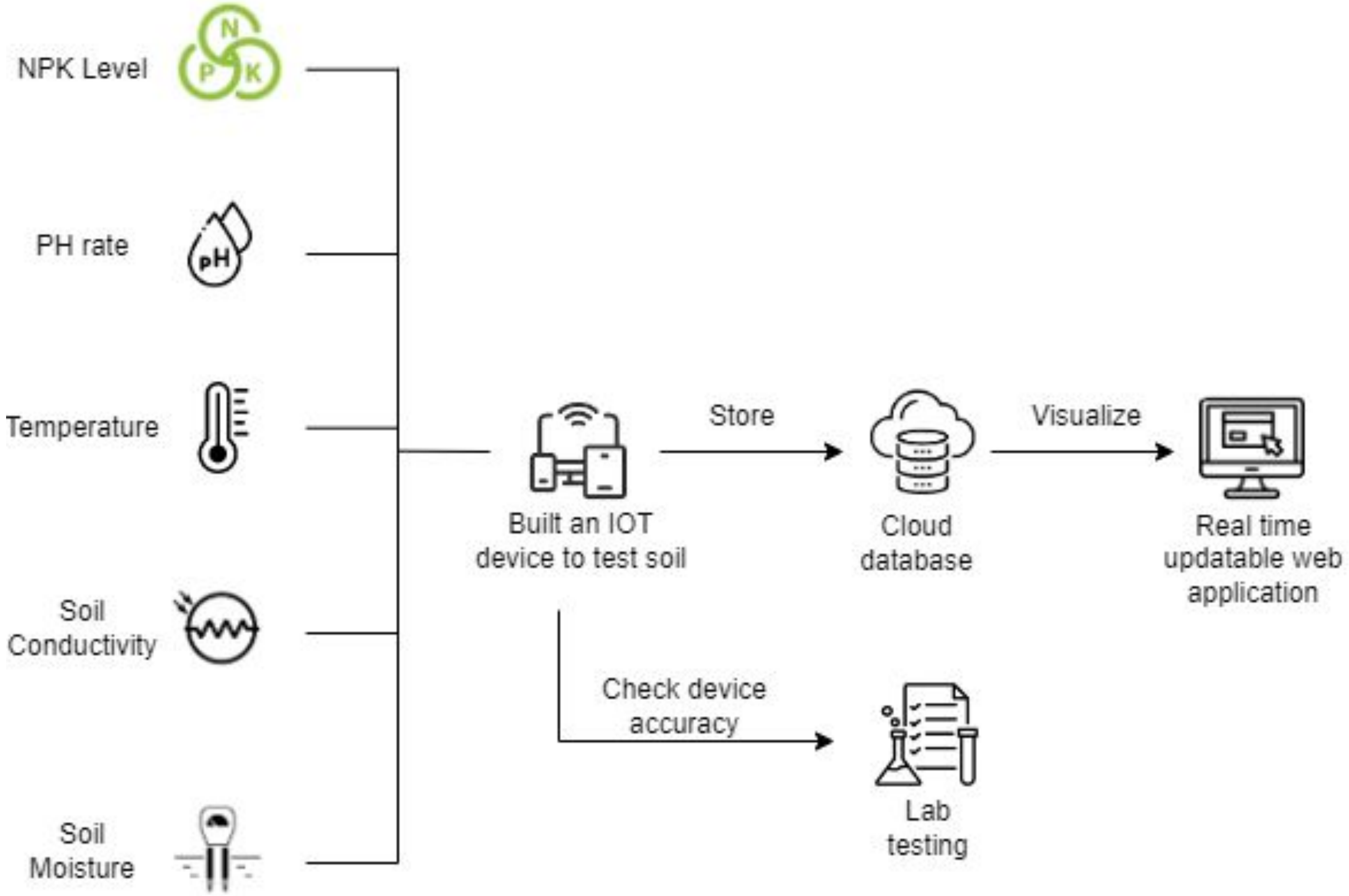
- **Specific Objectives :**
  - Soil testing and identification of soil conditions using IOT device.

- **Sub Objectives :**
  - Development of an IoT platform for integrating data from multiple sources to provide real-time soil condition monitoring.
  - Testing the accuracy of the data collected from the developed IoT device by lab testing.

Methodology

- **Develop an IOT device:** It can measure soil conditions (moisture, temperature, pH level, and nutrient content). It can be designed using sensors, microcontrollers, and wireless communication modules.
- **Measure soil conditions:** The device can measure soil moisture, temperature, pH level, soil conductivity and nutrient content continuously.
- **Test the accuracy of the data by lab testing:** The IOT device collects and tests soil data in a laboratory to ensure accuracy. This provides a reference for comparing the accuracy of the data collected by the device.
- **Store data in cloud storage:** The IOT device provides a secure and scalable solution for data transmission wirelessly to cloud storage for storage and analysis.
- **Get those data into a dashboard and visualization:** Dashboards and visualized data can be used to provide real-time information on soil conditions, trends, and alerts for critical values, allowing for data-driven decisions to optimize crop yields and soil health.

System Diagram



Technologies

- Arduino (microcontroller)
- ESP32 (microcontroller)
- Soil Moisture Sensor Module (Sensor - moisture)
- MAX6675 Thermocouple Sensor (Sensor - temperature)
- Liquid Water PH Value Detection Sensor Control Board Module with BNC Electrode Probe (Module - pH)
- PH Electrode Probe BNC Connector for Aquarium PH Controller Meter Sensor (Sensor - pH rate)
- 3IN1 Soil NPK Sensor RS485 Waterproof Irrigation Nitrogen Phosphorus Potassium Environmental Fertiliser Detector (Sensor - nutrient levels)
- DFR0300 Development Kit, Analog Electrical Conductivity Meter, K=1, Arduino, Gravity Series (Sensor - soil conductivity)
- React JS (Frontend)
- Firebase(Database)
- c/c++ (microcontroller coding language)

Firebase

Requirements

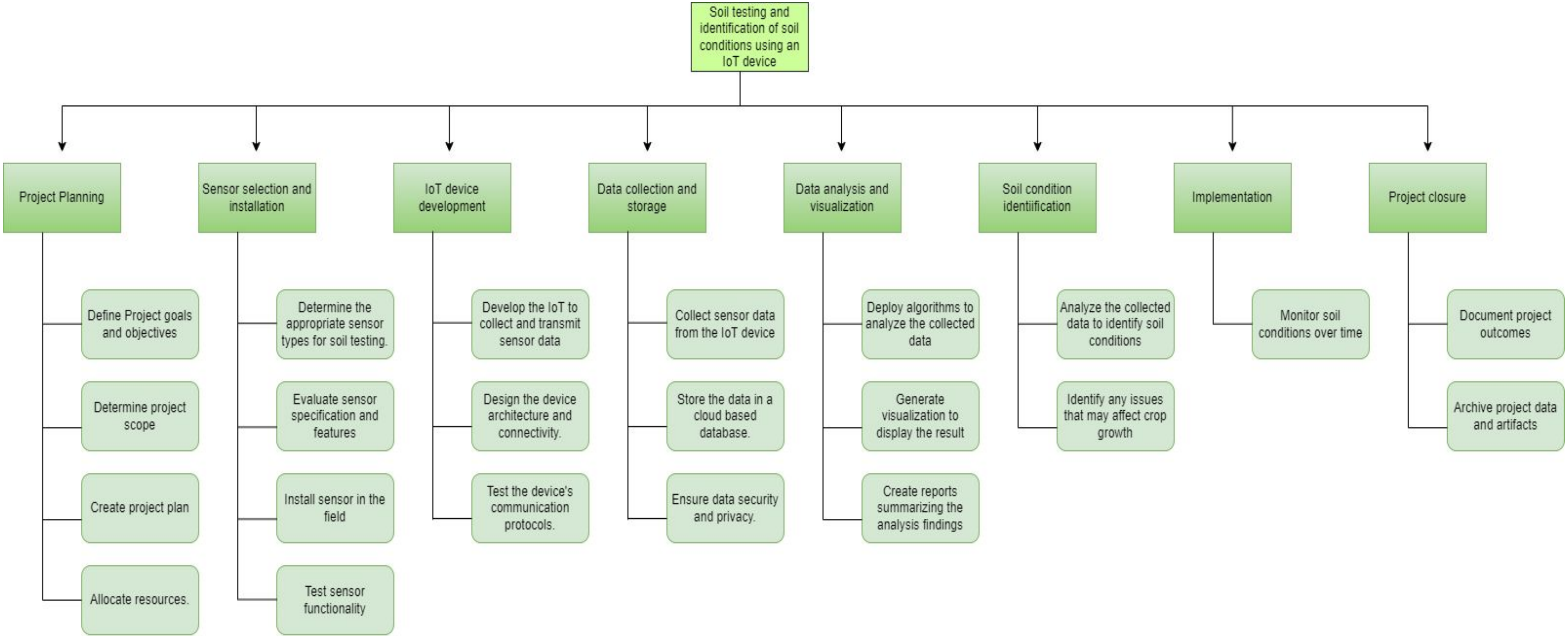
- Non-functional requirements

  - Availability
  - Reliability
  - Maintenance
  - Security
  - Cost Effective

- Functional requirements

  - Ability to develop the IOT Soil testing Device
  - Ability to identify accurate data

WBS



Soil testing and identification of soil conditions using an IoT device
Project Planning
Define Project goals and objectives
Determine project scope
Create project plan
Allocate resources.
Sensor selection and installation
Determine the appropriate sensor types for soil testing.
Evaluate sensor specification and features
Install sensor in the field
Test sensor functionality
IoT device development
Develop the IoT to collect and transmit sensor data
Design the device architecture and connectivity.
Test the device's communication protocols.
Data collection and storage
Collect sensor data from the IoT device
Store the data in a cloud based database.
Ensure data security and privacy.
Data analysis and visualization
Deploy algorithms to analyze the collected data
Generate visualization to display the result
Create reports summarizing the analysis findings
Soil condition identiification
Analyze the collected data to identify soil conditions
Identify any issues that may affect crop growth
Implementation
Monitor soil conditions over time
Project closure
Document project outcomes
Archive project data and artifacts

Gantt chart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[1]"Wireless Sensor Networks for Soil Moisture Monitoring: A Review." by M. V. C. Goncalves, et al. in IEEE Communications Surveys and Tutorials, 2016. This paper provides a review of wireless sensor networks for soil moisture monitoring, including IoT devices.

https://pubmed.ncbi.nlm.nih.gov/34770549/

[2]"Internet of Things for Agriculture: A Comprehensive Survey." by M. Banerjee, et al. in IEEE Access, 2017. This paper provides an overview of IoT technologies for agriculture, including soil testing devices.

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9139962

[3]"Design and Implementation of IoT-Based Soil Monitoring System." by Y. Zhang, et al. in IEEE Access, 2018. This paper describes the development of an IoT-based soil monitoring system using various sensors to measure soil parameters.

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9166510

[4]"Development of a Low-Cost IoT-Based Soil Moisture Sensor." by A. C. Basu and S. P. Mukherjee in Journal of Sensors, 2020. This paper describes the development of a low-cost IoT-based soil moisture sensor using an ESP8266 microcontroller and a capacitive sensor.

https://ijcrt.org/papers/IJCRT2005286.pdf

IT20121556| ARACHCHIGE P.D.A.M.

Information Technology

INTRODUCTION

This Research component is to ,

- Extract data from relevant places (**LRC**).
- Analyze those current data using ML techniques and retrieve for image processing.
- Retrieve lab tested and soil moisture data from datasource and update the GIS map.

Research Gap

- Research[1] - research gap that can be identified from this study in the need for future investigation into the use of remote sensing and GIS techniques for soil mapping in different condition.
- Research[2] - for further investigation into the effectiveness of random forest algorithm with multi-source data in crop mapping in other regions with different environmental and climatic conditions.
- Research[3] - lack of attention to the specific factors contributing to erosion risk in different agricultural landscapes.
- Research[4] - Potential biases or inaccuracies in the CNN classification model used for identifying unused landscapes.

Research Problem

- Inefficient land use practices.
- Lack of accurate and updated data.
- Soil degradation and erosion.
- Lack of access to information about bare lands.
- Limited resources for conservation.

Specific and Sub Objectives

Specific Objectives :

- Main objective is to introduce an automated GIS mapping technique for visualizing and analyzation of data set.

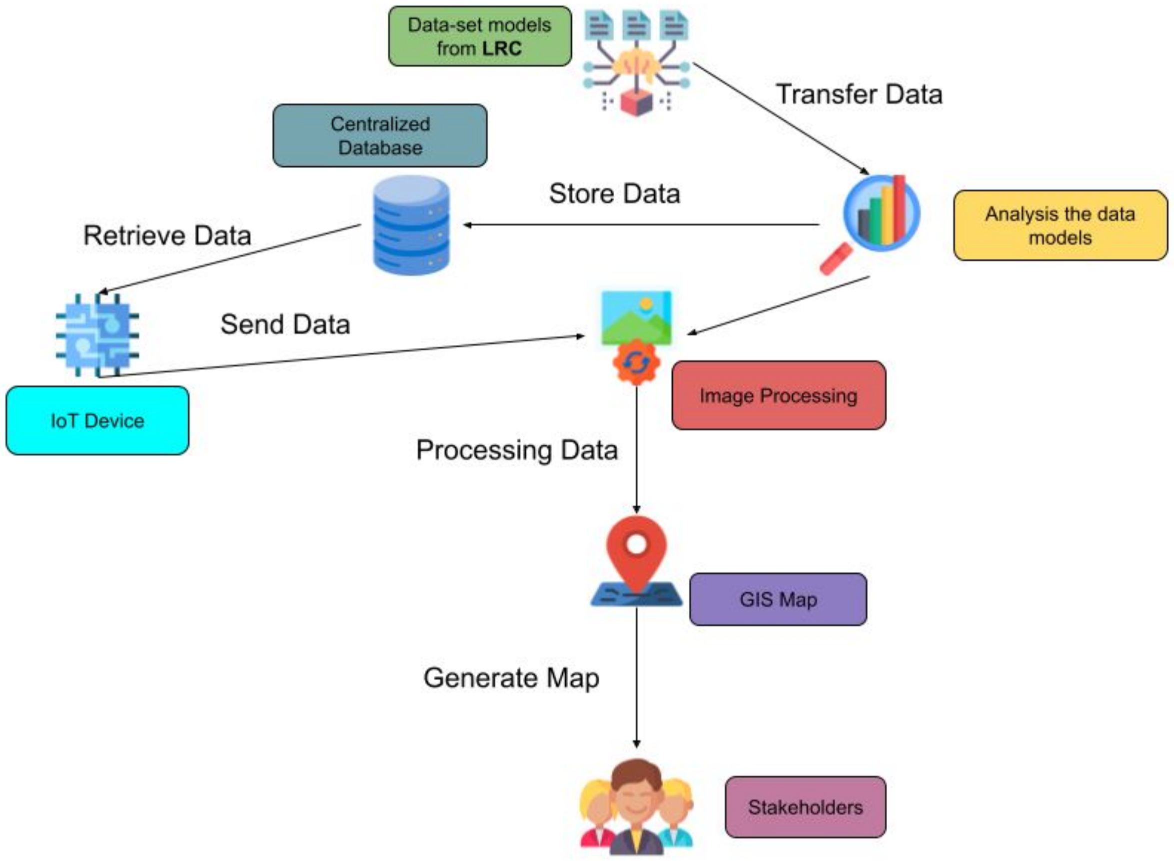
Sub Objectives :

- Develop a GIS map using existing data set from "LRC" without lab tested condition.
- Develop an updated GIS map with better analyzation and visualization the dataset after well tested with IoT devices.

Methodology

- Remote sensing and image processing: identifying and analyzing bare lands is to use remote sensing data such as satellite images.
- Spatial analysis : gis mapping techniques can be used to conduct spatial analysis of bare lands, including identifying the location. (buffer analysis, overlay analysis and hotspot analysis).
- Machine learning: random forest or support vector machines, can be used to classify satellite imagery and identify bare lands.
- Soil and vegetation sampling : Field sampling of soil and vegetation can be used to validate the results of remote sensing and GIS mapping techniques.
- Stakeholder engagement : Engaging with stakeholders, such as farmers, landowners, and local communities, can provide valuable insights into social, economic that contribute to the formation of bare lands.

System Diagram



Technologies

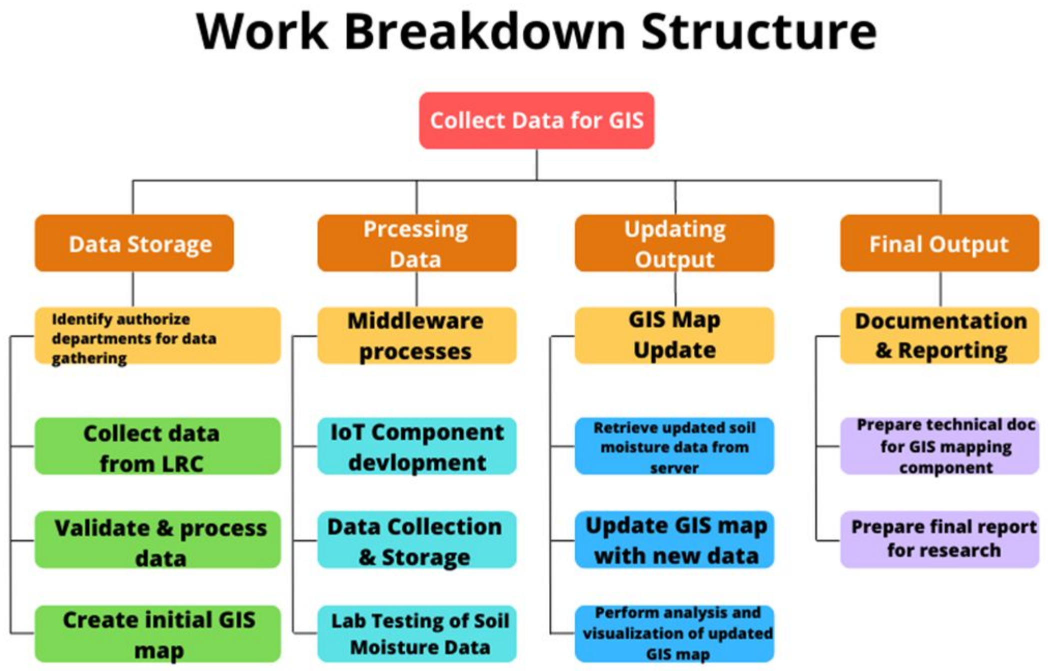
- Python (Back end)
- Tensor Flow (Framework)
- ML (Classifications)
- Google Earth Engine (API)
- QGIS (GIS Software)
- OpenCV (for IP, feature detection)
- ReactJS (Front end)
- Leaflet (Interactive maps ui)
- HTML (Front end)
- CSS (Front end)
- Bootstrap (Front end)
- Git Hub (Version control system)
- Jira (Project Management)

Requirements

- Non-functional requirements
  - Performance
  - Accuracy
  - Scalability
  - Usability

- Functional requirements
  - Data collection
  - Data processing
  - Image analysis
  - GIS mapping

WBS



Work Breakdown Structure
Collect Data for GIS
Data Storage
Prcessing Data
Updating Output
Final Output
Identify authorize departments for data gathering
Collect data from LRC
Validate & process data
Create initial GIS map
Middleware processes
IoT Component devlopment
Data Collection & Storage
Lab Testing of Soil Moisture Data
GIS Map Update
Retrieve updated soil moisture data from server
Update GIS map with new data
Perform analysis and visualization of updated GIS map
Documentation & Reporting
Prepare technical doc for GIS mapping component
Prepare final report for research

Gantt chart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References

[1] M. Aksoy and G. Özsoy, "Soil mapping approach in GIS using landsat imagery and SRTM data," Journal of the Indian Society of Remote Sensing, vol. 42, no. 4, pp. 759-770, Dec. 2014. doi:10.1007/s12524-014-0409-5.

[2] Li, H. et al. (2017) Mapping urban bare land automatically from landsat imagery with a simple index, MDPI. Multidisciplinary Digital Publishing Institute. Available at: https://doi.org/10.3390/rs9030249 (Accessed: March 26, 2023).

[3] Buryak, Z. and Marinina, O. (2020) Using GIS technology for identification of agricultural land with an increased risk of erosion, E3S Web of Conferences. EDP Sciences. Available at: https://www.e3s-conferences.org/articles/e3sconf/abs/2020/36/e3sconf_idsisa2020_04007/e3sconf_idsisa2020_04007.html (Accessed: March 26, 2023).

[4] S. Akshay, T. K. Mytravarun, N. Manohar and M. A. Pranav, "Satellite Image Classification for Detecting Unused Landscape using CNN," 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, 2020, pp. 215-222, doi: 10.1109/ICESC48915.2020.9155859.

Supportive information

Commercialization

- Our proposed system fundamentally focuses on import and export of commercially demanding crops such as perilla,patchouli and saffron.
- The aim of the project is to develop an integrated platform for identification of suitable lands and soil conditions for remunerative crops in Sri Lanka.

How does our system differ from other platforms?

- accuratable and updatable GIS map
- Integrated System

Target sector for marketing?

- Farmers, agricultural extension officers, and other stakeholders involved in the agriculture industry
- government agencies responsible for land management and agriculture policies, as well as private companies involved in agriculture or agribusiness.
- international organizations or investors interested in supporting sustainable agriculture in Sri Lanka

Marketing plan?

- Developing and maintaining a website

Budget

- The budget mentioned is a rough estimate and may vary according to the purpose when developing the system.
- There budget calculated is mainly for IOT device used for soil testing.

Item	Cost (in LKR)
Sensors	
Soil moisture	300.00
MAX6675 Thermocouple	2800.00
PH controller meter sensor	2200.00
NPK sensor RS485 detector	35000.00
Electrical conductivity DFR0300	20000.00
Microcontroller	
Esp32	3500.00
Arduino board	7500.00
Module	
pH value detection sensor control board module	7500.00
Domain	5000.00
Hosting space (if needed per month)	10000.00
Total	93800.00


Thank you