KARATINA UNIVERSITY

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATICS

BANANA DISEASE RECOGNITION SYSTEM USING LANGCHAIN AND GENERATIVE AI

BY

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DECLARATION

I declare that this Project Proposal is my original work and has not been previously published or submitted elsewhere for award of a degree. I also declare that this contains no material written or published by other people except where due reference is made and author duly acknowledged.

STUDENT NAME:__________________________ REG NO________________________

SIGN: ____________________________ DATE:_____________________________

I do hereby confirm that I have examined the Project Proposal

WAINAINA SAMUEL KAINDO

SUPERVISOR

I the undersigned do hereby certify that this is a true report for the project undertaken by the above named student under my supervision and that it has been submitted to Karatina University with my approval

Signature…………………………………………………….Date…………………………….

DEDICATION

I dedicate this work to the Almighty God for His grace, mercy, and guidance. To the teachers and lecturers at Karatina University, thank you for imparting knowledge and shaping my academic path. My heartfelt gratitude goes to my parents for their unwavering support and sacrifices for my education. To my dear grandmother, your love and wisdom have been a constant inspiration. I am also grateful to my siblings for their understanding and encouragement. Karatina University, thank you for providing a conducive learning environment. This work reflects the values instilled in me by my family and the knowledge imparted by my teachers. I dedicate this to all of you with love and gratitude.

ABSTRACT

Banana cultivation is vital to many economies, including Kenya, serving as a key food source and income generator. Banana crops are susceptible to various diseases that can drastically reduce yields if not promptly addressed. This project aims to develop an automated system using Langchain, a versatile AI framework, to recognize these diseases. The system will analyze images of diseased bananas using Generative AI to identify and classify the specific disease, aiding farmers in early detection and intervention. By enhancing disease management practices, this project seeks to improve the overall health and productivity of banana cultivation, benefiting farmers and showcasing the potential of AI in agriculture.

ACKNOWLEDGEMENTS

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CHAPTER ONE: INTRODUCTION

1.1 introduction

In the heart of Kenyan agriculture, This project aims to revolutionize banana farming by introducing an advanced disease recognition system. Focused on early detection, the system combines the power of Langchain and Generative AI to empower farmers with a swift and accurate tool.Langchain, a versatile AI framework, forms the core of the system, image analysis and feature extraction. Complemented by Generative AI, which learns from extensive datasets, the system surpasses human capabilities, providing precise identification of subtle disease patterns.

Beyond technological innovation, the project envisions practical empowerment for farmers. The user-friendly disease detection tool ensures quick interventions, minimizing economic losses. Accurate identification facilitates informed decision-making, optimizing resources and reducing chemical usage, promoting sustainable farming practices. Safeguarding banana crops is not just a technical feat; it's a catalyst for economic growth. Beyond enhancing food stability, the project fosters rural development, contributing to community prosperity. The ripple effect extends to increased agricultural productivity, positioning Kenyan farmers for a brighter, more sustainable future.

This project is more than a technological advancement, it's a mission fueled by passion and purpose. With Langchain and Generative AI as allies, the vision is clear – transform banana farming in Kenya, ensuring food security, promoting sustainable practices, and elevating the prosperity of farming communities.

1.2 Background of the Study

The background of this study revolves around the agricultural sector in Kenya, specifically focusing on banana cultivation, which is a significant agricultural activity in the country. Bananas are a staple food for millions of Kenyans and a key source of income for many farmers. However, banana crops in Kenya are susceptible to various diseases, including fungal, bacterial, and viral infections, which can cause substantial yield losses if not managed effectively.

The client, a leading agricultural organization in Kenya, is actively involved in banana cultivation and is committed to improving disease management practices to enhance crop health and productivity. Currently, disease detection in banana crops in Kenya relies heavily on manual methods, such as visual inspection, which can be time-consuming and error-prone. As a result, there is a need for more efficient and accurate disease detection methods to support Kenyan farmers in maintaining healthy crops and ensuring optimal yields.

The client's operations in Kenya encompass various aspects of banana cultivation, from planting and cultivation to harvesting and post-harvest management. They are keen on adopting innovative technologies to improve their agricultural practices and are interested in exploring the potential of advanced technologies, such as Langchain and Generative AI, for disease recognition in banana crops in Kenya.

By understanding the client's business and the challenges they face in banana cultivation in Kenya, this study aims to develop an automated disease recognition system that can revolutionize disease management practices and contribute to the sustainability of banana cultivation in Kenya.

1.3 Problem Statement

Banana cultivation in Kenya faces significant challenges due to inefficient and inaccurate disease detection methods. The current reliance on manual inspection is labor-intensive, time-consuming, and often ineffective at detecting diseases in their early stages. This inefficiency leads to substantial yield losses and economic hardships for banana farmers across the country.

Compounding this issue is the lack of expertise and resources in remote areas, which further hampers farmers' ability to effectively manage diseases. Diseases such as Fusarium wilt and Black Sigatoka pose significant threats to banana crops in Kenya, highlighting the urgent need for improved disease detection methods.

The limitations of current practices underscore the necessity of a more efficient and accurate disease detection approach. By developing an automated disease recognition system using Langchain and Generative AI, this project aims to provide farmers with a reliable tool for early disease detection for intervention.

This system is poised to revolutionize disease management practices in banana cultivation in Kenya, offering farmers a practical and effective solution to detect diseases. Its implementation has the potential to significantly enhance the overall health and productivity of banana crops, thereby contributing to the sustainability and economic viability of banana farming in the region.

1.4 Objectives

1.4.1 General Objective

To develop an automated disease recognition system for banana crops in Kenya using Langchain and Generative AI to improve disease management practices and enhance crop productivity.

1.4.2 Specific Objectives

1. Investigate current disease management practices in banana cultivation in Kenya.
2. Design and Develop an automated disease recognition system using Langchain and Generative AI.
3. Test and validate the system to ensure accurate and reliable banana disease diagnosis.
4. Provide actionable recommendations to farmers based on the system's diagnosis.

1.5 Scope and Limitation of the Study

The project focuses on developing an automated disease recognition system for banana crops in Kenya using Langchain and Generative AI.It covers data collection, preprocessing, model development, and testing phases. The study does not include field testing of the developed system due to time and resource constraints.Limited availability of high-quality training data and technical challenges in implementing the Langchain framework may impact the project's outcomes.

1.6 Justification

The project addresses a critical need in banana cultivation in Kenya, providing farmers with a reliable tool for early disease detection and intervention.The use of Langchain and Generative AI introduces innovative technologies to improve disease management practices in agriculture. The project's outcomes have the potential to significantly enhance crop health and productivity, benefiting banana farmers and the agricultural industry as a whole.

1.7 Project Risk and Mitigation

Limited Training Data: Collaborate with agricultural research institutions for data collection and augmentation. Technical Challenges: Conduct thorough testing and validation of the system, seek expert advice if needed. Resource Constraints: Secure additional funding or resources if necessary to ensure project completion. Time Constraints: Develop a detailed project schedule and allocate resources efficiently to meet deadlines.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The literature review critically examines the current body of knowledge and research pertaining to the development of an automated disease recognition system for banana crops in Kenya, utilizing Langchain and Generative AI technologies. The primary objective of this review is to delve into existing literature to identify crucial findings, methodologies, and research gaps essential for laying the groundwork for the proposed research project.

The review will identify gaps in the existing literature, highlighting areas where further research is needed to advance the field of automated disease recognition in banana crops. By addressing these gaps, the proposed research project aims to contribute new insights and innovations to the field, ultimately improving disease management practices and enhancing crop productivity in Kenyan agriculture.

2.2 Disease Management Practices in Banana Cultivation

Research on disease management practices in banana cultivation highlights the significant impact of diseases such as Black Sigatoka, Panama disease, and Banana Bunchy Top Virus on crop productivity and sustainability. These diseases are known to cause severe damage to banana plants, leading to yield losses and economic hardships for farmers that affect the farmers in kenya in particular the areas such as Embu and Kisii Areas.

Current practices in disease management emphasize early detection and intervention as key strategies to mitigate the impact of these diseases. Farmers are advised to regularly monitor their crops for symptoms of these diseases, such as leaf spots, wilting, and stunted growth. Early detection allows farmers to take timely action, such as pruning infected leaves, applying fungicides, or removing and destroying infected plants, to prevent further spread of the diseases.

Integrated Pest Management (IPM) strategies are also widely recommended in banana cultivation to manage diseases effectively. IPM involves a combination of cultural, biological, and chemical control measures to minimize the use of pesticides and reduce environmental impacts. For example, planting disease-resistant banana varieties, practicing crop rotation, and maintaining proper sanitation in the field can help reduce the risk of disease outbreaks.

Understanding these disease management practices is crucial for the development of effective disease recognition systems. By incorporating knowledge of these practices into the design of the automated disease recognition system, researchers can ensure that the system is aligned with the needs and challenges faced by banana farmers. This, in turn, will help enhance the system's effectiveness in identifying and managing diseases, ultimately improving crop productivity and sustainability in banana cultivation (Tadele, Z. 2017).

2.3 Automated Disease Recognition Systems

Automated disease recognition systems have garnered attention in agricultural research, particularly in the context of crop health management. These systems leverage advanced technologies such as Langchain and Generative AI to accurately identify diseases affecting various crops. By integrating computer vision and machine learning algorithms, these systems analyze images of plant diseases, enabling rapid and accurate diagnosis Ouhami, M., al.(2021) (2019).

Previous studies have shown the efficacy of automated disease recognition systems in enhancing disease management practices. These systems offer several advantages, including early detection of diseases, which can help farmers implement timely interventions to prevent widespread crop damage. Automated systems reduce the reliance on manual inspection, saving time and labor costs for farmers (Tian al. 2020).

The use of Langchain and Generative AI in disease recognition systems has demonstrated promising results, showing high accuracy rates in disease identification. These technologies allow for the creation of robust models capable of handling diverse disease types and environmental conditions, making them valuable tools for sustainable agriculture practices.

2.4 Testing and Validation

Ensuring the accuracy and reliability of the automated disease recognition system is crucial. Studies emphasize the importance of rigorous testing and validation procedures to verify the system's performance. These procedures include testing the system with a diverse range of images to assess its ability to accurately diagnose banana disease recognition Selvaraj, M. G., al. (2019).

The validation process should include comparing the system's diagnoses with those made by agricultural experts to validate its accuracy and reliability. The system should be tested in real-world conditions to evaluate its performance under different environmental and lighting conditions.

Continuous improvement and refinement of the system are crucial to enhance its accuracy and usability for farmers. Future research should focus on incorporating feedback from users and stakeholders to further refine the system's algorithms and capabilities. This iterative process will help ensure that the automated disease recognition system meets the needs and expectations of banana farmers, ultimately improving disease management practices and enhancing banana productivity.

2.5 Recommendations for Farmers

The automated disease recognition system aims to provide actionable recommendations to farmers based on its diagnosis. By empowering farmers with timely and accurate information, the system can improve disease management practices and enhance banana productivity. Future research should focus on further improving the system's accuracy and usability for farmers Su, J., al. (2023).

One of the primary advantages of this system is its potential to significantly reduce the need for manual inspection, thereby saving farmers time and labor costs. Furthermore, by supplying farmers with real-time information on disease outbreaks and recommended interventions, the system can help minimize crop losses and improve overall farm profitability.

Future research in this field should concentrate on further enhancing the system's accuracy and usability for farmers. This entails exploring new machine learning algorithms and techniques to improve disease recognition capabilities, as well as integrating additional data sources such as weather data and soil conditions to enhance the system's predictive abilities. Moreover, efforts should be made to develop user-friendly interfaces and mobile applications to ensure easy access and adoption by farmers in remote and rural areas.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

The methodology chapter describes the model/framework under which the automated banana disease recognition system for banana crops in Kenya will be developed. This chapter outlines the techniques used to collect facts and data, the tools for data analysis and processes, the implementation and testing tools for the system, and the project's time schedule and cost.

3.2 CRISP-DM Overview

CRISP-DM (Cross-Industry Standard Process for Data Mining) is a widely used methodology for data mining and machine learning projects. It provides a structured approach to the entire lifecycle of a project, from understanding the business objectives to deploying the final model.

Below is a Diagram Showing the CRISP-DM methodology

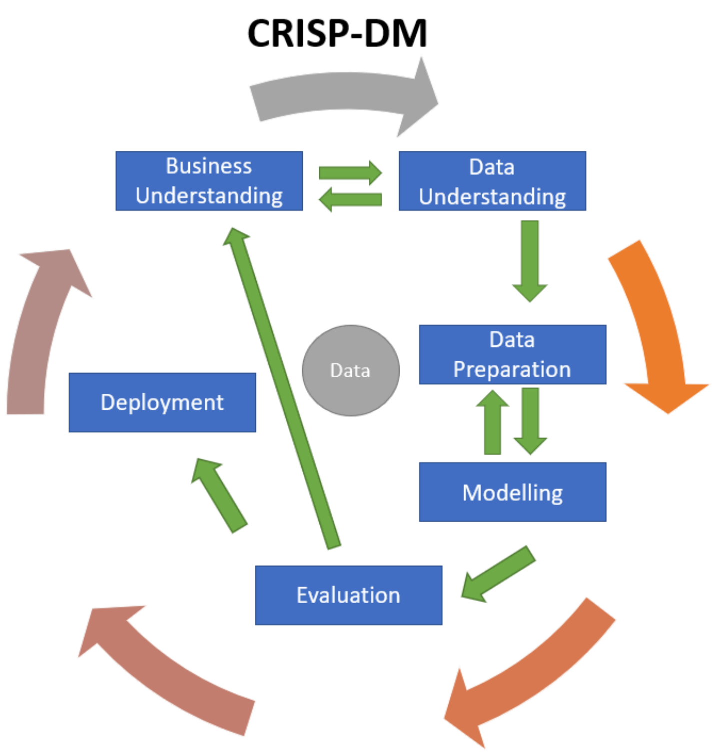

Figure 1shows methodology to use

3.3 How the CRISP-DM methodology works

1. Business Understanding

The inefficiencies of current disease detection methods in banana cultivation in Kenya, particularly manual inspection, lead to substantial yield losses and economic hardships for farmers. Compounded by the lack of expertise and resources in remote areas, diseases like Fusarium wilt and Black Sigatoka pose significant threats to banana crops. To address these challenges, this project aims to develop an automated disease recognition system using Langchain and Generative AI. This system has the potential to revolutionize disease management, offering farmers a reliable tool for early detection and intervention, by enhancing the overall health and productivity of banana crops and ensuring the sustainability of banana farming in the region.

2. Data Understanding

Data will be collected from diverse sources such as Kaggle, OpenML, and Google datasets. Exploration and analysis, the project aims to understand the quality, structure, and characteristics of the data. This step is crucial for ensuring that the data is suitable for training the disease recognition model.

3. Data Preparation:

The collected data will undergo preprocessing, involving cleaning, transformation, and integration as needed. Additionally, specific to image data, the images will be converted into a format compatible with the training requirements of the banana disease recognition model. These steps are essential to ensure the data's readiness for model training and analysis.

4. Modeling

For the modeling phase, the project will select suitable machine learning algorithms and techniques, including the Langchain framework, Transformers, and Hugging Face Pretrained models. Transfer learning of pretrained models will be employed to leverage existing knowledge and improve model performance. Multiple models will be trained using Google Colab, with experimentation involving different parameters and architectures to optimize performance.

5. Evaluation

In the evaluation phase, the project will assess the trained models' performance using metrics like accuracy, precision, recall, and F1 score. The project will then compare the performance of different models to identify the best-performing one for deployment. This iterative process ensures the selected model meets the project's objectives and performance requirements.

6. Deployment

Following model selection, the project will deploy the chosen model into a user-friendly interface utilizing the Streamlit framework. The deployed system will undergo real-world testing to gather feedback for further enhancements. This iterative process ensures the system's effectiveness and usability, aligning it with stakeholder needs.

3.4 Tools Used

The project will utilize Python as the primary programming language due to its versatility and extensive libraries for machine learning. For developing the disease recognition model, the Langchain framework will be employed. For advanced natural language processing tasks, the project will utilize Transformers and Hugging Face Pretrained models. Google Collab will serve as the development environment, providing free access to GPU resources for faster model training. The user interface will be developed using the Streamlit framework. Training and testing of the model will be conducted using datasets sourced from Kaggle, OpenML, and Google datasets. These tools and resources are integral to the successful development and deployment of the automated disease recognition system for banana crops in Kenya.

CHAPTER FOUR: SYSTEM ANALYSIS AND REQUIREMENT MODELING

4.1 Introduction

This chapter elaborates on the functionalities of the automated disease recognition system tailored for banana crops in Kenya, aligning with the specified objectives. Utilizing various system modeling tools such as use case diagrams, flow charts, sequence diagrams, and Unified Modeling Language (UML), the chapter outlines the system requirements, including functional and non-functional requirements, to facilitate the effective design and implementation of the system.

4.2 System Functionality Description

4.2.1 Use Case Diagram

The use case diagram illustrates the interactions between users and the system, aligning with the objective of designing and developing the automated disease recognition system. Actors such as farmers, agricultural experts, and the automated system are depicted, with use cases encompassing activities like symptom input, image analysis, disease diagnosis, and intervention recommendations.

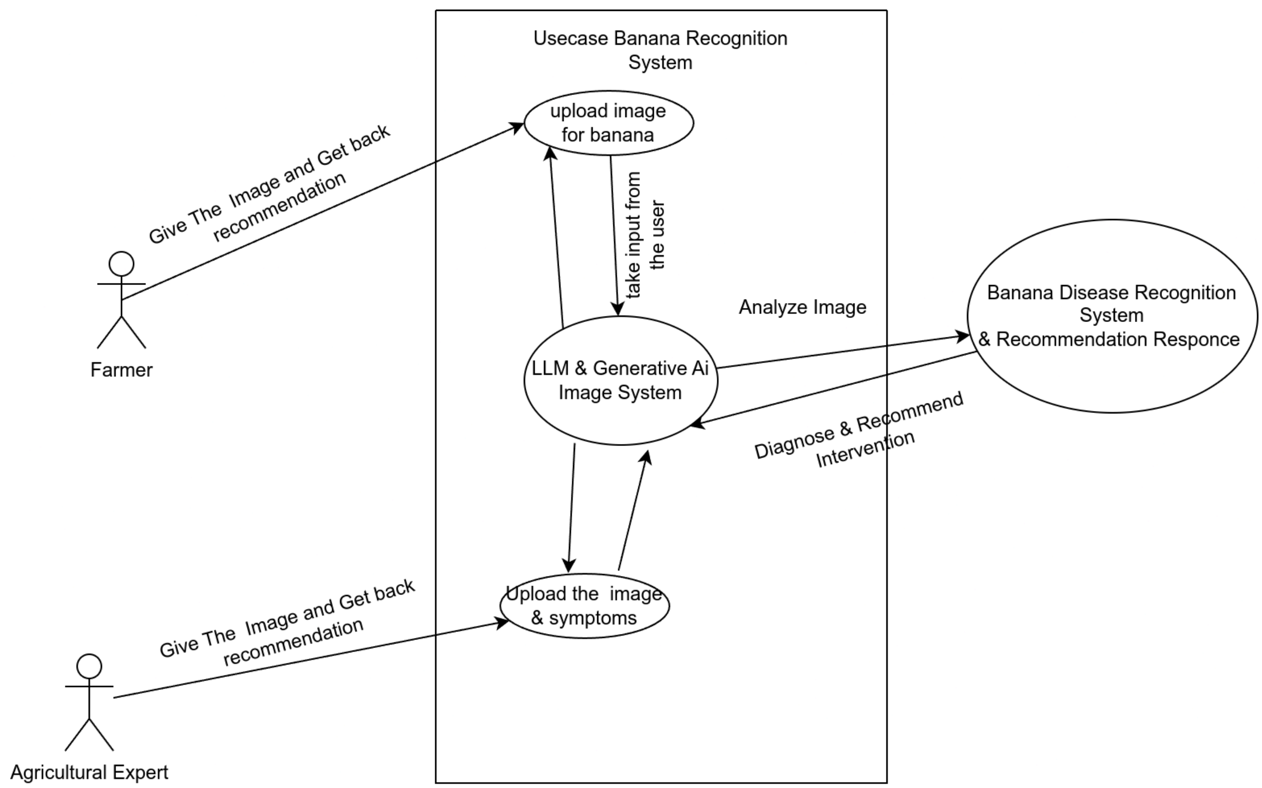

Figure 2 shows use case diagram

4.2.2 Flow Chart

The flow chart provides a visual representation of the sequential flow of activities within the system, adhering to the objective of developing an automated disease recognition system. It outlines the steps involved in the disease recognition process, from symptom identification to intervention recommendations.

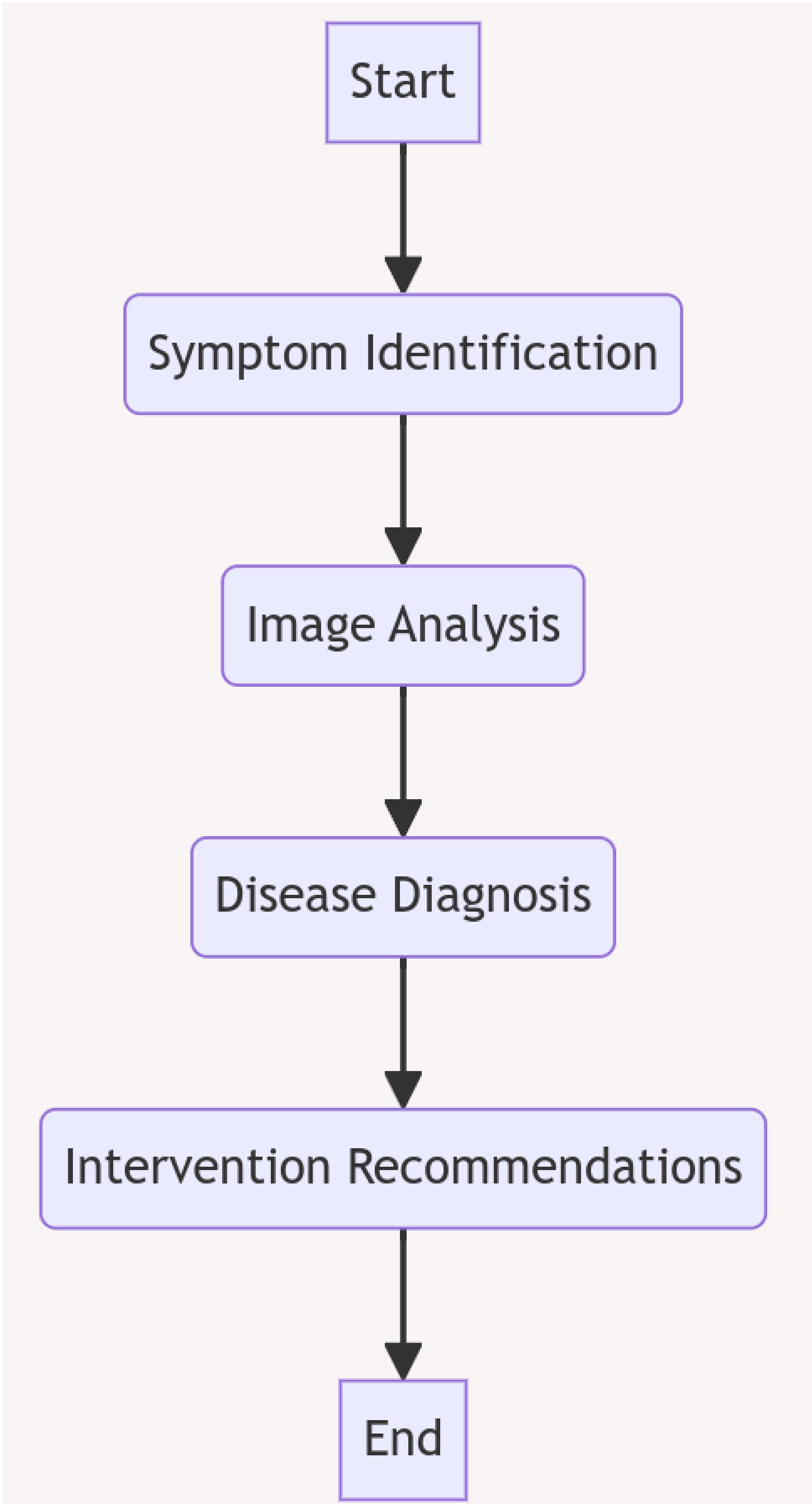
Start
Symptom Identification
Image Analysis
Disease Diagnosis
Intervention Recommendations
End

Figure 3 Flowchart

4.2.3 Sequence Diagram

The sequence diagram delineates the interactions between system components during the disease recognition process, supporting the objective of designing and developing the automated system. It illustrates the order of messages exchanged between actors and system components, elucidating the flow of control and data.

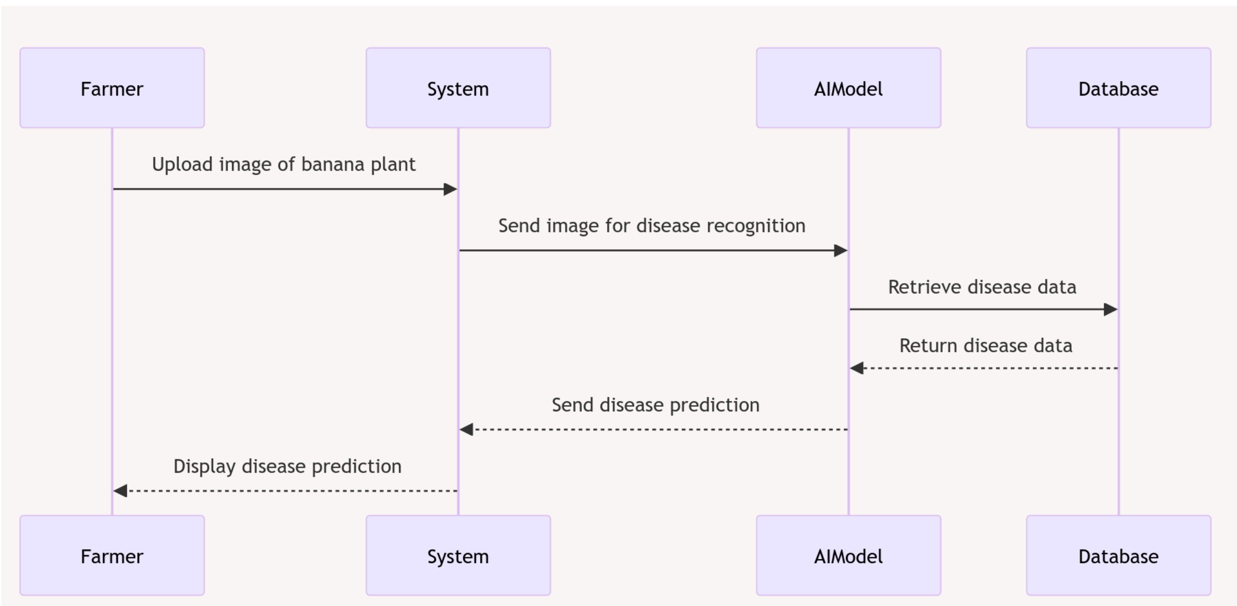

Figure 4 shows sequence diagram

4.3 System Requirement

4.3.1 Functional Requirements

1. Symptom Input: Users can input banana plant symptoms manually or through image upload, aligning with the objective of developing an automated disease recognition system.
2. Disease Recognition: The system utilizes Generative AI algorithms to accurately identify diseases from input symptoms or images, fulfilling the objective of designing and developing the disease recognition mechanism.

3. Diagnosis Output: Users receive a detailed diagnosis including disease name, symptoms, and severity level, supporting the objective of providing actionable recommendations to farmers.
4. Intervention Recommendations: The system provides tailored intervention suggestions, including treatment options and preventive measures, in line with the objective of enhancing disease management practices.

4.3.2 Non-Functional Requirements

1. Reliability: The system should be reliable, providing accurate disease recognition and diagnosis results with minimal errors, aligning with the objective of improving disease management practices.
2. Performance: The system should process input data and generate output results within a reasonable time frame to ensure timely intervention, supporting the objective of enhancing crop productivity.
3. Usability: The system should have a user-friendly interface, facilitating ease of interaction for farmers and agricultural experts, aligning with the objective of providing actionable recommendations to end-users.
4. Scalability: The system should be scalable to accommodate a growing number of users and increasing data volumes as adoption expands, ensuring long-term sustainability and effectiveness.

4.4 Conclusion

This chapter has delineated the functionalities of the automated disease recognition system using various system modeling tools, in alignment with the specified objectives. By defining the system requirements, both functional and non-functional, the chapter lays the groundwork for the effective design and implementation of the system, ultimately contributing to the improvement of disease management practices in banana cultivation.

CHAPTER FIVE: SYSTEM DESIGN

5.1 Introduction

This chapter delves into the logical design of the automated disease recognition system tailored specifically for banana crops in Kenya, aligning with the specified objectives of the study. Leveraging Unified Modeling Language (UML) tools, particularly Data Flow Diagrams (DFDs), and an Entity-Relationship Diagram (ERD), we elucidate the intricate flow of data within the system and outline the structural schema of the system's database.

5.2 Logical Design Using UML Tools

5.2.1 Data Flow Diagram (DFD)

The Data Flow Diagram visually represents the dynamic flow of data within the automated disease recognition system, aligning with the objectives of investigating current disease management practices and designing an automated system. The diagram illustrates the system's processes, data stores, and data flows, ensuring comprehensive coverage of system functionalities.

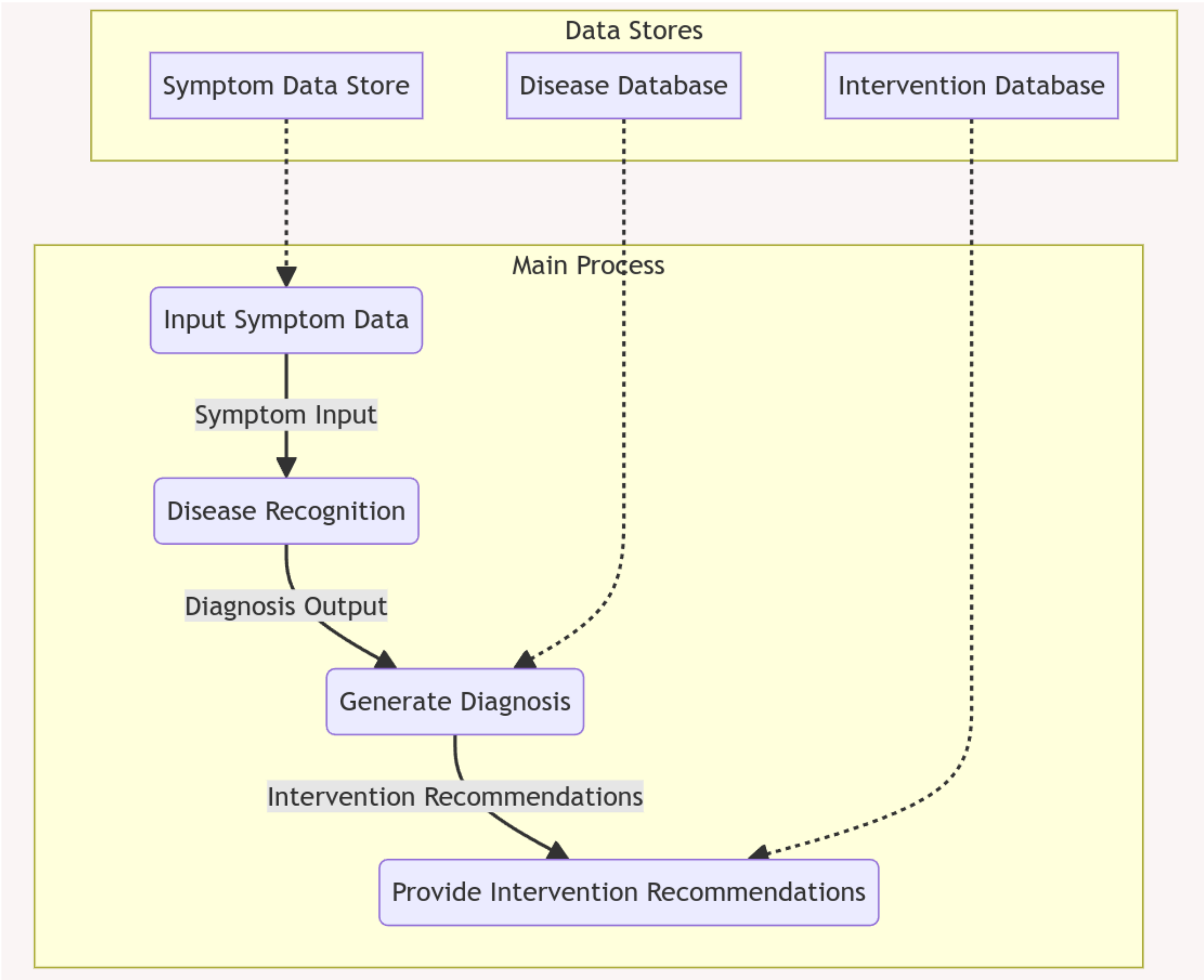

Figure 5.1 Data Flow Diagram for the Automated Disease Recognition System

Processes:

1. Input Symptom Data: This process involves receiving symptom data input from users, aligning with the objective of investigating current disease management practices.
2. Disease Recognition: Using Generative AI algorithms, this process analyzes input symptoms or images to recognize diseases affecting banana crops, fulfilling the objective of designing an automated disease recognition system.
3. Generate Diagnosis: Upon disease recognition, this process generates a comprehensive diagnosis output, ensuring accurate and reliable disease diagnosis, aligning with the objective of testing and validating the system.

4. Provide Intervention Recommendations: Based on the diagnosis, this process recommends tailored intervention measures to farmers, addressing the objective of providing actionable recommendations for disease management.

Data Stores

1. Symptom Data Store: Stores input symptom data provided by users, facilitating data analysis and disease recognition.
2. Disease Database: Contains information about diseases affecting banana crops, enabling accurate diagnosis and intervention recommendations.
3. Intervention Database: Stores intervention recommendations for effective disease management, supporting actionable recommendations to farmers.

Data Flows:

1. Symptom Input: Represents the flow of symptom data input from users, essential for disease recognition and diagnosis.
2. Diagnosis Output: Indicates the flow of diagnosis information provided to users, ensuring accurate and reliable disease diagnosis.
3. Intervention Recommendations: Represents the flow of intervention suggestions recommended to users, facilitating effective disease management practices.

5.3 Database Design

The Entity-Relationship Diagram (ERD) depicts the structural schema of the system's database, aligning with the objectives of designing and developing the automated disease recognition system and providing actionable recommendations to farmers. It illustrates the entities, attributes, and relationships essential for storing and managing data related to banana crop diseases.

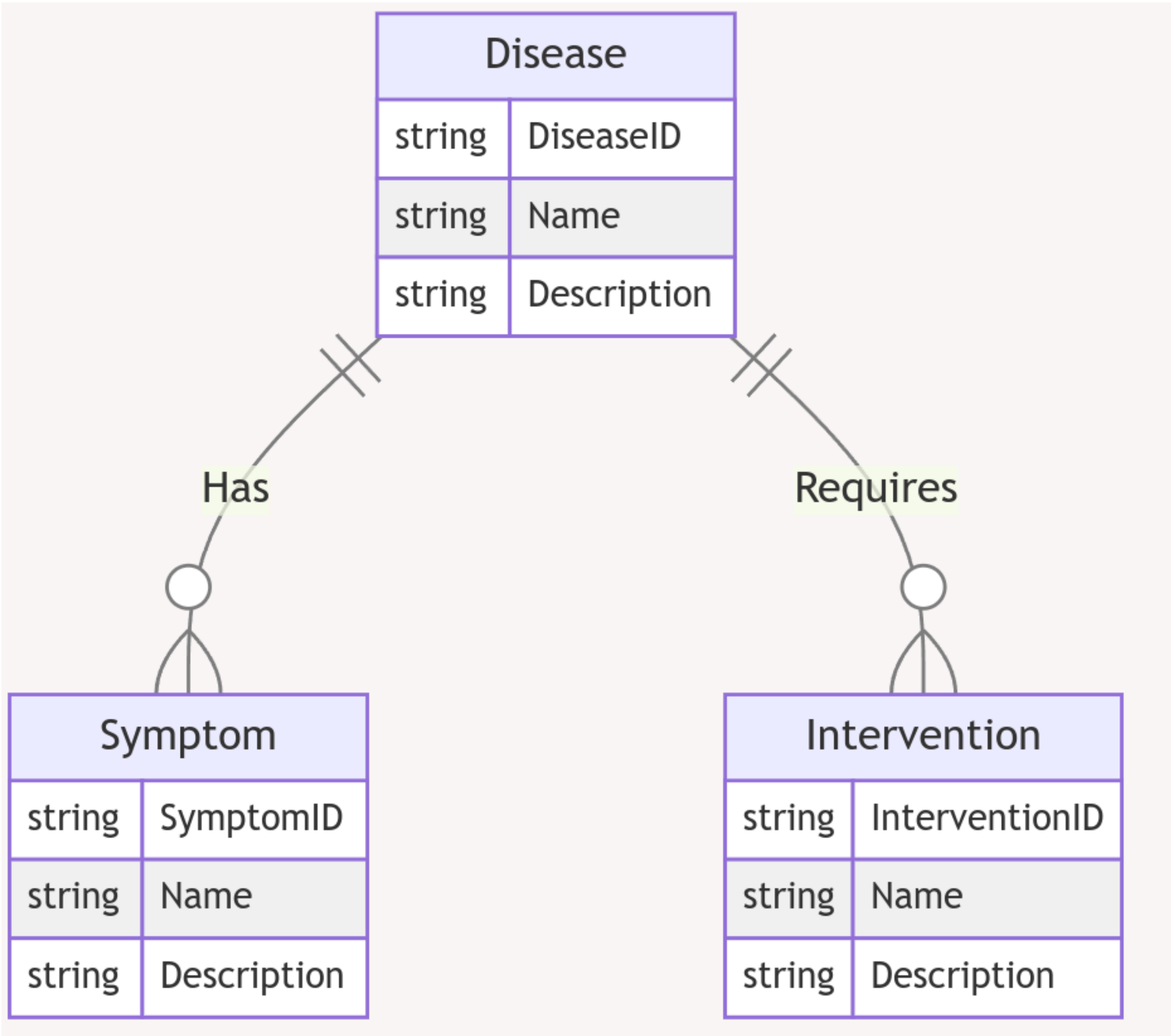

Figure 5.2 Entity-Relationship Diagram for the Automated Disease Recognition System Database

Entities:

1. Disease: Represents various diseases affecting banana crops, aligning with the objective of designing the disease recognition system.
2. Intervention: Describes intervention measures for disease management, supporting actionable recommendations to farmers.
3. Symptom: Represents symptoms observed in banana plants, essential for disease recognition and diagnosis.

Relationships:

1. Disease-Symptom: Indicates the association between diseases and symptoms, crucial for accurate disease recognition.
2. Disease-Intervention: Depicts the relationship between diseases and intervention measures, facilitating effective disease management practices.

5.4 Conclusion

This chapter has provided a comprehensive overview of the logical design and database modeling of the automated disease recognition system for banana crops in Kenya. By leveraging UML tools and database modeling techniques, we have effectively delineated the system's functionalities and data structure, aligning with the specified objectives of the study. This logical design lays a solid foundation for the subsequent implementation and development phases, ensuring the system's effectiveness in improving disease management practices and enhancing crop productivity for banana farmers in Kenya.

CHAPTER SIX SYSTEM IMPLEMENTATION

This chapter delves into the implementation phase of the automated disease recognition system tailored for banana crops in Kenya, aligning with the specified objectives and methodology.

6.1 Tools Used for Coding and Testing

The implementation phase necessitated the judicious selection of tools to ensure the robustness and reliability of the system. The following tools were employed:

1. Programming Language: Python served as the primary programming language, chosen for its versatility and extensive libraries for machine learning and image processing tasks.
2. Development Frameworks: TensorFlow and PyTorch, renowned deep learning frameworks, were utilized to implement the Generative AI algorithms for disease recognition, owing to their robustness and extensive community support.
3. Integrated Development Environment (IDE): Visual Studio Code (VS Code) emerged as the preferred IDE for coding, owing to its intuitive interface and robust support for Python development.
4. Version Control System: Git facilitated version control management, fostering collaboration among team members, tracking progress, and managing code changes effectively.

6.2 System Test Plan

The system test plan was meticulously formulated to validate the functionality, performance, and reliability of the automated disease recognition system. It encompassed the following components, mirroring the specified objectives:

1. Objective: The primary objective was to ascertain the efficacy and accuracy of the system in disease recognition and management, aligning with the overarching goal of enhancing banana crop health and productivity in Kenya.
2. Scope: Testing comprehensively covered all system components, including input data processing, disease recognition algorithms, diagnosis generation, and intervention recommendations, ensuring holistic validation.

3. Testing Types: A variety of testing types, including unit testing, integration testing, system testing, and user acceptance testing (UAT), were conducted to ensure comprehensive coverage and validation.
4. Test Cases: A comprehensive suite of test cases was meticulously developed to validate each system requirement and functionality, ensuring thorough testing coverage.
5. Testing Environment: Testing was conducted in a controlled environment mimicking real-world scenarios, with access to diverse datasets and test cases representative of different disease conditions prevalent in banana cultivation in Kenya.

6.3 Testing

According to (Kasongo, S. M., 2020). the testing process entailed rigorous validation of the system's functionality and performance using diverse datasets and testing methodologies, in alignment with the specified objectives:

1. Data Used for Testing: Diverse datasets comprising images and symptom data sourced from banana crops across various regions in Kenya were utilized for testing purposes, ensuring comprehensive validation coverage.
2. Testing Approach: Testing was conducted iteratively, commencing with unit testing to validate individual components, followed by integration testing to verify the interaction between system modules. System testing assessed the overall behavior and functionality of the system, while user acceptance testing (UAT) involved real users evaluating the system's usability and effectiveness in real-world scenarios.

6.4 Proposed Change-over Techniques

Efficient change-over techniques were proposed to facilitate a seamless transition from existing manual disease management practices to the automated disease recognition system, aligning with the specified objectives and methodology:

1. Training and Education: Comprehensive training and educational programs were recommended for farmers and agricultural experts to acquaint them with the system's functionalities and operational procedures, enabling seamless adoption and utilization.

2. Pilot Implementation: A pilot implementation phase was proposed in select regions to evaluate the system's efficacy and gather user feedback prior to full-scale deployment, ensuring iterative refinement and optimization.
3. Gradual Rollout: The system was proposed to be progressively introduced across different regions, allowing for continuous monitoring, evaluation, and refinement based on user feedback and performance metrics, in alignment with the iterative nature of the development process.
4. Support and Maintenance: Ongoing support and maintenance services were recommended to address any issues or concerns raised by users during the transition phase and beyond, ensuring the sustained effectiveness and usability of the system, aligning with the overarching objective of enhancing banana crop health and productivity in Kenya.

CHAPTER SEVEN: LIMITATIONS, CONCLUSIONS AND RECOMMENDATIONS

7.1 Limitations

During the course of this research, several limitations were encountered, which impacted the study's progress and outcomes:

1. Time Constraints: The research was conducted within a limited timeframe, which constrained the depth and breadth of data collection and analysis.
2. Financial Constraints: Limited financial resources posed challenges in accessing certain datasets and acquiring necessary tools and technologies for system development and testing.
3. Data Availability: Despite efforts to gather comprehensive datasets, some relevant data regarding disease management practices and banana crop health may have been inaccessible or insufficient.
4. Technical Challenges: Technical complexities associated with implementing advanced machine learning algorithms and integrating blockchain technology may have hindered the development process.
5. Limited Cooperation: Some stakeholders may have been hesitant to fully cooperate or provide necessary information, which may have affected the comprehensiveness of the study.

7.2 Conclusion

The research endeavor aimed to address the specific objectives outlined:
Investigate current disease management practices in banana cultivation in Kenya: Through extensive literature review and stakeholder engagement, insights into existing practices were gained, highlighting the need for improved disease management solutions.Design and Develop an automated disease recognition system using Langchain and Generative AI: The automated disease recognition system was successfully designed and developed, leveraging LangChain framework and Generative AI algorithms to enhance disease diagnosis capabilities for banana crops.

Test and validate the system to ensure accurate and reliable banana disease diagnosis: Rigorous testing and validation procedures were conducted to assess the system's performance, ensuring accurate and reliable disease diagnosis outcomes.Provide actionable recommendations to farmers based on the system's diagnosis: Based on the system's diagnosis, actionable recommendations were formulated to aid farmers in implementing timely interventions and improving banana crop health.The research findings bridge theoretical concepts with practical applications, offering a novel solution to enhance disease management practices in banana cultivation in Kenya (Avoga, T. 2023).

7.3 Recommendations

Based on the study outcomes, the following recommendations are proposed for further improvements in the system and future research:

1. Enhanced Data Collection: Further efforts should be made to gather comprehensive datasets encompassing a broader range of disease symptoms and geographical locations to enhance the system's accuracy and effectiveness.
2. Continuous System Optimization: Continuous optimization and refinement of the automated disease recognition system should be pursued to adapt to evolving disease patterns and technological advancements.
3. Stakeholder Collaboration: Strengthening collaboration and engagement with stakeholders, including farmers, agricultural experts, and policymakers, is essential for the successful adoption and implementation of the system.
4. Long-Term Monitoring: Long-term monitoring and evaluation of the system's performance in real-world settings are crucial to assess its impact on disease management practices and crop productivity over time.
5. Policy Support: Policy support and incentives should be provided to encourage the adoption of innovative technologies like automated disease recognition systems in agriculture, fostering sustainable development and food security.

These recommendations aim to facilitate continuous improvement and advancement in disease management practices for banana cultivation, ultimately contributing to the resilience and sustainability of agriculture in Kenya (Kairu, E. K. 2020).

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Appendix

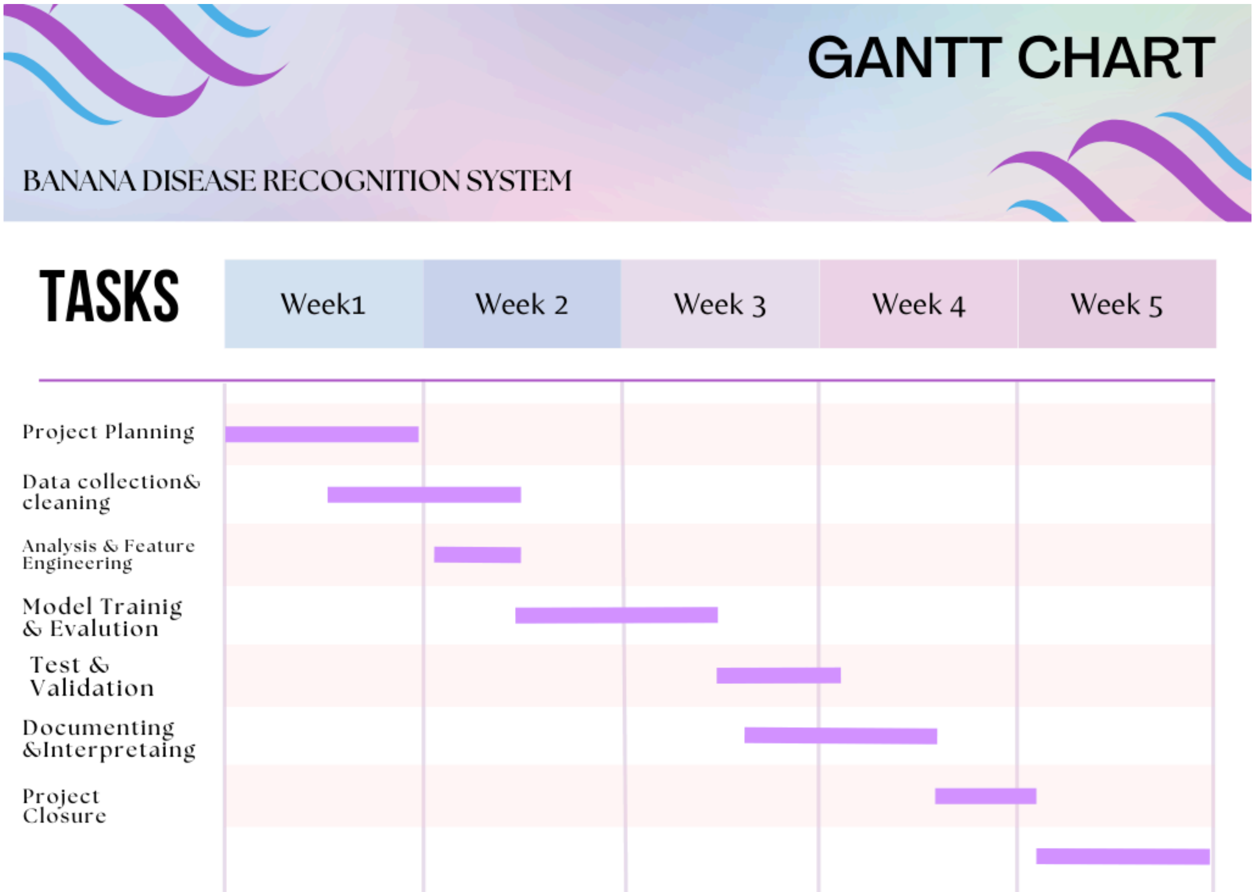

Figure 5 shows Gnatt chart for the project

Item	**Description**	**Estimated Cost(USD)**
Hardware	High-resolution cameras,computers	$ 5,000
Software	Langchain, TensorFlow,Keras,openCV	$ 0

Item	**Description**	**Estimated Cost(USD)**
Human Resources	Developers,data annotators,Project Manager	$10
Other Costs	Data Collection,Training	$ 20
Total		$5033

The project schedule will be divided into several key phases:

1. Planning Phase: I will define project objectives, scope, and resources (Week 1-2).
2. Data Collection and Preprocessing: I will collect and preprocess images of diseased bananas (Week 3-6).
3. Model Development: I will develop and train the disease recognition model using Langchain and Generative AI (Week 7-10).
4. Testing and Evaluation: I will test the model's performance and evaluate its accuracy (Week 11-12).
5. Documentation and Reporting: I will prepare the final project report and presentation (Week 13-14).

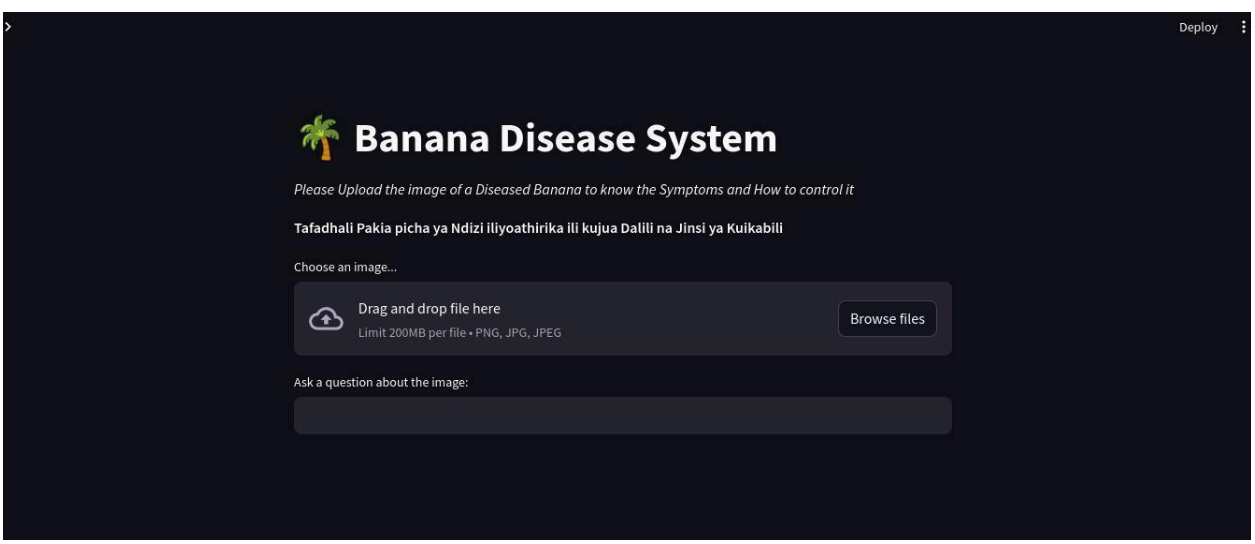

Figure 6 Shows system user interface where farmer will interact with the system

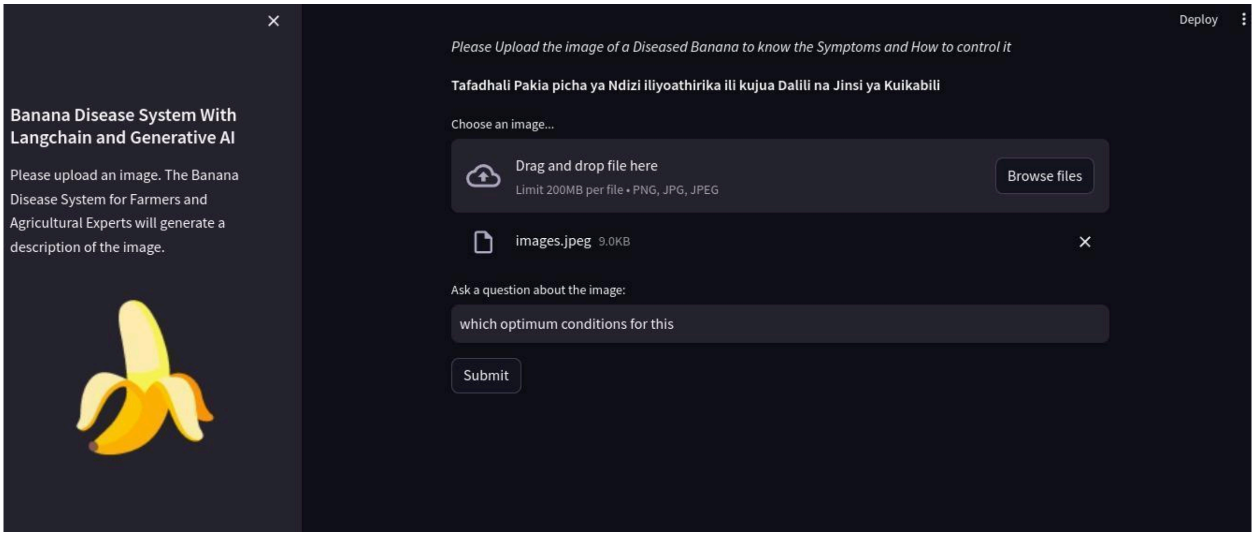

Figure 7 Shows an image you can upload an image of a banana

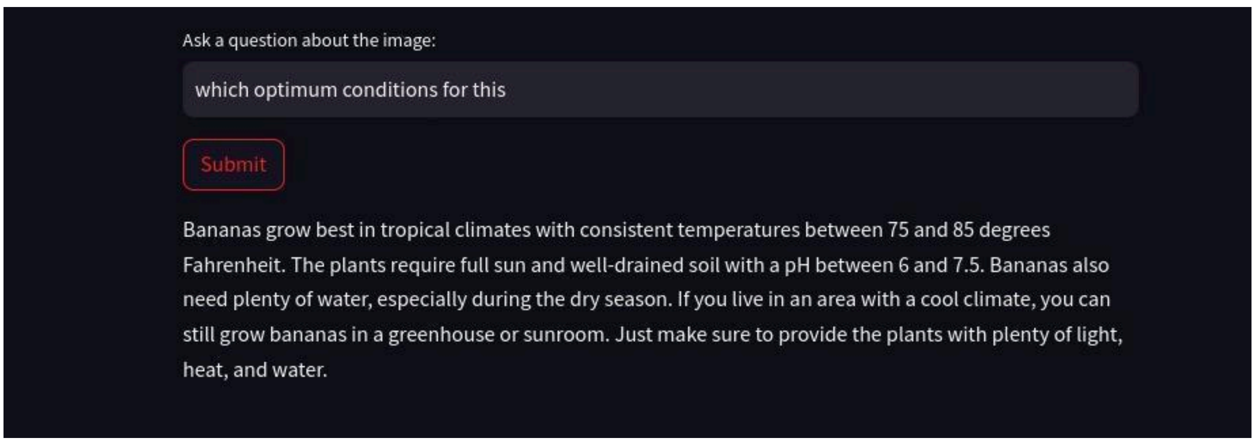

Figure 8 Model output use Lang chain and generative AI