Revolutionizing Tomato Production and quality assessment using AI

Project ID: 24-25J-337

Project Proposal Report

Samarasinghe G.D.M.J

B.Sc. (Hons) in Information Technology Specialized in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology Sri Lanka

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DECLARATION OF THE CANDIDATE & SUPERVISOR

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Samarasinghe G.D.M.J – IT21013164 Date

08/12/24

....

The above candidate is carrying out research for the undergraduate Dissertation under my supervision

Signature of the supervisor Date

09/12/24

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(Mr. Amila Senarathna)

Signature of the Co-supervisor Date

09/12/24

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(Dr. Lakmini Abeywardhana)

ABSTRACT

This research is designed to develop an advanced AI-driven system to revolutionize tomato farming by incorporating machine learning, image processing, and adaptive decision-making technologies. The proposed solution would aim at the precise determination of the stage of ripeness of tomatoes, such as unripe, half-ripe, and fully ripe, by utilizing a Convolutional Neural Network trained on an extensive dataset of tomato images. The system detects and classifies multiple tomatoes in one image using YOLOv5, hence speeding up large-scale ripeness assessment. In addition, a predictive model will analyze the data of the level of ripeness with dynamic environmental conditions to suggest the best time for harvest to achieve maximum yield and quality.

It provides an intuitive web interface, accessible through any smartphone app, with real-time insight, warnings, and harvest suggestions, thus enabling the farmer with actionable advice. This is continuously updated with the ever-changing ripening patterns and environmental factors, making this quite a dynamic and adaptive way to make agricultural decisions. This package further extends to pre-market classification of tomatoes according to their ripeness for better market placement and more in tune with consumer preferences.

This research introduces a whole new dimension by incorporating an adaptive framework that collates the ripeness detection, environmental analysis, and real-time decision support, which goes beyond conventional disease detection methods. It is in providing very accurate, useful, and flexible harvesting recommendations that optimize productivity with efficiency in tomato farming, while contributing to sustainable agricultural practices.

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1. INTRODUCTION

1.1. Background & Literature survey

Tomato farming has been one of the most vital parts of agriculture; hence, it is a major source of nutrition and income among farmers all over the world. Nevertheless, conventional farming methods have normally presented several inefficiencies, such as poor ripeness detection, improper harvest timing, and unsuitable market timing. All these factors contribute to reduced yields, increased waste, and economic losses among farmers. Such challenges call for technological advancements that can improve decision-making and optimize farming practices.

This research proposes a novel AI-driven system that can bring revolution in tomato farming by integrating machine learning, image processing, and adaptive decision-making technologies. The proposed system will be able to accurately identify the three stages of tomato ripeness—unripe, half-ripe, and fully ripe—with high precision using a CNN trained on an extensive dataset of images of tomatoes. It also detects and classifies multiple tomatoes in one image with the help of YOLOv5, thus greatly speeding up the process of ripeness assessment for large-scale farming.

Predicting aside, the system is complete with a predictive model: taking as input ripeness data and dynamic environmental conditions of temperature and humidity to make suggestions on the best time to harvest. This will make sure that farmers achieve their maximum yield with quality, while waste is reduced at all levels. Farmers receive, through an easy web interface hosted on their smartphones, real-time insights, warnings, and harvest suggestions with actionable recommendations.

This will be done through a system designed to adapt to the evolving patterns of ripening and environmental changes for dynamic and flexible decision-making in agriculture. In addition, the solution extends beyond the farm with the pre-market classification of tomatoes according to their state of ripeness to improve market placement in response to consumer preferences.

This work, therefore, proposes a new adaptive framework that will integrate ripeness detection, environmental analysis, and real-time decision support, unlike conventional research that is mainly focused on disease detection. The system will go a long way in ensuring the optimization of productivity and efficiency, as well as sustainable agricultural practices, through the provision of accurate and workable harvesting recommendations. The study will seek to raise the bar in tomato farming by incorporating high-level technology with practical approaches toward the resolution of pertinent challenges in the industry.

1.2. Research Gap

The gap in research is that the existing applications used in the domain of farming tomatoes are highly limited to address the needs for precision and usability. The existing apps offer only elementary functionalities and lack advanced features that modern agriculture requires. Most of the available solutions do not analyze the input images to identify key features such as the stage of ripeness or other important characteristics with recommendations for best harvest timing. This inability to provide timely, precise, and proper suggestions reduces the ability of farmers to make appropriate decisions on farm produce, yield quality, and productivity.

Besides, the existing applications have a very general approach, with no focused content prepared to address the specific needs of tomato farming. They lack dynamic systems that could adapt to changes in the environment or different patterns of ripening. In such cases, farmers are left with static tools that are not reliable. Most of these applications target only Android operating systems, making them inaccessible to other operating systems, like iOS. This naturally limits scalability and adoption for a large set of farmers who could use different types of devices.

The proposed research will bridge this gap by developing a robust and user-friendly mobile application that will be able to utilize advanced machine learning and image processing techniques. The system will identify the stages of tomato ripeness with high accuracy using a CNN, while the detection and classification of multiple tomatoes in one image will be done using YOLOv5. Moreover, the solution will feature a predictive model that analyzes ripeness data along with dynamic environmental conditions to recommend optimal harvesting times, ensuring maximum yield and quality. A user-friendly interface, accessible on both iOS and Android devices, will empower farmers with real-time insights, warnings, and actionable recommendations. This research accordingly intends to bridge the prevailing gaps and raise a new bar for technology-driven change in tomato cultivation by offering an all-inclusive, adaptive, focused solution.

Features	Proposed Mobile Application	Other apps
Mobile App	✓	✓
Input Image	✓	✗
Identify Harvesting Time	✓	✗
Identify Tomato Stages	✓	✗
Focused Content	✓	✗
Device Compatibility	IOS / Android	Android

Figure 1- Novelty of the proposed system

Moreover, none of the available applications are designed with the latest technologies like deep learning frameworks or higher-order image processing techniques such as YOLO for multi-object detection and classification. This technological deficiency results in inefficiency at large-scale farming levels where the need to analyze several tomatoes at once and classify them precisely is paramount.

1.3. Research Problem

Timing in tomato harvest is critical in terms of determining the overall market value, quality, and profitability of the product. Tomatoes that are harvested too early never achieve full ripeness, when they are sweet and full of flavor, while those that stay on the plant too long tend to over-ripen, which shortens their storage life and leads to spoilage, thereby reducing their freshness in the market. Both conditions lead to low income for farmers, since the produce does not meet the expected quality standards and consumers' preferences.

Besides, the determinations of the best time to harvest are further complicated by some variable environmental factors such as temperatures, humidity, and sun exposures that affect the ripening process. Most farmers either use traditional methods or depend on subjective visual assessments without any precision or consistency in arrival at the best decisions to harvest. Moreover, it is almost impossible to monitor the ripeness of tomatoes in large-scale farming activities.

This problem urges the need for a reliable, accurate, and adaptive solution that can help farmers decide the best time to harvest. Such a system should combine high-level technologies like machine learning and image processing for the precise detection of the stage of ripeness, as well as give actionable recommendations. Addressing such challenges will enable farmers to guarantee maximum yield quality, enhance profitability, and make their produce acceptable in the market.

1.3.1. Proposed Project

Our project aims to create an AI-driven system for tomato cultivation for precise agriculture. Key areas that our project address is inconsistent ripeness identification, manual quality grading and delayed disease detection. The goal is to improve productivity, reduce waste, and empower farmers with a reliable tool for optimizing tomato farming practices.

Ripeness Detection: Develop a Convolutional Neural Network model to classify tomatoes into three stages of ripeness, namely unripe, half-ripe, and fully ripe, using a large dataset of images. Implement YOLOv5 for efficient multi-object detection, enabling the system to assess multiple tomatoes simultaneously.

Predictive Harvest Recommendations: Develop a predictive model, which will use information of ripeness in concert with dynamic environmental conditions of temperature and humidity to recommend the best times of harvest. This will ensure that farmers achieve maximum yield and quality while reducing waste.

User-Friendly Interface: Design an intuitive web interface that can be accessed by smartphones, which provides real-time insights, alerts, and harvest recommendations to farmers. The interface will be user-friendly, allowing farmers to easily upload images, view ripeness classification, and manage their crop decisions accordingly.

Continuous Improvement: Establishing a feedback loop for the continuous learning of the system from fresh data supplied by the users is important. This would be consistently updated to fine-tune these models and further improve the accuracy of this platform, assuring its continued relevance amid the ever-evolving challenges in farming.

2. OBJECTIVES

2.1. Main Objective

The key goal of this research is to create a mobile application that would help tomato farmers decide the optimal time for the harvesting of tomatoes. It utilizes machine learning and image processing techniques to classify tomatoes into stages of unripe, half-ripe, and fully ripe. The system then uses the analyzed data of the level of ripeness combined with other environmental factors to predict the best time to harvest, ensuring the quality, yield, and market value of the produce. Equipped with an intuitive smartphone interface, the application gives real-time insights and actionable recommendations to the farmers for making proper decisions, reducing post-harvest losses, and accepting sustainable farming practices.

2.2. Specific Objectives

The application will be designed with a simple and easy-to-use interface, such that even the most uninformed farmer can access and use it easily. This would include clear visuals, easy-to-understand instructions, and various interactive elements that enhance user experience. This will make the application highly accessible and useful to farmers in a wide array of regions.

The mobile application will be optimized to run smoothly on devices with limited hardware capabilities. This includes minimal battery consumption, reduced data usage, and the ability of the app to perform well on low-end smartphones. This makes it more practical for farmers in rural or resource-constrained areas to adopt and use.

The core functionality of the application is to analyze the ripeness of tomatoes using real-time image recognition. Farmers can take pictures of their crops through the app, which will then use machine learning models such as CNNs and YOLO algorithms to classify the tomatoes into different stages of ripeness: unripe, half-ripe, and fully ripe. Based on this analysis, the app will also predict the best harvesting time, considering factors like ripeness patterns and environmental conditions.

By addressing these sub-objectives, the app will provide an effective decision-support tool for farmers. This app will help farmers in determining when tomatoes should be harvested to achieve the maximum quality and yield, apart from being resource-efficient, user-friendly, and technologically sound, thereby bringing significant farming output and contributing to environmental sustainability.

3. METHODOLOGY

This research is focused on the design of an advanced AI-driven system for changing the face of tomato farming by integrating machine learning, image processing, and adaptive decision-making technologies. This methodology involves data collection, preprocessing of a large dataset of images of tomatoes, which will be used for training a Convolutional Neural Network, and utilizing YOLOv5 for efficient multiple detections and classification of tomatoes in one image. A predictive model will be developed to assess stages of ripeness against dynamic environmental conditions, delivering optimal harvest timing recommendations in real time. The design will include an intuitive web interface that presents actionable insights, warnings, and suggestions for harvests, accessible on smartphones for farmers. This system will keep learning and updating the changing patterns of ripening and environmental changes, ensuring sustainable agricultural practices, maximum productivity, and waste reduction. This approach forms a fresh method of addressing the challenges conventional farming presents and optimizes farming and marketing appeal for tomatoes. In this way, the tomato-growing industry will be improved in both quality and profitability.

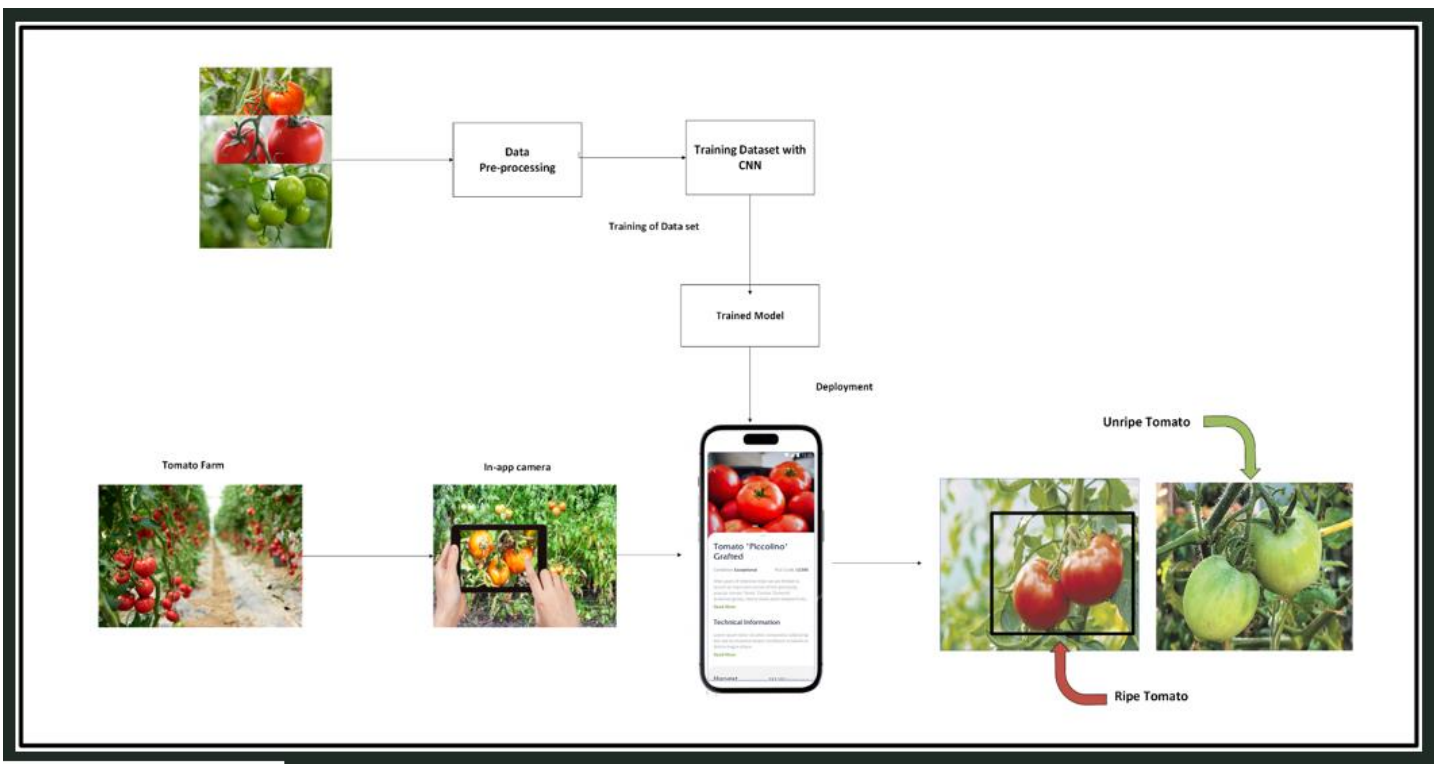


Figure 2 System overview

3.1. Conceptual Design

The first phase of the methodology involves the conceptual design of the Identify the ripeness stages accurately and recommend the best time to harvest tomatoes analyzing ripeness detection. This phase includes defining the user experience, identifying the specific learning outcomes, and detailing the functionalities of the scanning tool. The primary objectives during this phase are to:

Identify Learning Objectives: Focus on enhancing farmers' creativity, cognitive skills, and understanding of tomato ripeness stages through interactive best time to harvest.

User Interface Design: Develop an intuitive, user-friendly interface that allows farmers to identify tomatoes using pictures, ensuring the platform is accessible to all.

Feature Specification: The AI-driven tomato farming system optimizes ripeness detection, harvest timing, and market preparation using CNN, YOLOv5, and predictive models. It features a user-friendly mobile interface, real-time notifications, and adaptive learning to provide accurate, actionable insights. The system is lightweight, accessible, and designed to enhance productivity, quality, and sustainability in tomato farming.

3.2. Model Development and Training

The development and training of the AI-driven tomato farming system includes several key processes to build, refine, and optimize the machine learning models that are necessary for accurate ripeness detection, multi-object detection, and predictive harvest recommendations. The methodology for model development and training includes:

Data Collection and Preparation:
The process begins with the gathering of a dataset of tomato images at different stages of ripeness from various sources. The images are then preprocessed to standardize them, augmented to represent different real-world conditions, and annotated for stages of ripeness and multiclass tomato classification. These provide the necessary data required for training the models.

Model Development:
A CNN is designed for the correct classification of ripeness, while YOLOv5 is used for multi-tomato detection. Both models are trained on the preprocessed dataset with rigorous validation to ensure high performance. Techniques like dropout and regularization are applied to prevent overfitting. YOLOv5 is fine-tuned to handle multi-object detection efficiently.

System Integration and Design of Web Interface:

The trained models are then integrated into a user-friendly web interface that can be easily accessed on a smartphone. This interface will provide real-time insights, notifications, and historical tracking to make the system accessible and user-friendly for farmers. Such a design allows the system to adapt dynamically to any evolving pattern of ripening and environmental changes for continuous effectiveness.

Continuous Learning and Improvement:

A feedback mechanism is implemented to collect user data on the system's performance, which is used to refine the models and improve the system. Regular updates based on new data ensure the system remains effective, evolving alongside changes in farming practices and environmental conditions. This approach ensures the system will be relevant in the long term and continuously improves productivity and sustainability in tomato farming.

3.3. Ripeness Stages and Harvesting time Detection

The AI-driven tomato farming system provides a CNN for correct estimation of the ripeness stage-grading of tomatoes into unripe, half-ripe, and fully ripe, along with YOLOv5 for efficient detection in multi-objects. It integrates a predictive model by considering dynamic environmental conditions for recommending an optimal harvesting strategy. The real-time Web interface of the system avails instant feedback and actionable insights from farmers, thus rendering it user-friendly and accessible. This approach ensures improved productivity, sustainability, and profitability for the farmers, turning traditional farming upside down into more efficient data-driven farming.

3.4. System Integration

Once the development of the models and the web interface of the AI-powered tomato farming system is over, then integration with the bigger agricultural platform would be done. These would include the following:

- Backend Integration: The AI-driven tomato farming system integrates the models into the platform backend, allowing for seamless communication between the CNN model for ripeness detection, YOLOv5 for multi-tomato detection, and the predictive model. This ensures efficient processing and presentation of real-time harvest recommendations based on user inputs, facilitating smooth data flow between the models and the web interface.
- User Interaction flow: The flow of interaction within the system is user-friendly, hence allowing farmers to upload images and input environmental data and get real-time feedback on stages of ripeness and time of harvest. Features like real-time notifications and visual feedback would encourage iterative learning, refinement in practices by farmers. The goal is to make the system accessible and intuitive for users of all technical backgrounds.
- Testing and Refinement: It undergoes extensive testing with target users, namely farmers and agricultural professionals, to understand its usability and effectiveness. Feedback is sought from the users regarding the correctness of the recommendations and overall user experience. Based on the feedback received, refinement is done in the system through model updates, optimization of algorithms, and improvement in the user interface to suit emerging needs.

3.5. Evaluation and Assessment

The AI-powered Tomato Farming system will go through intensive testing and evaluations to ensure effectiveness and satisfaction of its users. It includes on-field testing with farmers, checking the system for usability and accuracy, collecting feedback for the user interface, model performance, and updating it continuously as suggested by the end users. The CNN for detecting ripeness and the YOLOv5 for multi-tomato detection are supposed to be regularly updated with new datasets for sustaining the accuracy of the models. This will create a continuous feedback loop for sustained improvement, relevance, and responsiveness of the system under ever-evolving agricultural practices and environmental conditions. Long-term assessments will also be used to measure the impact of this system on sustainability and efficiency in farming for lasting benefits to farmers.

3.6. Conclusion

The AI-based smart tomato farming system marks the greatest achievement in agriculture, from poor detection of the stage of ripeness to inappropriate timings of harvest, causing much waste. Equipped with technologies like machine learning, image processing, and adaptive decision making, this forms a perfect solution to optimize farm-related activities. The integration from the backend ensures seamless interaction between the models and the web interface, providing live insights, warnings, and actionable recommendations on smartphones. The system is designed to evolve with the users, guaranteeing continued value over time through its user-friendly design coupled with a feedback-driven refinement process. This approach improves productivity, reduces waste, and enables sustainable agricultural practices by adapting to the changing patterns of ripening and environmental conditions. This innovative framework now sets a new benchmark for tomato farming, presenting a workable, technology-driven solution to the industry's problems and paving the way for a more efficient, profitable, and sustainable future in agriculture.

3.7. Project Requirements

3.7.1. Functional Requirements

- Data Collection and Preprocessing: The system will provide the farmer with the ability to upload images of tomatoes, which are preprocessed- resizing, normalizing, and augmenting- to prepare them for model training. This ensures the images are ready for input into the CNN and YOLOv5 models.

- Ripeness Detection using CNN: The system should integrate a CNN model to classify tomatoes with high accuracy into different stages of ripeness, such as unripe, half-ripe, and fully ripe, based on uploaded images, providing real-time visual indication.

- Multi-Tomato Detection using YOLOv5: The system should leverage YOLOv5 in efficiently detecting and classifying multiple tomatoes in one image for fast visual indication to farmers.

- Predictive Harvest Recommendations: The system should be able to provide optimal harvest timing by analyzing the predictive model of ripeness data and environmental conditions for the best time of harvest. This provides actionable insights that help farmers maximize yield and reduce waste

- User Interface: The system should be designed to include a user-friendly web interface, accessible via smartphones, through which farmers can interact with the system, upload images, receive real-time notifications, and view harvest recommendations.

- Feedback Mechanism: A feedback loop should be incorporated within the system to gain insights from users in refining the models and interface for further improvement in accuracy and usability over time.

- System Adaptability: Changes in environmental conditions and varied ripening patterns call for a system that is consistently updating its models with new data so that it remains relevant long into the future.

3.7.2. Non-Functional

- Response Performance: The system should ensure fast real-time responses to whatever actions the user makes and handle high volumes of requests efficiently to ensure timely decision-making by the farmers. It should be able to support large-scale operations without performance degradation.

- Reliability: The system should have high uptime with minimal downtime and integrity of user data throughout the interaction. This includes the secure handling of sensitive information and ensuring that data is accurate at all times.

- Availability: The system must be accessible 24/7, with a robust disaster recovery plan to ensure swift recovery in case of failures. It should be usable across different devices, including smartphones and tablets, maintaining consistent performance.

- Security: Strong security measures are required to protect user data from breaches, including secure data encryption and multi-factor authentication. Access controls should limit what features different user roles can view and manipulate.

- Usability: It should be an intuitive system whose interface is friendly and quite easy to handle by farmers with varying technological skills. Easy-to-access help resources in overcoming common problems should be handed.

- Maintainability: The system should be modular to permit updates and the addition of new functionality easily. The system should provide performance monitoring and user interaction tools, including regular log generation for troubleshooting and continued system improvements.

3.7.3. Software Requirements

- TensorFlow - An open-source platform used for implementing and training Convolutional Neural Networks (CNNs) to recognize.

- OpenCV- A library used for image processing tasks like detecting and analyzing drawn shapes and features to extract the necessary data for animation.

- Python - The primary programming language for developing and integrating the AI models, image processing tasks, and other backend functionalities of the system.

- Git-bash - Git Bash is a very convenient Unix-like command line, which developers can use for running Git and other Unix utilities in one environment for version control and various command-line tasks on Windows.

- MySQL or PostgreSQL - A relational database management system to store user-generated content, model data, and animation assets.

3.8. Commercialization

The target of this AI-driven tomato farming system ranges from individual farmers to large agricultural entities using different subscription packages in tiers: Basic, Standard, Premium, and Enterprise. A 14-day free trial period to promote adoption will be provided. Reach expansion shall be through direct sales with agricultural events, partnerships with technology providers, and online channels. Regular strategic customer support, updates, and engagement at all levels will drive user retention. The system will focus on domestic markets but aims to expand internationally, continuously innovating in response to evolving needs. This strategy ensures the system's accessibility, affordability, and long-term sustainability in the agricultural sector.

3.8.1. Free Trial Period

As an incentive for new users to come onboard to enjoy the benefits of such AI-driven tomato farming, the basis of this trial will cover a 14-day time frame. In this connection, the user shall have an uninterrupted interface of accessing various features of the platform concerning Basic, Standard, and Premium plans during the tenure specified, without incurring the cost of availing. This trial period will allow individual farmers, small-scale operations, and larger institutions to assess the impact of the system on their farming practices, test the features, and make an informed decision on subscribing to a paid plan. At the end of the 14-day period, users will have to subscribe to a plan to continue using the system.

3.8.2. Target Market and Outreach

The targeted users of this AI-driven tomato farming system range from individual farmers to large-scale agricultural institutions. The Basic Plan is suited for small-scale farmers, while the Standard and Premium Plans are aimed at mid-sized farms and larger commercial operations. Outreach strategies will include digital marketing through social media and agricultural forums, as well as personalized sales approaches and partnerships with industry groups. It aspires to have an extensive clientele in various fields through offering affordable, friendly solutions, with relationships developed through customer service and community building.

3.8.3. Pricing Strategy

The platform will be offered at a competitive subscription rate of Rs.435.91 per month per user. This pricing is designed to ensure affordability while maintaining the quality and sustainability of the platform. The subscription model will include the following tiers:

- Basic Plan: The Basic Plan targets individual farmers and small-scale agricultural activities. It gives access to the core features of the AI-driven system, such as ripeness detection, multi-tomato detection, and best harvest recommendations. This plan is best for small-scale farmers and beginners, with limited usage quotas that make it accessible and affordable. It is available at Rs.435.91 per month per user, thus assuring affordability while delivering essential functionalities to those just starting with the technology.

- Standard Plan: The Standard Plan aims at mid-sized farms, agricultural cooperatives, and early adopters. It features all core functionalities and then some, with increased customization possibilities and more classroom management functionalities. This plan can sustain a higher degree of generosity on the usage limits and could suit moderate-scale farming operation needs. Priced at Rs.871.82 per month per user, it strikes a balance between affordability and the enhanced capabilities needed by mid-sized farming entities.

- Premium Plan: This Premium Plan targets bigger agricultural institutions, commercial farms, and organizations that have wide farming needs. It provides unlimited access to all the features of the system, including advanced analytics, extended customization options, and even dedicated support. This is very suitable for institutions requiring wide usage across multiple locations. It is offered at Rs.1,453.3 per month, per user, which suits those users who are demanding of their service providers to offer the fullest array of tools and support toward their farming.

- Enterprise Plan: This solution targets large-scale agricultural organizations, networks of farms, and agribusinesses: the Enterprise Plan. Besides the basic functionalities provided by this application, it will be offering customized integrations, tailored features, and support for any specific institutional needs. Pricing will be based on detailed consultations with the institution to tailor it to specific requirements. The plan ensures that the system will be fully customized to meet the unique demands of large-scale agricultural operations, making it scalable and flexible for complex farming environments.

3.8.4. Special Offers and Incentives

These special offers and incentives will be used to attract new users, retain subscribers, and establish long-term relationships with farmers and educational institutions for extensive adoption and maximum impact of the AI-driven tomato farming system.

3.8.5. Continuous Feedback and Improvement

Throughout the free trial and initial launch phases, there will be active solicitation of feedback from the users on how to create a better user experience. This user-centered approach enables the platform to evolve over time, catering to new needs that users may have while staying competitive and relevant within the greater educational technology marketplace.

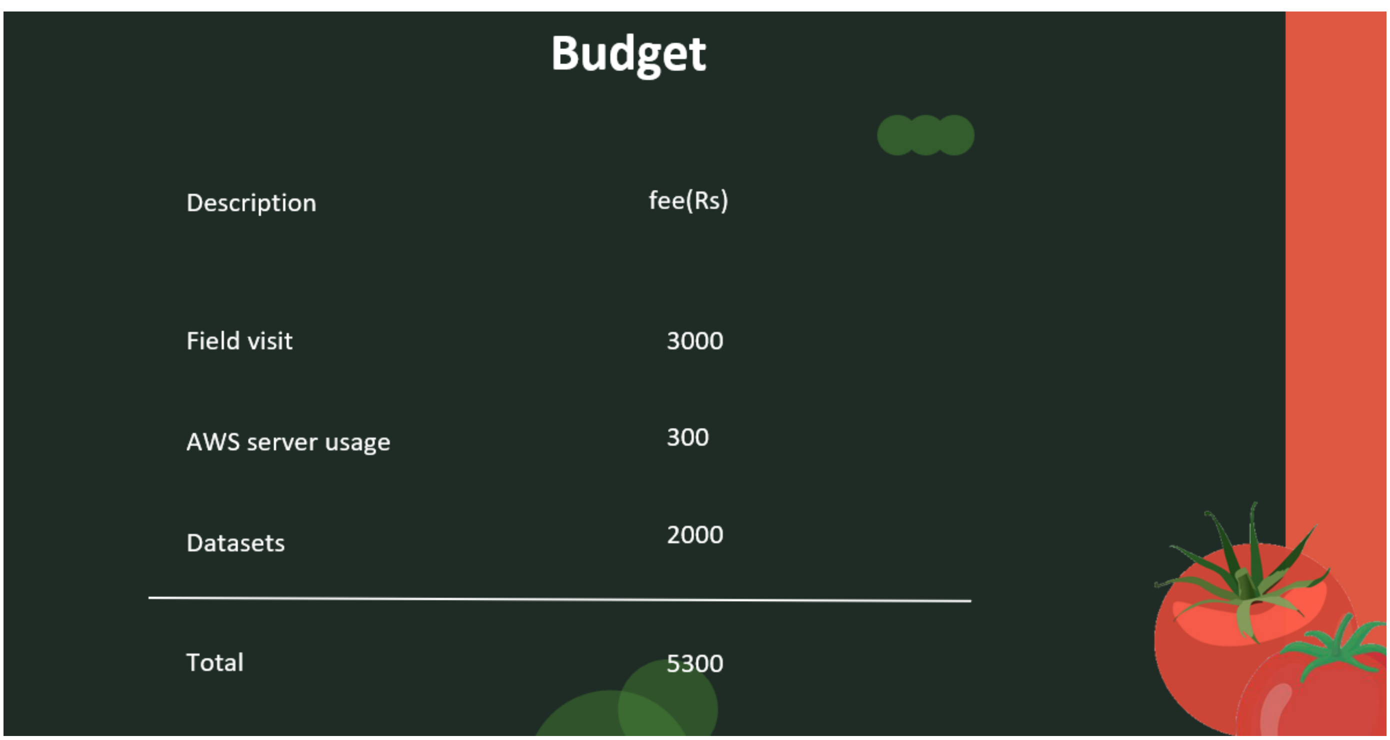
3.8.6. Social Impact and Accessibility

The AI-driven tomato farming system empowers farmers by providing actionable insights through machine learning and image processing. It reduces waste and enhances productivity, hence promoting sustainable agriculture. The system is accessible via a user-friendly mobile interface, compatible with both Android and iOS, and optimized for low-resource smartphones, making it inclusive for all farmers. Its real-time notifications and adaptability to varying conditions ensure relevance and support for diverse farming practices, hence bridging traditional and modern agricultural approaches.

3.8.7. Long-Term Sustainability

The complete solution to the immediate challenges facing agriculture with long-term sustainability, AI-driven tomato farming brings together ways of reducing waste, adapting to environmental changes, and enhances productivity and profitability with environmental responsibility through efficient and farmer-friendly practices. It is a process that changes not only tomato farming but also lays down the foundation for a more sustainable and resilient agricultural future.

4. BUDGET AND JUSTIFICATION



Budget

Description	fee(Rs)
Field visit	3000
AWS server usage	300
Datasets	2000
Total	5300

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APPENDICES

Gantt chart

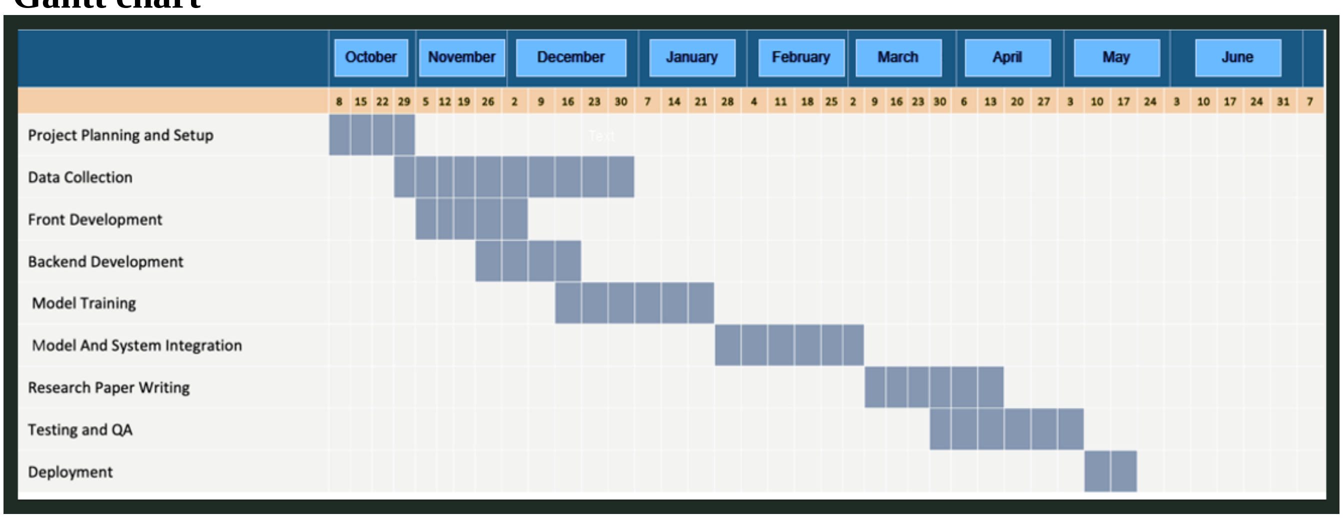

Figure 3Gantt chart

Work Breakdown Structure

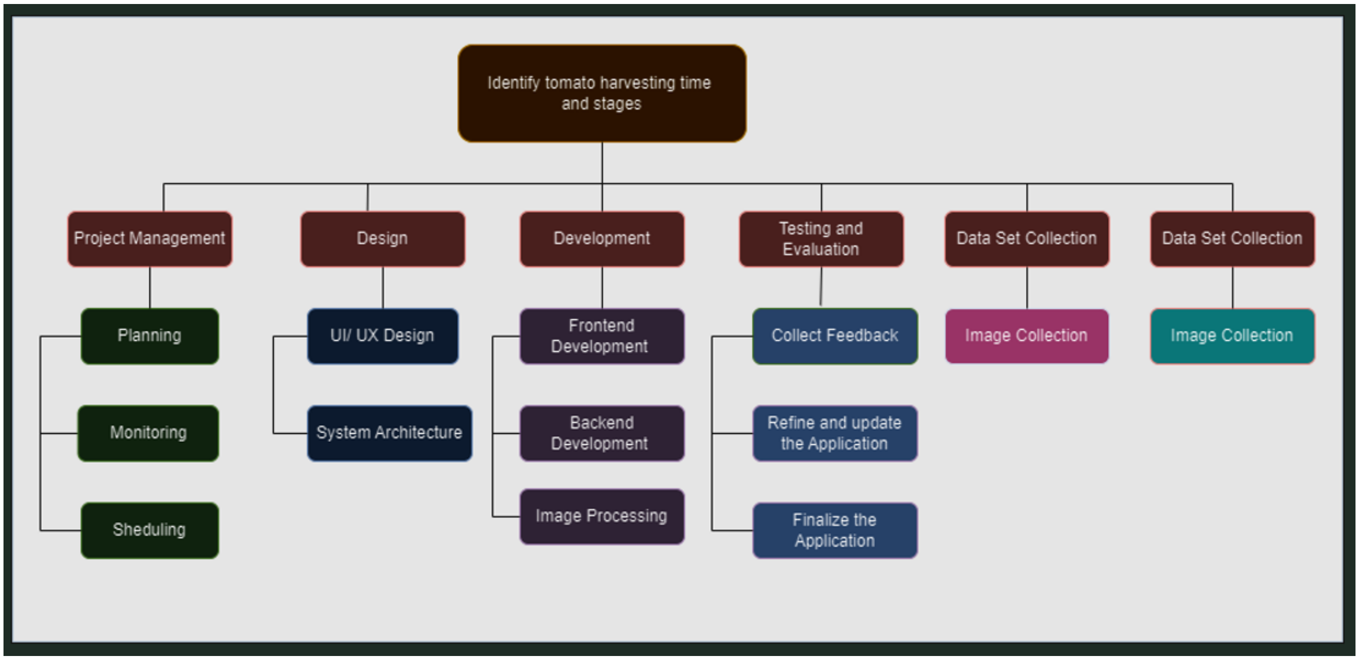

Figure 4 Work Breakdown Structure

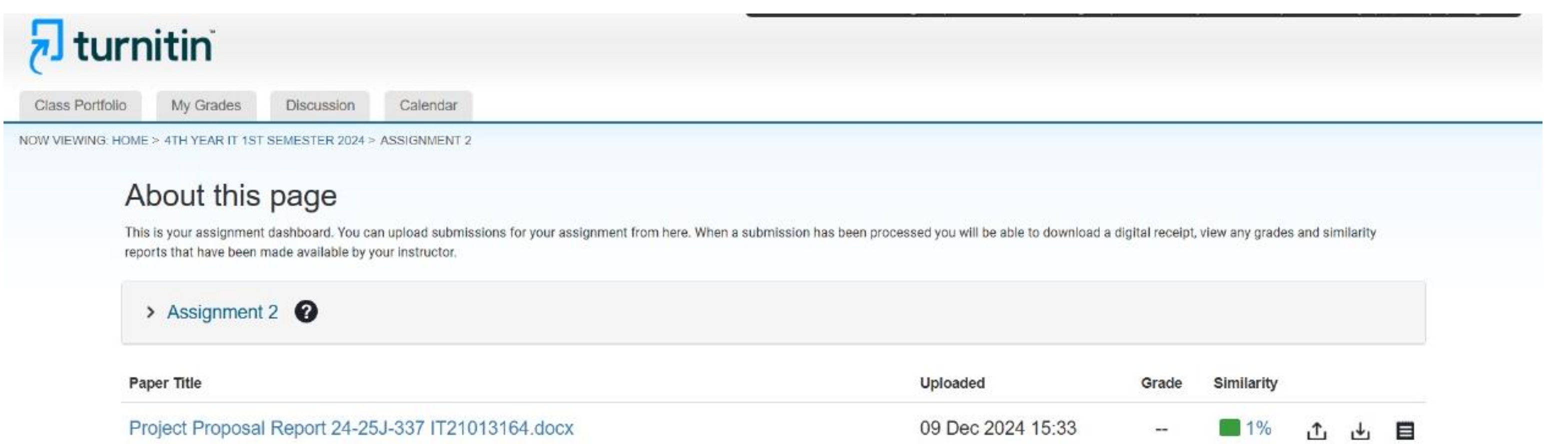

Figure 5 Plagiarism Report