Smart Pest Identification and Control Mobile App for Gherkins Cultivation

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Declaration

I declare that this is my own work, and this proposal does not incorporate without acknowledgment 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.

Name	Student ID	Signature
Jinasena H.D.S.S	IT21042560	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

2/29/2024

Signature of the supervisor Date

Abstract

This paper is dedicated to the problem of Gherkin growing linked with precise pest diagnosis and the way to present the solution which can be useful for farmers through a mobile application. In Sri Lanka, the agriculture sector is occupying a most important position, as it is employing 27.1% of the population and is contributing 7.4% to the nation's GDP. Gherkins, a crop that have a well-recognized brand with world market, over 10-20% of the harvest per annum being damaged by thrips attacking. Modern pest control methods are inefficient. They highlight that we do have to develop new methods of handling with that. Inno Agri mobile application that operates on artificial intelligence, image processing, and augmented reality opens a broad spectrum of options in pests control of cultivating cucumbers. The objective of this app is to help overcome language hindrance while unravelling logic in training settings and complexity of pests and disasters. The export of garcinia has increased dramatically, particularly to Europe, and has reached 6984 tons in 1991 as compared to 320 tons in 1988 which indicate the demand. Crop reduction is a long-term research issue due to pests which delays preventive measures hence loses occur economically. The proposed app is well equipped with machine learning models likeYOLOv3 and Xception that are known to be highly accurate. In addition, it applies mixed reality to demonstrate farmers the full dimension of the pests and helps them to better comprehend the topic. Ino Agri app innovative, modern, and farmer friendly results in productivity, efficiency and sustainability, making gherkin production to grow. Our proposed budget is also aligned with the process through which the system will perform the functions of steering the Sri Lanka agricultural establishment.

Keywords – Image Processing, Machine Learning, Convolutional Neural Network, Augmented Reality, Pest Identification and Control, YOLOv3, Xeception

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List of Abbreviations

Abbreviation	Description
GDP	Gross domestic product
SVM	support vector machines
ANN	Artificial Neural Network
AR	Augmented Reality
KNN	K-Nearest Neighbor
CNN	Convolutional Neural Network

Introduction

Background and Literature Survey

The main activity in Sri Lanka is agriculture. 27.1 percent of the population will be involved in agriculture field in 2020 which surpasses 7.4 percent of the national GDP [1]. Different vegetable and fruit crop grown in Sri Lanka. Gherkins holds significant importance in Sri Lanka's agriculture and has high demand worldwide. Gherkins are a versatile crop, widely used in pickles, salads, and various culinary dishes. But the "gherkin disease" which is actually the tendency of the gherkin plant to attract pests is one of the severest challenges of the current season. Sri Lanka exported a mere 320 metric tons of gherkins in 1988. This rose to 6984 tons in 1991 with the total earnings of Rs. 189 million. This indicates that the gherkin production has been popularized in Sri Lanka in a very short period [2]. Gherkins are accounted in Sri Lanka for the export market and grown in a wide range of solid and climate conditions.

Sri Lanka lost 10% to 20% of its harvest each year because of pest infections [3]. In India, the outbreaks of pests are abrupt and have caused approximate 18% losses, or up to 90,000 million rupees lost annually [4]. Therefore, Pest control is quite important to improve agriculture production and food quality. Fresh farmers rarely receive formal training in pest detection or pest control techniques. It relies heavily on agricultural experts because of the large number of subtle differences among pest species. Gherkins pest disasters are very complex and large, Plant pests are uneven, diverse, widely distributed, increase suddenness and randomness, reproduce quickly and in large numbers, and can also cause an increase in resistance. Traditional methods and theories are different to deal with pests and are no longer suitable for solving pest disasters. Therefore, our smartphone mobile app for pests detection and provision of good control recommendations to help farmers in their crop production is a good step to control this problem.

In emerging countries, agriculture is the primary source of livelihood, national income, and raw materials for industry [5]. Then the image recognition technology of artificial intelligence has achieved great success in many computer vision-tasks. This report is about the automatic detection method of any pest that would need the use of several algorithms but the main three are, identify the lifecycle of stage of that pest, capture the stage of damage in the plant and only then would a biological preventive method be provided. However, most farmers do not have good knowledge of English. They could not understand the recommendations. Then, that app provides translated recommendations to avoid pests. Therefore, farmers can simply understand all details about pests and recommendations. The automated monitoring system provided detailed information about the application of chemicals, including quantity, usage guidelines, and application methods. The app outcome will be shown as augmented reality, and then it is described as simultaneous integration of digital information with the farmer's environment. Provide translated solutions and augmented reality 3D based animation to increase farmers' interest in new technologies.

A novel technique of pest categorization is putting the natural environment at risk among the agricultural activities and changes in farmers' lifestyle on the top of the list. Implementation of automated surveillance system with camera devices that are meant to ward off and control insect infestation should not be overlooked [6]. The results we attained were quite high. The system, incorporating machine learning for pest identification and providing farmer-friendly solutions, improves the efficiency, productivity, and sustainability of gherkin cultivation in Sri Lanka. Traditionally, pest identification based on visual observation and experiential knowledge passed down through generations. This process has a lot of limitations. Fresh farmers faced difficulties identifying pests before the disaster. The lack of comprehensive understanding and technical knowledge about different pests causes delayed identification of infestations, reduced harvests, and economic losses for farmers.

In agriculture field, Machine learning, deep learning, and Image Processing model methods to precisely identify pests and several types of research have been done regarding pest

attacks and detections [7]. Digital image processing tools aided on photos of crop insects by performing the pre-processing, segmentation, and feature extraction steps, to evaluate the insect shape. In the early stage of pest recognition, handcraft-feature methods were the primary solutions. Mayo et al. proposed an automatic identification method using support vector machines (SVM). It has a novel approach for the early detection of whiteflies, aphids, and thrips on greenhouse crops [8].

Thenmozhi Kasnathan et al. [9] Wang and Xie dataset were experimented for the identify of 9 and 24 insect classes, respectively using algorithms such as Support Vector Machines (SVM), Artificial Neural Network (ANN), K-Nearest Neighbor (KNN). The results shows that the Convolutional Neural Network (CNN) model, using datasets from Wang and Xie. It provides pest classification accuracy of 91.5 percent and 90 percent for 9 and 24 classes of insects.

Yufeng Shen et al. [10] presented implementing a system for detecting and identifying stored-gran insects by applying a deep neural network. They used faster R-CNN (Region-based Convolutional Neural Network) to identify the insects in those areas. The result was that the developed method could detect and identify insects under stored grain conditions. These conventional methods have some disadvantages in terms of practicality, contributing to delayed pest identification, recognized accurate pest, provided farmer friendly solutions.

Research Gap

To identify and control pests in gherkins industry, the following key points are considered.

- Identify accurate pest.
- A study of pest distribution, growth, and harm.
- A study of avoid techniques for pest.
- A study of applying chemicals to the farm.
- Provide farmer friendly smart solution system.

1.1 Comparisons between former research and the systems

Research	Pest identification	Pest re-identification and detection	Provide solutions to pests	Augmented reality pest visualization	Translate the solutions
Smart Pest Management: An Augmented Reality Based Approach for an Organic Cultivation	✓	×	×	✓	×
Pest Identification and Control using Deep Learning and Augmented Reality	✓	✓	×	×	×

Insect Pest Detection and Identification Method Based on Deep Learning for Realizing a Pest Control System	✓	×	✓ (only chemical name)	✓	×
Pest Identification and Control using Deep Learning and Augmented Reality	✓	×	✓	×	×
The Study of Traditional Pest Image Recognition and Deep Learning Pest Image Recognition	✓	×	×	×	×
A Research Review of Pest Identification and Detection Based on	✓	×	×	×	×

Deep Learning					
Faster-PestNet: A Lightweight Deep Learning Framework for Crop Pest Detection and Classification	✓	×	✓	×	×
Proposed System	✓	✓	✓	✓	✓

Research Problem

The main challenge in the gherkin industry is identifying and controlling pest infestations while lacking experiential knowledge. Fresh farmers often struggle to recognize pests in their early stages, leading to delayed interventions and substantial losses in harvest yields. Additionally, there is a lack of knowledge of various pests and the corresponding chemical solutions. The critical aspect of this research problem revolves around the fact that fresh farmers having limited or no past experiences to identify pests and provide solutions. Unlike experienced farmers who can rely on years of observation and accumulated knowledge. Furthermore, farmers waste a lot of time and money to avoid pest infections because they lack good knowledge of English. Considering Image [Figure 1.1] provided survey details about farmers interest and experience of information technology usage. It shows that 57% of farmers do not have a good knowledge of information technology. Then the past pest identification app did not work in an effective and efficient way. The main reason for this is farmers having a lack of experience, and the system is not farmer friendly.

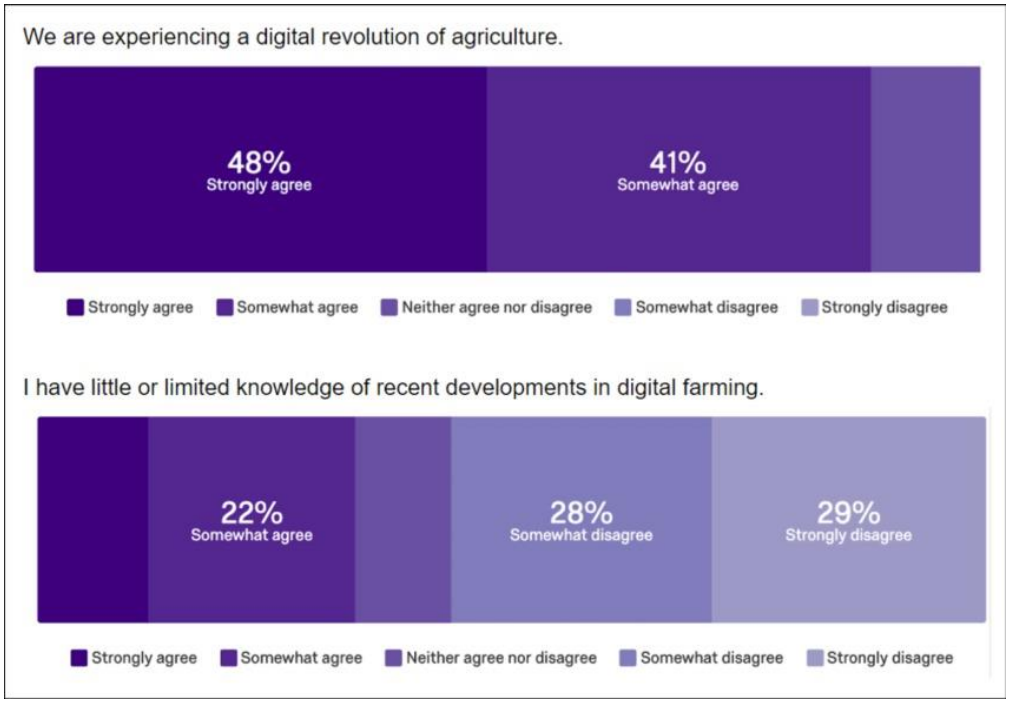

Figure 1.1 Farmer knowledge of the digital agricultural revolution

Moreover, identifying highly accurate pests is another critical research problem. Using machine learning, Algorithm provides real-time pest identification with an accurate rate of 90% [10]. However, achieving high accuracy required careful consideration in the pest identification step. In this step, the system identifies the wrong pest, and the process goes the wrong way. It is very harmful to the overall industry. Farmers are applying according to the identification and recommendation in this application. Therefore, it reduces the quality and quantity of the gherkins harvest. Pest recognition with 95% accuracy using machine learning models will increase the harvest and time in the agriculture industry.

The research problem of accurate pest identification and design for a farmer-friendly system includes the challenges of experiential knowledge, time-intensive learning processes, and language barriers. Providing machine learning for accurate pest identification and developing farmer friendly systems are crucial avenues for research. By solving these challenges, researchers can contribute to the implementation of sustainable and accessible solutions that empower new farmers and increase overall agricultural resilience and productivity.

Objectives

Main Objectives

The primary objective of this system is to develop a mobile application to identify accurate pests in gherkin cultivation and provide effective solutions to address pest-related challenges. The mobile app is implemented to be innovative, smart, and farmer-friendly with considering the latest information technology features. The term "innovative" describes the application's use of cutting-edge information technology (IT) features and discovering new technologies. And the "Smart" refers to intelligent, unique, and flexible functionalities tailored to the specific requirements of farmers. Finally, the main objective is to produce an efficient mobile app for the Gherkins industry to increase global market value.

Sub Objectives

- Identification of Gherkins Pests

  Build robust systems to identify accurate pests affecting grain crops. This involves advanced machine learning models and algorithms to ensure precision in pest identification.

- Pest Re-Identification and Detection

  Implement a system to identify pests by using two machine learning algorithms and continuous detection of pests. This ensures that farmers can monitor and address pest-related issues throughout the gherkin's cultivation.

- Augmented Reality (AR) Based Pest Visualization

  Implement augmented reality (AR) technology into the mobile app to provide farmers with a three-dimensional visual representation of pests. This specific feature improves

farmer's understanding of pest characteristics and behaviors, contributing to more informed pest management.

- Translation of Pest Solutions to Sinhala

  Identify the language barrier by translating pest solutions and information into Sinhala, the native language of Sri Lanka. This ensures that the mobile app is accessible and comprehensible to a wider audience, particularly farmers who may not be proficient in English.

Methodology

System Architecture Diagram

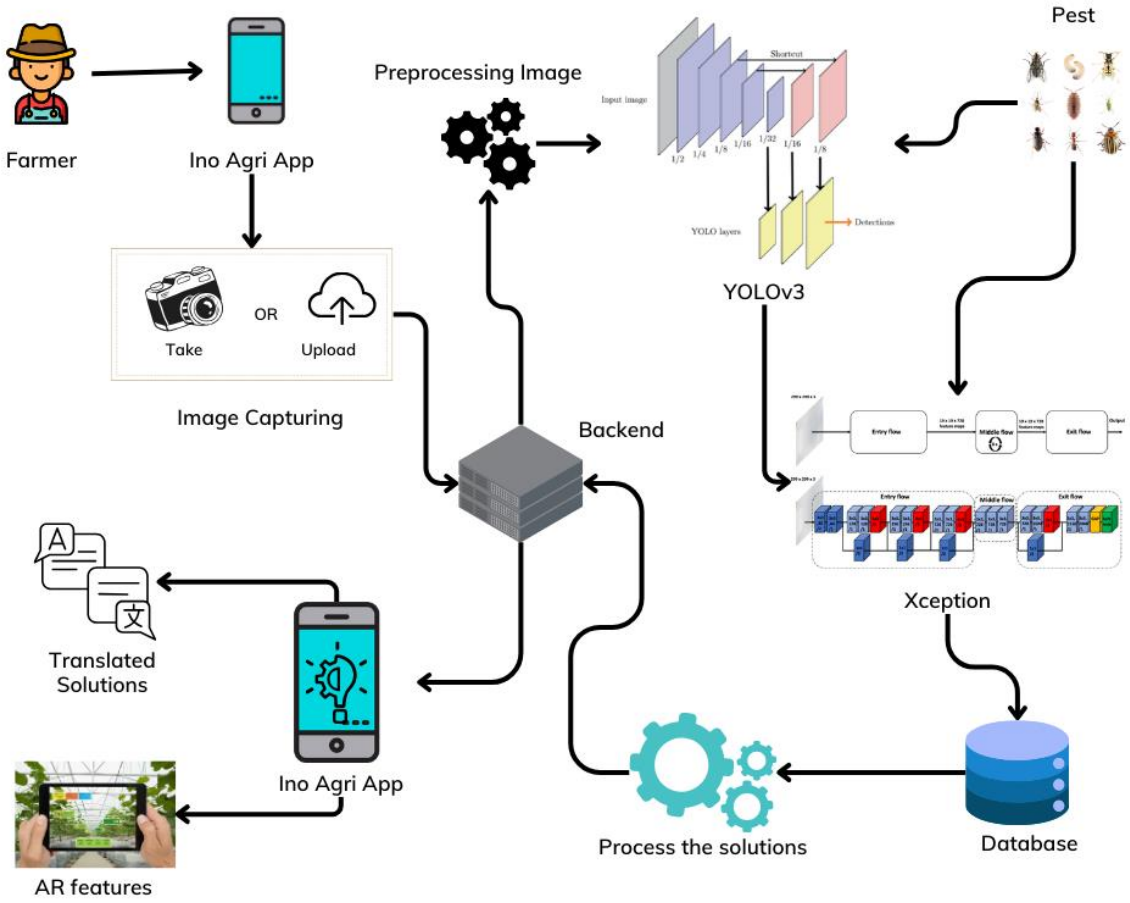

Figure 7.1 System architectural diagram

The system diagram of the Ino Agri App for farmers is illustrated in figure 1. The application app aims at a effective tool for pest control that quickly detects the pest and provides simple solutions. The App has two main parts.

1. Accurate pest identification
2. Provide user-friendly recommendations.

The app will use two convolutional neural network (CNN) machine learning algorithms to accurately identify pests. Once an image is submitted, initial identification is done by a convolutional neural network (CNN) algorithm called YOLOv3 (You Only Look Once). Given

that training has been completed, the machine learning (ML) model s will give the binary outputs. To develop that model We will use python with the following libraries: NumPy for the processing of the array data of the images, OpenCV for image classification, TensorFlow, and Keras to deal with the ML framework. The model ensures accurate pest identification with real time object detection capabilities. Output the accurate pest identification, the backend use dataset of previously identified pests.

The Ino Agri App employs the sophisticated Xception algorithm for a secondary analysis or re-identification of the image. That extra layer of scrutiny and an optimized pest identification process will improve the overall efficacy and accuracy of the answers given to farmers. As a result of this process, we collected and documented accurate information, such as pests and their characteristics. This data is stored in a dedicated database to be retrieved for future analysis.

To serve those users who are not conversant in the English language, especially in the context of likely user base of the app in Sri Lanka, the Ino Agri mobile app steps forward. It makes use of Google Translate API which translates the results in Sinhala, the native language of the region. This makes it possible for the recommendations and insights developed by the app to go beyond the realm of those who fully understand the technical details of the software.

The app takes the user experience to a new level by infusing it with innovation with the use of augmented reality (AR) to display the pest insects visually. This capability provides farmers with a 3D view of the pests and thus helps them to develop a deeper perception and clearer picture of the characteristics and behaviors of the pests.

Finally, the Ino Agri mobile app is a multipurpose solution as it is a combination of different technologies to diagnose pests in a more precise manner in Gherkins cultivation. The user-friendly interface, language accessibility, and augmented reality features put altogether make it inseparable to the farmers who need efficient and optimal pest management.

Data Collecting Techniques

Through several ways, data will be collected. These various ways are mentioned below.

- Engagement with Gherkin Export Companies - Collaborate with HJS Gherkin export companies for industry insights and Conduct field visits to test the application in real world scenarios.
- Review of research papers - Analyze local and international research papers on gherkin cultivation and pest management.
- Consultation of Recognized Books - Study recognized books on gherkin cultivation and pest identification.
- Engagement with university resource person - Meet with university lectures, supervisors, and co-supervisors.
- Field Visits - Meeting home garden farmers.

Tools and Technologies

- Mobile App Development
  - React Native
  - Node JS
  - MongoDB

- Machine learning & deep learning libraries
  - OpenCV (Open-Source Computer Vision Library) - Enables versatile use of machine learning and computer vision.
  - YOLOv3 (You Only Look Once) - Real-time object detection algorithm vital for prompt pest identification.
  - Xception - Specialized algorithm for re-identifying pests, optimizing the identification process.

    - TensorFlow - End-to-end open-source platform supporting comprehensive machine learning.
    - CNN (Convolution Neural Network) - Neural network class specializing in grid-based data processing.

- Augmented reality for pest visualization - Display a 3D view of pests to increase farmers understanding of the pests.
- Google translate API for Sinhala translations - Using Google Translate API convert solution to Sinhala language.
- Tools
    - VS Code – for developers Visual Studio code - code editor.
    - PyCharm - Python IDE for professional developers.
    - Git and GitHub - Version control system (Git), code management and collaboration.
    - Jupiter Notebooks - An interactive notebook for data science and machine learning tasks, fostering experimentation and visualization.
    - Docker - Containerization tool for creating and managing lightweight, portable environments, ensuring consistency across different systems.
    - Postman - API development and testing tool, facilitating the testing of API endpoints and requests.
    - Tensor Board - Visualization tool for TensorFlow, aiding in understanding, debugging, and optimizing machine learning models.

Requirements

Functional Requirements

- Pest Identification

  The mobile app should develop machine learning algorithms (such as YOLOv3 and Xception) to accurately identify pests affecting gherkin crops.

- Translated language Support.

  Utilize Google Translate API to translate pest identification answers and recommendations into Sinhala for accessibility farmers.

- User friendly interface

  Implement an attractive and user-friendly interface for easy navigation, catering to users with varying technical expertise.

- Real time Image Processing

  Enable users to upload or capture real-time images of gherkins crops.

- Reporting and Analytics

  Generate reports on pest identification and effectiveness of recommended solutions.

- Database Management

  Maintain a comprehensive database of pests, and recommended solutions, ensuring accuracy and relevance.

Non-Functional Requirements

- Performance: The system should deliver quick and reliable pest identification results within seconds to support real-time decision-making.
- Scalability: Design the system to scale seamlessly as the database grows, accommodating the increasing volume of gherkin cultivation data.
- Security: Implement robust security measures to protect user data, ensuring confidentiality and integrity.
- Reliability: The system should be reliable, minimizing downtime and ensuring consistent availability for users at HJS Condiments.
- Usability: Conduct user testing to ensure the system is user-friendly and meets the needs of both experienced and novice cultivators.

System requirements

- The app is designed to needs of HJS Condiments Limited, focusing on gherkin cultivation in Sri Lanka.
- The mobile app is compatible with both Android and iOS operating systems.
- Consideration for Sinhala language support to enhance accessibility for local users.

Description of Personal and Facilities

Mr. Gayan Fernando

Mr. Gayan Fernando working at Hayleys PLC as a Manager IT Infrastructure, Group IT, will be guiding us throughout the project as our external supervisor

Raw Data

HJS Condiments Limited will provide the collection of pest infection and recommendation data.

Budget and Budget Justification

Ino Agri mobile app, pest identification system for Gherkin cultivation presents a valuable solution for HJS Condiments limited. This can be utilized to ensure the success of Sri Lanka's ongoing crop cultivation project. Depending on what the system requires, more components can be added. The proposed pest identification system is mainly designed to meet the requirements of Gherkin farmers. By providing features like real-time object identification, augmented reality visualization, and Sinhala translations, the system becomes efficient for gherkin cultivation. However, there may be a fee for services.

10.1 Budget allocation table

Item	Budget (USD)	Budget (LKR)
Sample Cultivation	10	3110
field visits	16.08	5000
Server Cost	25.73	8000
Total	51.81	16110

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