Industrial Internship Report on

”Crop and weed detection”

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Executive Summary
This report provides details of the Industrial Internship provided by upskill Campus and The IoT Academy in collaboration with Industrial Partner UniConverge Technologies Pvt Ltd (UCT). This internship was focused on a project/problem statement provided by UCT. We had to finish the project including the report in 6 weeks’ time. Our project, Crop and weed detection is an application of technology particularly in the fields of agriculture and computer vision, to identify and distinguish between crops and unwanted plants(weeds) easily and providing solutions. This internship gave us a very good opportunity to get exposure to Industrial problems and design/implement solution for that. It was an overall great experience to have this internship.

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1.Preface

a. Summary of the whole 6 weeks work:
Week 1: Project initiation, defining objectives, and assembling the team.
Week 2 : Data collection, annotation, and preprocessing.
Week 3 : Model development and training.
Week 4 : Integration of real time processing.
Week 5 : User interface design, comprehensive testing, and user feedback.
Week 6 : Deployment, documentation, and continuous improvement.

b. About need of relevant internship in career development : Relevant internships are instrumental in career development for several compelling reasons:
1) Practical experience : Internships provide an opportunity to gain hands-on experience in a specific field orindustry.
2) Skill Development: Internships offer a platform for honing industry-specific skills. Whether it's coding, marketing, engineering, or any other field.
3) Networking: Internships enable you to build a professional network. You interact with colleagues, supervisors, and industry professionals.

c. Brief about your project/problem statement : Design and develop an AI-based Crop and Weed Detection system that can accurately identify and differ entiate between crops and weeds in agricultural fields. The system should provide real-time or near-real-time detection capabilities to assist farmers in optimizing crop management and reducing weed infestation.

d. Opportunity given by UST/UCT : We would like to extend our heartfelt gratitude for offering us the opportunity given by UST/UCT, for their unwavering support and for offering me the invaluable opportunities and resources that have greatly contributed to the successful completion of this project.

e. How program was planned : The Crop and Weed Detection AI program was planned in stages:
Objectives : Set clear goals for accurate crop and weed identification.
Resources : Allocate personnel, budget, and data sources.
Model development : Train the AI model for detection.
Integration : Develop a real time processing system.
User interface : Design an accessible interface.
Testing : Assess model accuracy.
Documentation : Maintain records.
Deployment : Prepare for field use.
Continuous improvement : Monitor, collect data, and refine.
Compliance : Ensure legal and ethical adherence, and summarizing, lessons learned in the report

2 Introduction

2.1 About UniConverge Technologies Pvt Ltd

A company established in 2013 and working in Digital Transformation domain and providing Industrial solutions with prime focus on sustainability and RoI.

For developing its products and solutions it is leveraging various **Cutting Edge Technologies e.g. Internet of Things (IoT), Cyber Security, Cloud computing (AWS, Azure), Machine Learning, Communication Technologies (4G/5G/LoRaWAN), Java Full Stack, Python, Front end** etc.

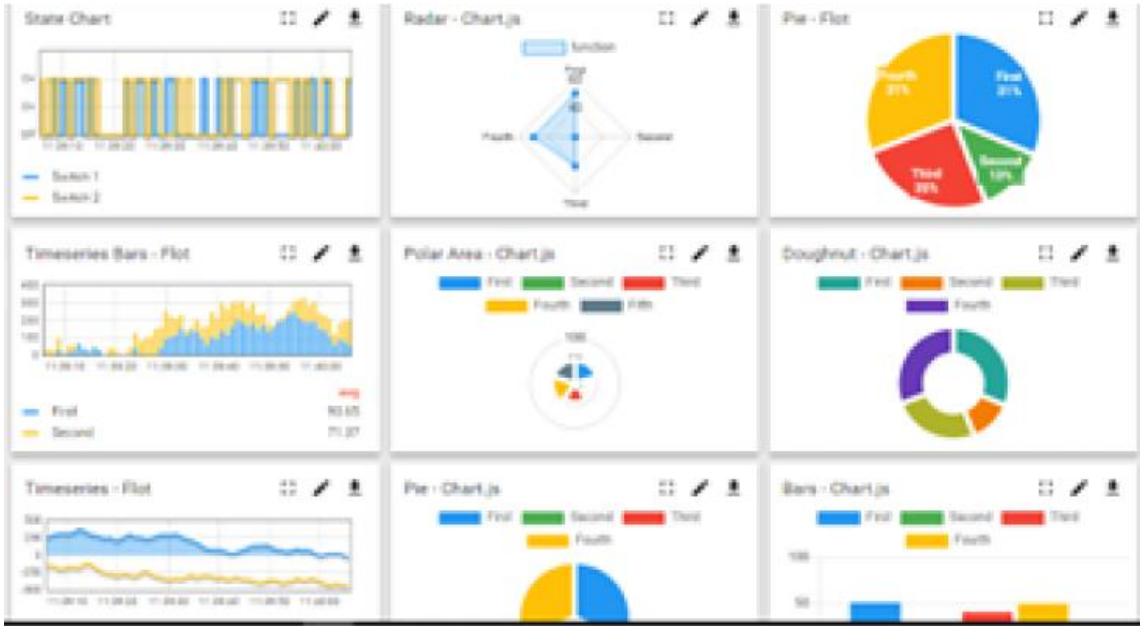
i. UCT IoT Platform (UCT Insight)

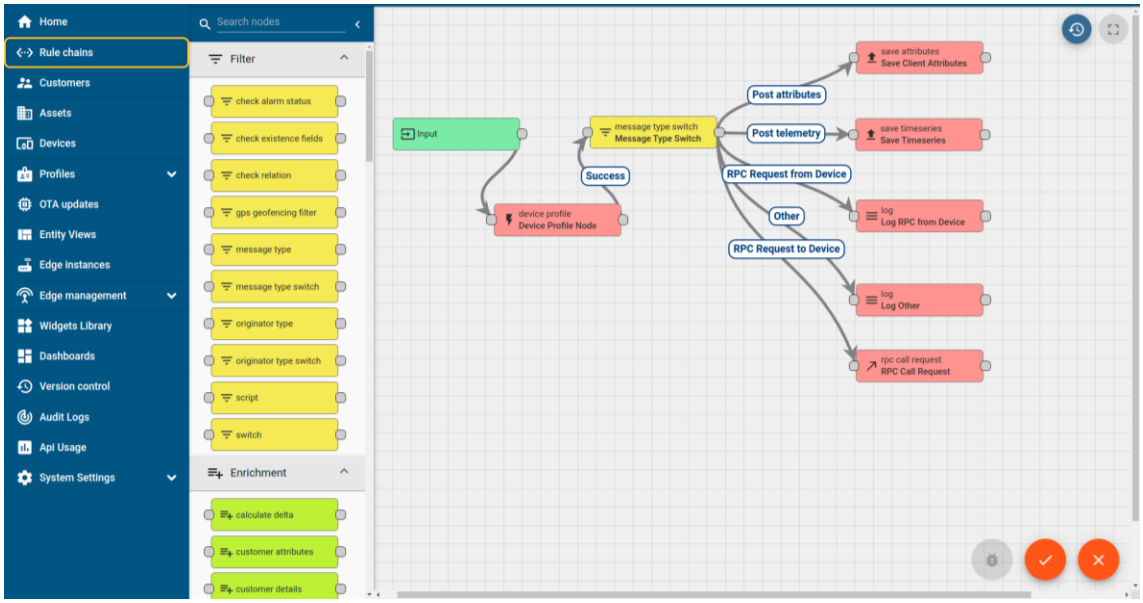
UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable "insight" for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- It enables device connectivity via industry standard IoT protocols - MQTT, CoAP, HTTP, Modbus TCP, OPC UA
- It supports both cloud and on-premises deployments.

➔ It has features to

- Build Your own dashboard
- Analytics and Reporting
- Alert and Notification
- Integration with third party application(Power BI, SAP, ERP)
- Rule Engine





ii. Smart Factory Platform

Factory watch is a platform for smart factory needs.

It provides Users/ Factory

- with a scalable solution for their Production and asset monitoring
- OEE and predictive maintenance solution scaling up to digital twin for your assets.
- to unleased the true potential of the data that their machines are generating and helps to identify the KPIs and also improve them.
- A modular architecture that allows users to choose the service that they what to start and then can scale to more complex solutions as per their demands.
- Its unique SaaS model helps users to save time, cost and money.

Machine	Operator	Work Order ID	Job ID	Job Performance	Job Progress		Output		Rejection	Time (mins)				Job Status	End Customer
					Start Time	End Time	Planned	Actual		Setup	Pred	Downtime	Idle		
CNC_S7_81	Operator 1	WO0405200001	4168	58%	10:30 AM		55	41	0	80	215	0	45	In Progress	i
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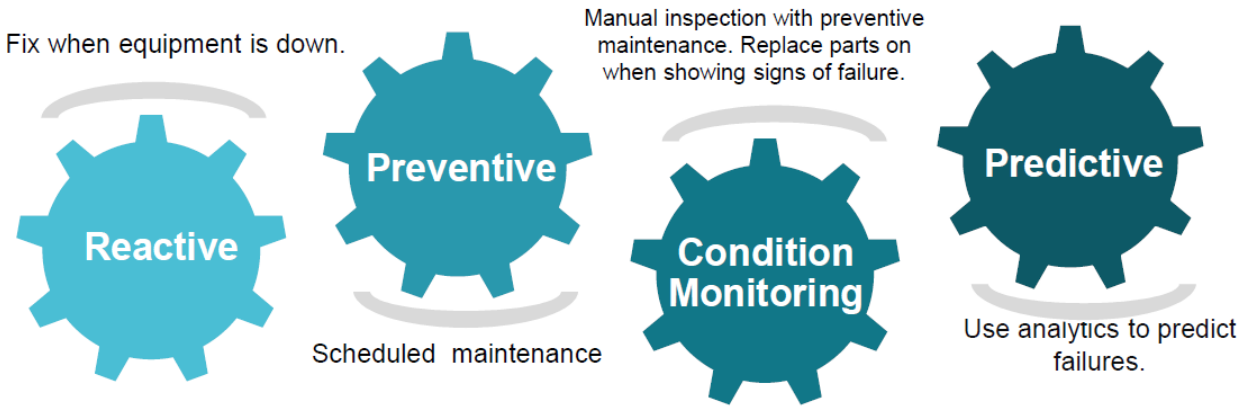
iii. Based Solution

UCT is one of the early adopters of LoRaWAN technology and providing solution in Agri tech, Smart cities, Industrial Monitoring, Smart Street Light, Smart Water/ Gas/ Electricity metering solutions etc.

iv. Predictive Maintenance

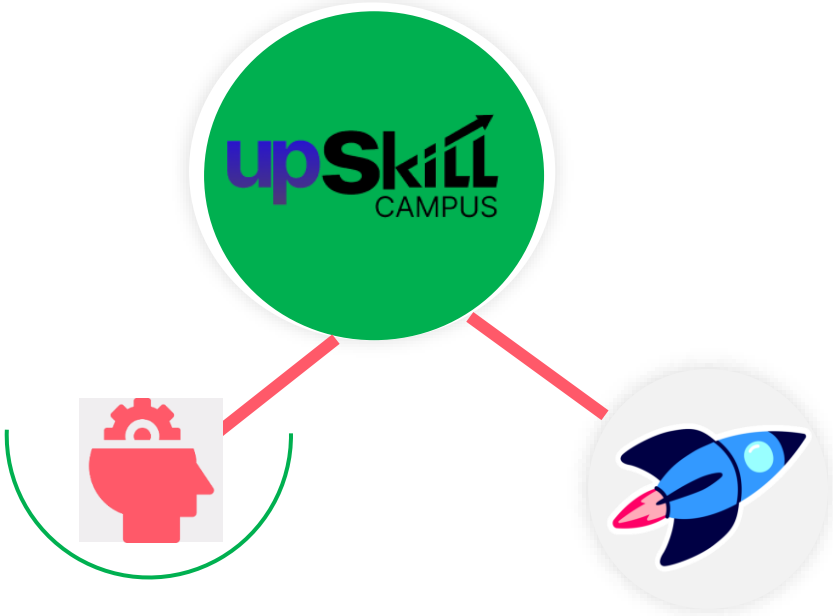
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



2.2 About upskill Campus (USC)

upskill Campus along with The IoT Academy and in association with Uniconverge technologies has facilitated the smooth execution of the complete internship process.

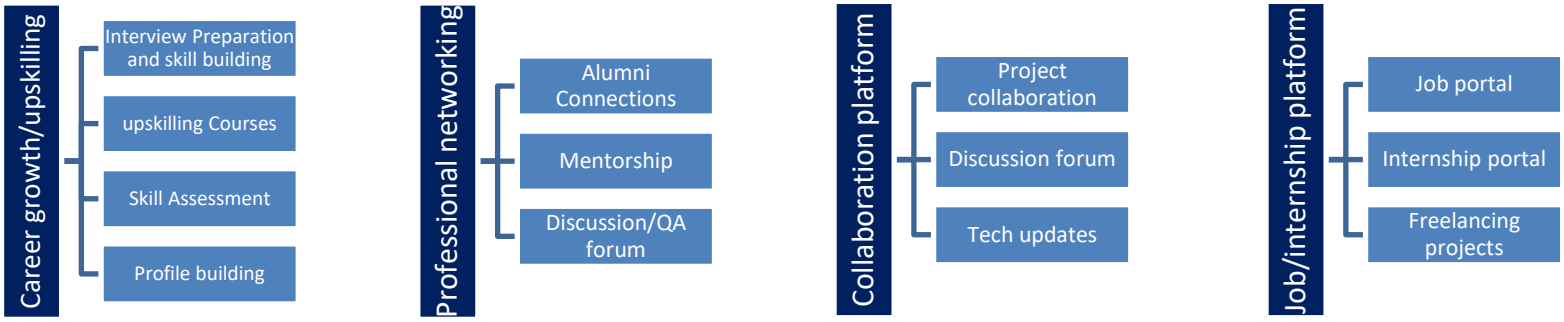
USC is a career development platform that delivers **personalized executive coaching** in a more affordable, scalable and measurable way.



Seeing need of upskilling in self paced manner along-with additional support services e.g. Internship, projects, interaction with Industry experts, Career growth Services

upSkill Campus aiming to upskill 1 million learners in next 5 year

https://www.upskillcampus.com/



The IoT Academy

The IoT academy is EdTech Division of UCT that is running long executive certification programs in collaboration with EICT Academy, IITK, IITR and IITG in multiple domains.

2.3 Objectives of this Internship program

The objective for this internship program was to

- ☛ get practical experience of working in the industry.
- ☛ to solve real world problems.
- ☛ to have improved job prospects.
- ☛ to have Improved understanding of our field and its applications.
- ☛ to have Personal growth like better communication and problem solving.

2.4 Reference

[1] Food and agriculture organization (FAO) (www.fao.org) : FAO offers reports, publications, and statistics related to global agriculture and crop production.

[2] Other academic databases like IEEE Xplore (ieeexplore.ieee.org) and ACM digital library (dl.acm.org) can provide access to research papers and conference proceedings in computer vision and ML.

[3] Websites of agricultural research institutions often publish research reports related to our project. Some renowned institutions include: Cornell university college of agriculture and life sciences.

2.5 Glossary

Terms	Acronym
Artificial Intelligence	AI
Computer Vision	CV
Machine learning	ML
Deep Learning	DL
Object Detection	OD

3 Problem Statement

In the assigned problem statement the objective of this project is to develop an innovative and robust system capable of accurately detecting and distinguishing crops from weeds in real time . The system should utilize advanced technologies such as computer vision, machine learning , and data analytics to provide farmers with timely information for decision making.

1) **Background :** Precision agriculture has gained significant traction in recent years due to its potential to improve crop yield, reduce resource wastage, and enhance farming efficiency. One critical aspect of precision agriculture is the accurate detection and differentiation of crops from weeds in agriculture fields. Therefore, there is a pressing need for an automated crop and weed detection system to address these challenges.

2) **Specific Requirements** : Some of the components required are as follows:

a) **Crop identification :** Develop a machine learning model capable of identifying various crop types at different growth stages.
For Ex : Apple, corn, potato, tomato.

b) **Weed detection :** Create a robust algorithm for detecting common weed species in the target agricultural region. Implement a real time weed detection system that can identify weeds accurately and provide their locations within the field.

c) **Image acquisition and processing :** Integrate image acquisition devices such as cameras to capture high resolution images of the agriculture field. Implement image preprocessing techniques to enhance image quality and reduce noise.

3) **User interface** : Develop a user friendly interface (web or mobile application) that allows farmers to access the detection results in real time. Provides visualization and alerts to help farmers make informed decisions regarding weed management and crop health.

4 Existing and Proposed solution

Crop and weed detection is a critical aspect of precision agriculture, as it helps farmers optimize their crop management practices, reduce resource wastage, and increase overall productivity.

Existing Solutions and their limitations :

1) **Satellite and drone imagery :** Satellites and drones equipped with various sensors can capture high resolution images of large agricultural fields. These images can be used to monitor crop health and identify weed infestations.
    - **Limitations** : Cloud cover, weather conditions, and cost of equipment and image processing can be limiting factor.
2) **Remote sensing :** Technologies such as LiDAR and hyperspectral imaging, can provide detailed information about crop and weed characteristics, including heights, density, and spectral signatures.
    - **Limitations** : High costs and the need for specialized equipment and expertise can be barriers.

Proposed Solutions :

1) **Advanced sensors and imaging technologies :** Ongoing advancements in sensor technology and imaging, including multispectral and hyperspectral sensors.
2) **Data fusion and Integration** : Combining data from multiple sources, such as satellite imagery, ground sensors, and weather data, can enhance accuracy and provide a holistic view of crop and weed conditions.

Additional Values :

1) **Machine learning algorithm :** Utilize advanced machine learning algorithms, such as deep learning models for ex : convolutional neural networks or recurrent neural networks.
2) **Data visualization :** Create interactive dashboards and data visualization tools to present easily understandable format.

4.1 Code submission : https://github.com/TsewangChoskit123/crop_weed_AI

4.2 Report submission : https://github.com/TsewangChoskit123/pdf_file

5 Proposed Design/ Model

Designing a crop and weed detection project involves several components, including hardware, software and data management. Some of them are : Hardware components like : Camera or sensors , computing hardware and Software components like : Image preprocessing, feature extraction, user interface. Data collection and management, training and evaluation.

5.1 High Level Diagram

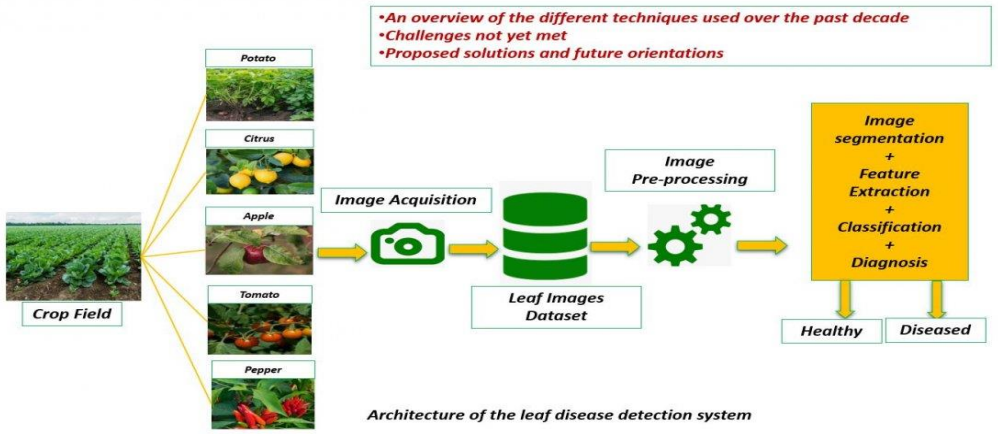


Fig 1 : High level diagram

5.2 Low Level Diagram

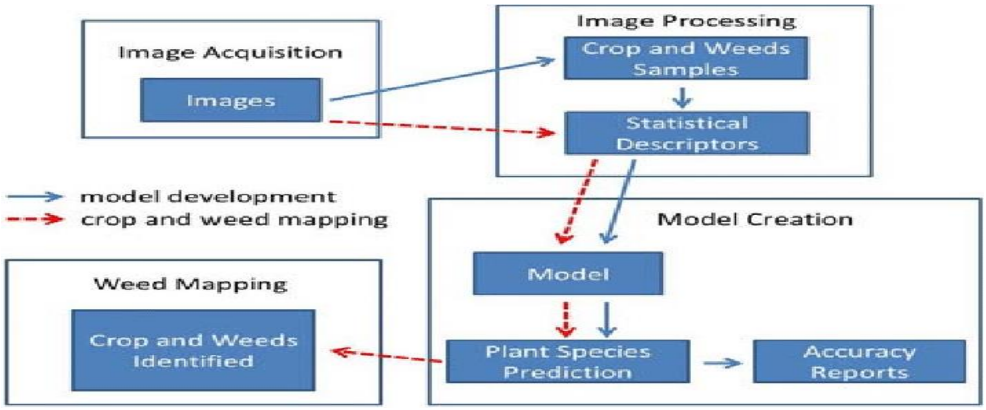


Fig 2 : Low level diagram

5.3 Interfaces

It contains Web based dashboards, mobile apps, machine vision software, data analytics platforms, machine learning model interfaces, and API's (Application programming interfaces).

6 Performance Test

It Is the crucial step in evaluating the effectiveness of crop and weed detection project, especially if it involves computer vision, machine learning, or any other complex type algorithms. Performance testing is an iterative process, and its essential to ensure that our crop and weed detection system meets the desired accuracy and efficiency criteria in real world scenarios.

1) **Define performance metrics** : Identify the key performance metrics that we want to measure.
2) **Data preparation :** Collect diverse dataset that includes various types of crops and weed in different environmental conditions.
3) **Performance threshold :** Determine an appropriate threshold for our model predictions.

6.1 Test Plan/ Test Cases

Creating a test plan or test case is essential to ensure the accuracy and reliability of the system. Below is an outline of a test plan along with some sample test cases help us to get started.

- Test 1: Image acquisition
- Test 2 : Verify image preprocessing
- Test 3 : Test object detection
- Test 4 : Verify object classification
- Test 5 : Validate accuracy with labelled dataset
- Test 6 : Test under different lighting conditions
- Test 7 : Test under different weather conditions

6.2 Test Procedure : There are various methods and technologies available for crop and weed detection , a general test procedure include : Data collection, Model selection, Model training, model evaluation, deployment, documentation, performance improvement.

6.3 Performance Outcome : Ultimately the performance outcome of crop and weed detection systems should be evaluated based on specific goals and requirements of agriculture operations. Performance factors include : Accuracy, Precision, F1 score, detection speed, robustness, dataset quality, integration and farming practices, recall (sensitivity).

7 My learnings

Our project crop and weed detection encompasses key takeaways and lessons learned throughout the process. Our project is a multidisciplinary effort that involves data science, agricultural expertise, and engineering. It can have a significant impactness on the agriculture, leading to more efficient and sustainable farming practices when executed more and effectively. In essence our project will provide strong foundation for a versatile and dynamic career.

Our project provide valuable insights and skills that can benefit us in various ways in the future. Here are some potential highlights and how they can help us :

1) **Data science and machine learning skills :** Learning how to collect, preprocess, and analyze agricultural data can enhance our data science skills, which are highly sought after various industries, including agriculture, health care, finance, and more.
2) **Computer vision expertise :** Gaining expertise in computer vision, including image processing and object recognition, can open up career opportunities in fields like autonomous vehicles, medical imaging, and robotics.
3) **Problem solving and critical thinking :** Working on complex projects like this hones our problem solving and critical thinking abilities, which are invaluable in any profession.
4) **Agricultural insights :** Understanding agricultural processes and challenges can be beneficial if we ever work in agribusiness sector or want to develop technologies for sustainable agriculture.
5) **Research and innovation :** If we are interested in pursuing further education or research , the experience gained from this project can provide a strong foundation for advanced studies in related fields.
6) **Continuous learning :** Given the rapid advancements in technology, our commitment to continuous learning and staying updated on the latest developments will be essential for future success.
7) **Environmental impacts :** Our knowledge can contribute to environmental initiatives, especially those aimed at reducing pesticides and promoting sustainable farming practices.
8) **Transferable knowledge :** The skills we acquire in crop and weed detection , such as model development and optimization, can be applied to a wide range of other machine learning and computer vision projects.

8 Future work scope

The future work scope of crop and weed detection project is promising, as they have the potential to significantly improve agricultural efficiency, reduce environmental impact, and contribute to global food security. However, it will require continued innovation, collaboration, and adaptation to meet the evolving needs of the agriculture industry. Here are some potential areas of future work and development for project :

1) **Machine learning model updates :** Implement mechanisms for continuous model training and updates to adapt changing conditions and emerging weed species.

2) **Crop health assessment :** Expand the project to include the assessment of overall crop health, including factors such as nutrient deficiencies, disease detection, and stress analysis. It contains visual inspection, remote sensing and sensor networks.

3) **Research and development :** Invest in ongoing research and development to stay at the forefront of technology and innovation in agriculture.

4) **Enhanced accuracy and precision :** Continuously improve the accuracy of crop and weed detection algorithms using advanced machine learning and computer vision techniques.

5) **Multi sensor integration :** Combine data from various sensors such as LiDAR, hyperspectral imaging, and images to enhance detection capabilities and provide a more comprehensive view of the field.

6) **Weed management strategies :** Develop intelligent algorithms that not only detect weeds but also recommend and implement effective weed management strategies, which could include precision herbicide application, mechanical removal, or biological control.

7) **Crop disease management :** Crop and weed detection can also aid in early disease detection. By identifying signs of disease in plants, farmers can take preventive measures to protect their crops and prevent outbreaks.