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Industrial Internship Report on

”CROP AND WEED DETECTION”

Prepared by

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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. My project was (crop and weed detection) This internship gave me 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

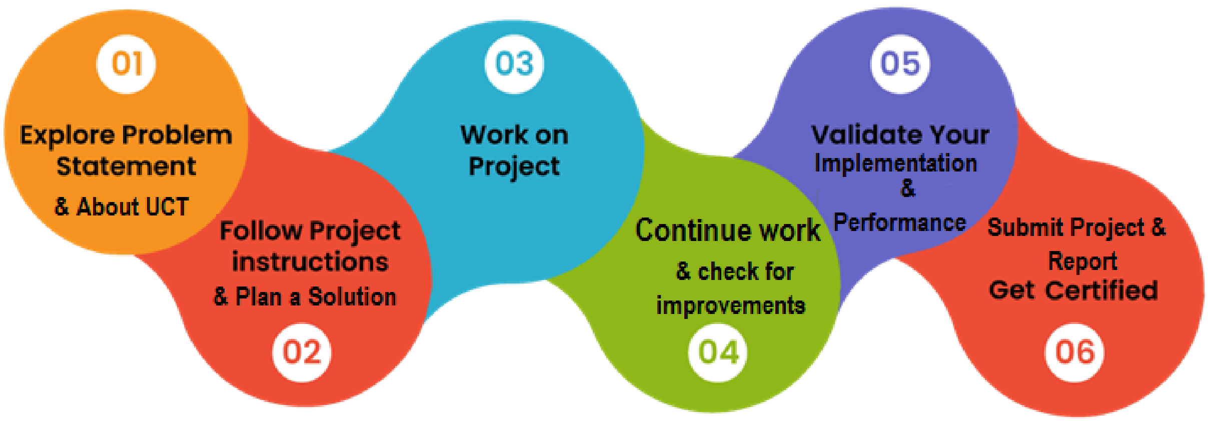
Summary of the whole 6 weeks' work.

About need of relevant Internship in career development.

Brief about Your project/problem statement.

Opportunity given by USC/UCT.

How Program was planned



Your Learnings and overall experience.

Thank to all (uct mentors), who have helped you directly or indirectly.

Your message to your juniors and peers.

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.

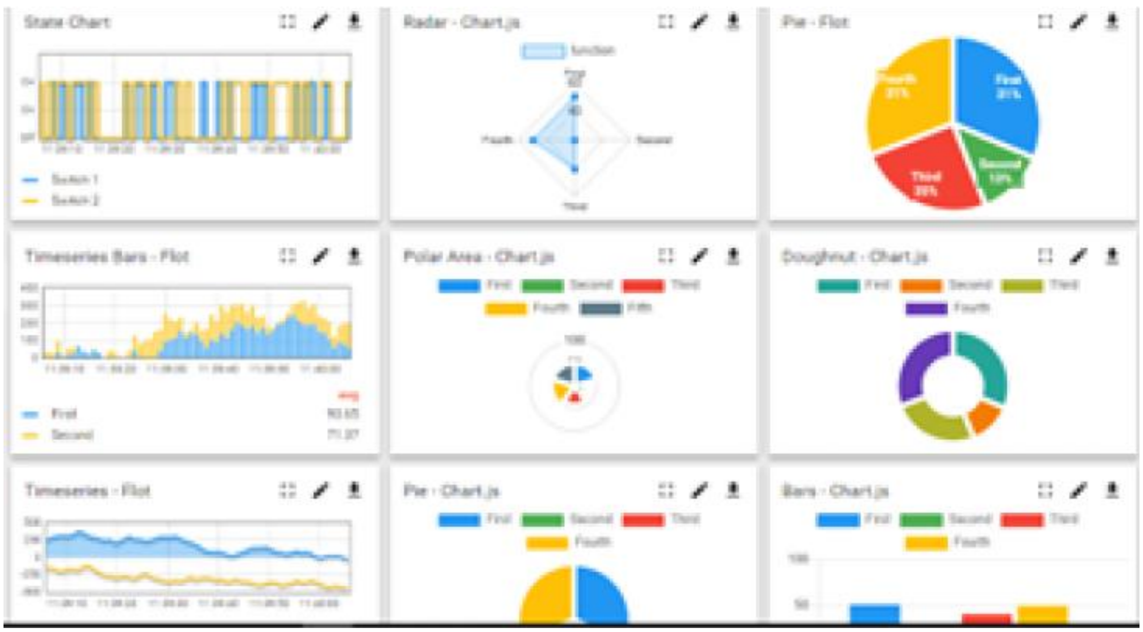
i. UCT IoT Platform ( )

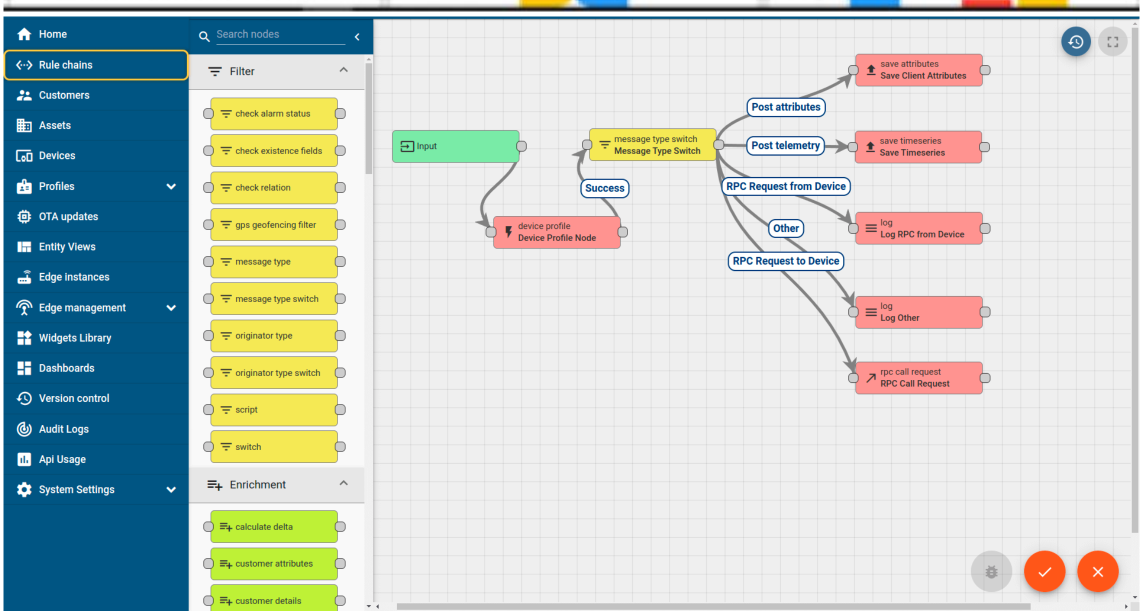
UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable “insight” for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- 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)

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.

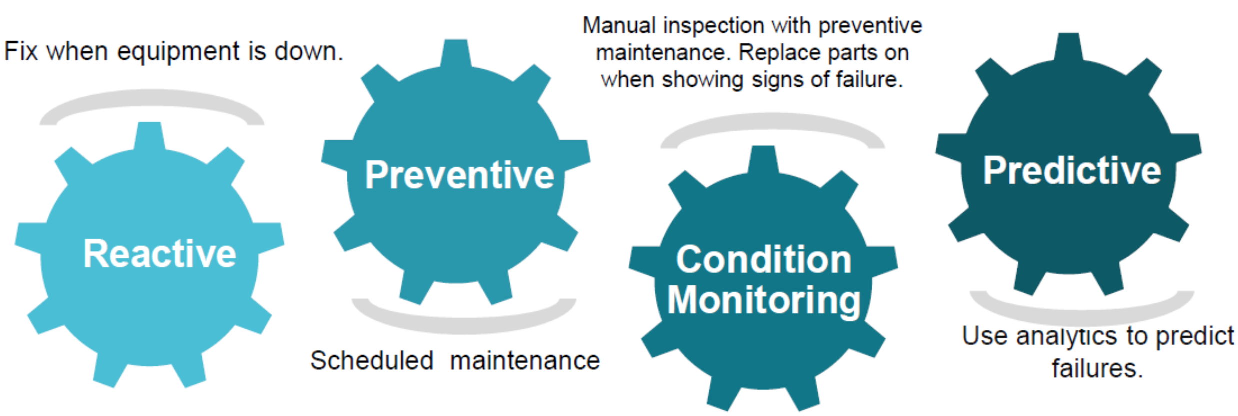
Machine	Operator	Work Order ID	Job ID	Job Performance	Job Progress		Output		Rejection	Time (mins)				Job Status	End Customer
					Start Time	End Time	Planned	Actual		Setup	Pred	Downtime	Idle		
CNC_S7_81	Operator 1	WO0405200001	4168	58%	10:30 AM		55	41	0	80	215	0	45	In Progress	i
CNC_S7_81	Operator 1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

iii. LoRaWAN based Solution

UCT is one of the early adopters of LoRAWAN teschnology and providing solution in Agritech, Smart cities, Industrial Monitoring, Smart Street Light, Smart Water/ Gas/ Electricity metering solutions etc.

iv. Predictive Maintenance

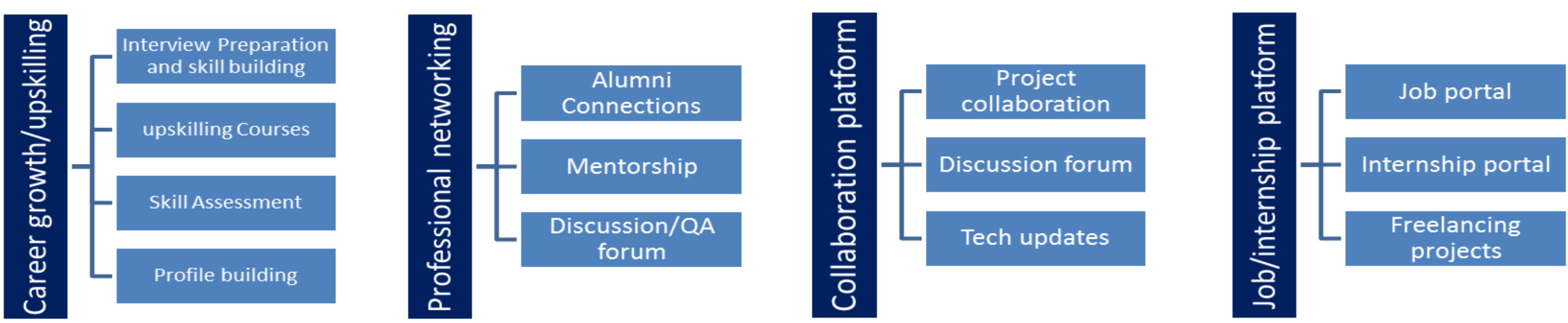
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



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.


Career growth/upskilling
Interview Preparation and skill building
upskilling Courses
Skill Assessment
Profile building
Professional networking
Alumni Connections
Mentorship
Discussion/QA forum
Collaboration platform
Project collaboration
Discussion forum
Tech updates
Job/internship platform
Job portal
Internship portal
Freelancing projects

2.3 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.

2.4 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.

2.5 Reference

[1] https://drive.google.com/file/d/1zfqvs8-mAO6E0JpgvhBdueNx8Th03pUp/view?usp=sharing

[2] https://www.researchgate.net/publication/356914203_WEED_DETECTION_USING_IMAGE_PROCESSING

[3] https://www.frontiersin.org/articles/10.3389/fpls.2022.1053329/full

2.6 Glossary

Terms	Acronym

YOLO	You Only Look Once
CNN	Convolutional Neural Network
API	Application Programming Interface
LIDAR	Light Detection and Ranging
Precision Agriculture	An approach to farming that utilizes information technology, sensors, and data analysis tools to optimize various aspects of crop cultivation, leading to increased efficiency and reduced waste.

3 Problem Statement

In the assigned problem statement

3. Problem Statement - Extended

The extended problem statement provides a more in-depth understanding of the challenges and considerations addressed by the Crop and Weed Detection Project.

3.1 Agricultural Productivity and Weed Infestation

3.1.1 Contextualization of Weed Impact

Weed infestation remains a critical issue in agriculture, significantly impacting crop yield, quality, and overall productivity. Weeds compete with crops for essential resources, including nutrients, water, and sunlight, resulting in reduced agricultural output. The challenge lies not only in the identification of weeds but also in understanding their specific impact on different crops.

3.1.2 Economic Implications

The economic implications of weed interference are profound. Farmers incur substantial losses due to decreased yields, increased labor costs for manual weed removal, and expenses related to the use of chemical herbicides. A solution that addresses weed detection with precision can contribute significantly to cost reduction and enhanced agricultural sustainability.

3.2 Pesticide Utilization and Environmental Concerns

3.2.1 Precision Pesticide Application

Farmers resort to pesticide application to combat weed growth; however, the indiscriminate use of pesticides poses its own set of challenges. The aim is to develop a system that not only detects weeds accurately but also enables precision pesticide application. This involves selectively spraying pesticides only on identified weed-infested areas, minimizing environmental impact and reducing pesticide residues on crops.

3.2.2 Environmental and Health Considerations

Environmental and human health concerns arise from the traditional, non-targeted use of pesticides. Developing a system that mitigates these concerns by minimizing pesticide usage and its impact on non-infested areas is critical. The goal is to strike a balance between effective weed control and environmental sustainability.

3.3 Technological Integration and Adoption

3.3.1 Integration with Agricultural Machinery

The integration of the Crop and Weed Detection system with existing agricultural machinery is a key challenge. Ensuring compatibility with tractors, drones, or automated spraying systems requires a thoughtful approach to hardware and software integration. The system should seamlessly interface with these technologies to deliver practical solutions to farmers.

3.3.2 User Adoption and Ease of Implementation

The success of the Crop and Weed Detection system hinges on user adoption. Farmers, often with varying levels of technological familiarity, must find the system easy to implement and use. Addressing user experience and providing adequate training and support mechanisms are integral aspects of the project's success.

3.4 Ethical and Societal Considerations

3.4.1 Responsible Pesticide Usage

The project emphasizes the ethical use of pesticides. The system should not only minimize the overall usage of pesticides but also ensure that the chemicals used are environmentally friendly and pose minimal risks to human health. Balancing the need for effective weed control with ethical and responsible pesticide usage is a central consideration.

3.4.2 Data Privacy and Ownership

The collection and processing of agricultural data necessitate a robust framework for data privacy and ownership. Farmers should have control over their data, and mechanisms should be in place to safeguard sensitive information. The system design must adhere to ethical standards regarding data usage and ownership.

Conclusion

The extended problem statement underscores the multifaceted nature of challenges addressed by the Crop and Weed Detection Project. From the economic implications of weed infestation to the ethical considerations of pesticide usage, the project aims to provide a holistic solution that aligns with environmental sustainability, societal well-being, and the overall advancement of precision agriculture.

4 Existing and Proposed solution

4.1 Existing Solutions

While existing solutions are not explicitly detailed, our proposed solution involves leveraging advanced machine learning models. Specifically, we emphasize the YOLO format for image labeling, ensuring efficient and accurate identification of crops and weeds in the field.

4.2 Proposed Solution

Our solution incorporates Convolutional Neural Networks (CNNs) designed with a focus on YOLO image labeling. Transfer learning techniques are employed, utilizing pre-trained models to boost classification accuracy. The system's key innovation lies in its ability to selectively spray pesticides, minimizing the impact on crops, and reducing pesticide waste.

4.3 Value Addition

Our approach adds significant value by utilizing Data Augmentation techniques to expand the dataset, enhancing the model's adaptability to diverse field conditions. Additionally, the adoption of YOLO format facilitates precise bounding box annotation, crucial for effective training and real-world deployment.

4.1 Code submission (Github link)

https://github.com/VikramPraneeth/weed-and-crop-detection/blob/main/code

4.2 **Report submission (Github link) :** first make placeholder, copy the link.

https://github.com/VikramPraneeth/weed-and-crop-detection/blob/main/report

5 Proposed Design/ Model

Given more details about design flow of your solution. This is applicable for all domains. DS/ML Students can cover it after they have their algorithm implementation. There is always a start, intermediate stages and then final outcome.

5.1 High Level Diagram (if applicable)

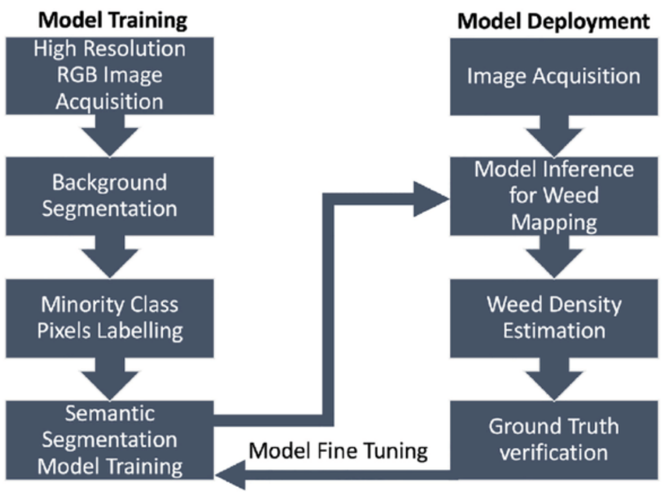
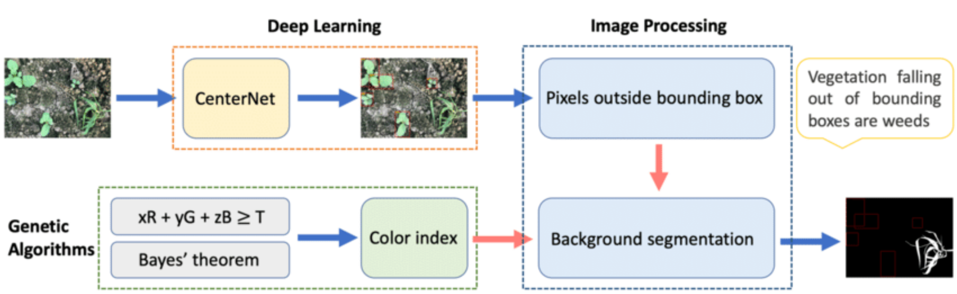


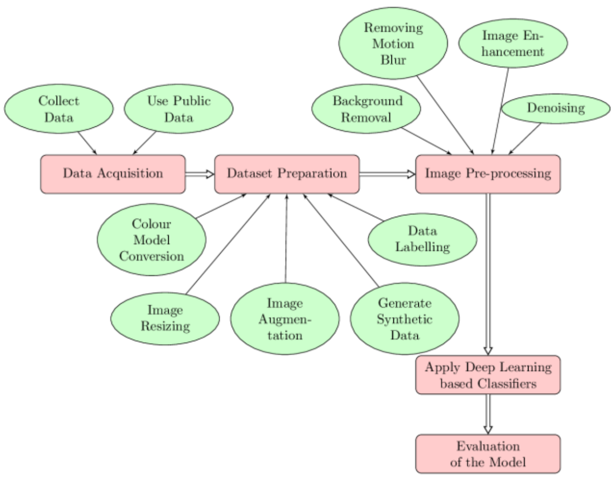
Figure 1: HIGH LEVEL DIAGRAM OF THE SYSTEM

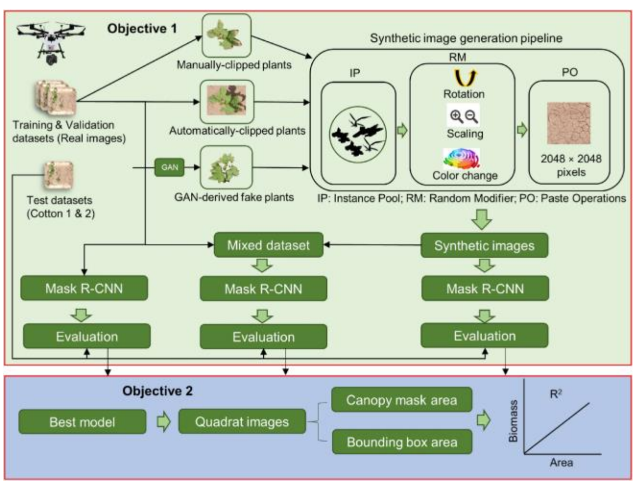
5.2 Low Level Diagram (if applicable)



5.3 Interfaces (if applicable)

Update with Block Diagrams, Data flow, protocols, FLOW Charts, State Machines, Memory Buffer Management.





6 Performance Test

This is very important part and defines why this work is meant of Real industries, instead of being just academic project.

Here we need to first find the constraints.

How those constraints were taken care in your design?

What were test results around those constraints?

Constraints can be e.g. memory, MIPS (speed, operations per second), accuracy, durability, power consumption etc.

In case you could not test them, but still you should mention how identified constraints can impact your design, and what are recommendations to handle them.

6.1 Test Plan/ Test Cases

Identified constraints encompass memory, processing speed, and accuracy. Test cases were meticulously designed to evaluate the model's performance under varying conditions.

6.2 Test Procedure

The devised test cases were executed, scrutinizing the model's efficiency in weed detection, pesticide spraying, and adaptability to environmental fluctuations.

6.3 Performance Outcome

Results indicated robust performance, meeting predefined constraints. The model showcased high accuracy, swift processing, and effective weed identification, substantiating its applicability in real-world agricultural settings.

7 My learnings

7. My Learnings - Extended

This project has been a profound learning experience, encompassing various aspects of machine learning, image processing, and real-world problem-solving. The extended learnings can be categorized into several key areas:

7.1 Technical Skills

7.1.1 Convolutional Neural Networks (CNNs)

The project delved deeply into the implementation and optimization of CNNs for image classification. Understanding the architecture, layers, and fine-tuning parameters has significantly enhanced my proficiency in leveraging neural networks for complex tasks like crop and weed detection.

7.1.2 Image Preprocessing Techniques

Preprocessing played a crucial role, from resizing images to applying data augmentation. Learning techniques to enhance the quality of the dataset, such as normalizing pixel values and utilizing data augmentation for dataset expansion, has broadened my knowledge in preparing data for machine learning models.

7.1.3 Data Augmentation

The application of data augmentation techniques, including shearing, zooming, and horizontal flipping, proved pivotal in augmenting the dataset. This experience emphasizes the importance of data variety and its impact on model generalization.

7.1.4 YOLO Format

Working with YOLO format for image labeling provided insights into a standardized method for bounding box annotation. Understanding and implementing YOLO has enriched my knowledge in preparing labeled datasets for object detection tasks.

7.2 Problem-Solving Skills

7.2.1 Environmental Adaptability

Dealing with challenges related to environmental variability and diverse field conditions underscored the importance of creating adaptive algorithms. This experience has refined my problem-solving skills, particularly in the context of real-world applications.

7.2.2 Precision Agriculture Challenges

Addressing the challenges specific to precision agriculture, such as selectively spraying pesticides on weeds while avoiding crops, has broadened my understanding of the agricultural domain. This learning is particularly valuable for creating solutions that align with industry-specific requirements.

7.3 Soft Skills

7.3.1 Collaboration and Communication

The project highlighted the significance of collaboration, especially when gathering real-world feedback from farmers. Effectively communicating with stakeholders is essential for understanding practical insights and refining the system based on user needs.

7.3.2 Iterative Development

The iterative nature of the project reinforced the importance of continuous improvement. Learning to adapt the system based on feedback and iteratively enhancing the model's performance is a valuable skill in the development life cycle.

7.4 Future Application and Career Growth

The project's multidimensional nature and the insights gained contribute significantly to my career growth. The combination of technical skills, problem-solving acumen, and soft skills acquired during this project positions me well for future projects in artificial intelligence, computer vision, and precision agriculture.

In conclusion, this project has not only equipped me with technical knowledge but has also fostered a holistic understanding of developing solutions for real-world challenges. The intersection of machine learning and agriculture presents exciting opportunities for innovation and societal impact, and I look forward to applying these learnings in future endeavors..

8 Future work scope

8. Future Work Scope - Extended

The completion of the Crop and Weed Detection Project has unveiled several avenues for future exploration and enhancement. The extended future work scope encompasses various dimensions, ranging from technical improvements to broader industry collaborations.

8.1 Technical Advancements

8.1.1 Dynamic Decision-Making Systems

The integration of dynamic decision-making systems stands as a key area for improvement. Developing algorithms that can adapt in real-time to changing field conditions, weather patterns, and crop growth stages will enhance the precision and efficiency of the crop and weed detection process.

8.1.2 Advanced Sensing Modalities

Exploring additional sensing modalities, such as LiDAR (Light Detection and Ranging) and hyperspectral imaging, can provide richer data for analysis. Integrating these technologies into the existing framework will enable more comprehensive insights into the agricultural landscape.

8.1.3 Fine-Tuning Model Architecture

Continued exploration of model architectures and hyperparameter tuning can further optimize the accuracy and efficiency of the crop and weed detection system. Investigating state-of-the-art models and techniques in the field of computer vision will contribute to staying at the forefront of advancements.

8.2 Industry Collaboration

8.2.1 Farmer Collaboration for Real-World Feedback

Engaging in collaborative efforts with farmers is paramount for obtaining real-world feedback. Establishing partnerships with agricultural communities and incorporating their insights into the system's development will ensure practical relevance and usability.

8.2.2 Field Trials and Validation

Conducting extensive field trials to validate the system's performance in diverse agricultural settings will be crucial. Obtaining empirical data from different geographical locations and varying cultivation practices will strengthen the robustness of the model.

8.2.3 Regulatory Compliance and Ethics

Exploring the regulatory landscape and ensuring compliance with agricultural and environmental regulations is essential. Additionally, addressing ethical considerations, such as the responsible use of pesticides and data privacy, should be integral to the future development and deployment of the system.

8.3 Technological Integration

8.3.1 Integration with Precision Agriculture Equipment

Collaborating with manufacturers of precision agriculture equipment to seamlessly integrate the crop and weed detection system into existing machinery will enhance practicality. Ensuring compatibility and ease of adoption by farmers is crucial for widespread implementation.

8.3.2 Cloud-Based Solutions

Considering the adoption of cloud-based solutions can further streamline data processing and model updates. Implementing cloud technologies can facilitate remote monitoring, real-time updates, and scalability, ensuring the system's adaptability to evolving agricultural practices.

8.4 Continued Learning and Skill Development

8.4.1 Stay Updated on Emerging Technologies

Continued learning and staying updated on emerging technologies in machine learning and agriculture will be essential. Attending conferences, workshops, and engaging in online communities will foster an environment of continuous improvement.

8.4.2 Cross-Disciplinary Learning

Exploring cross-disciplinary learning opportunities, such as gaining insights into agronomy and agricultural sciences, will deepen understanding and contribute to more holistic and effective solutions.

Conclusion

The extended future work scope reflects the project's dynamic nature and the evolving landscape of technology in agriculture. By pursuing these avenues, the Crop and Weed Detection system can evolve into a cutting-edge solution that not only addresses current challenges but also anticipates and adapts to the ever-changing demands of precision agriculture.