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.

My project was about building a system which detects and classifies whether in an image, there is a crop present or a weed. It localizes the position which can help in spraying pesticide only where there is weed and not where there is a crop present.

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 Six-Week Internship

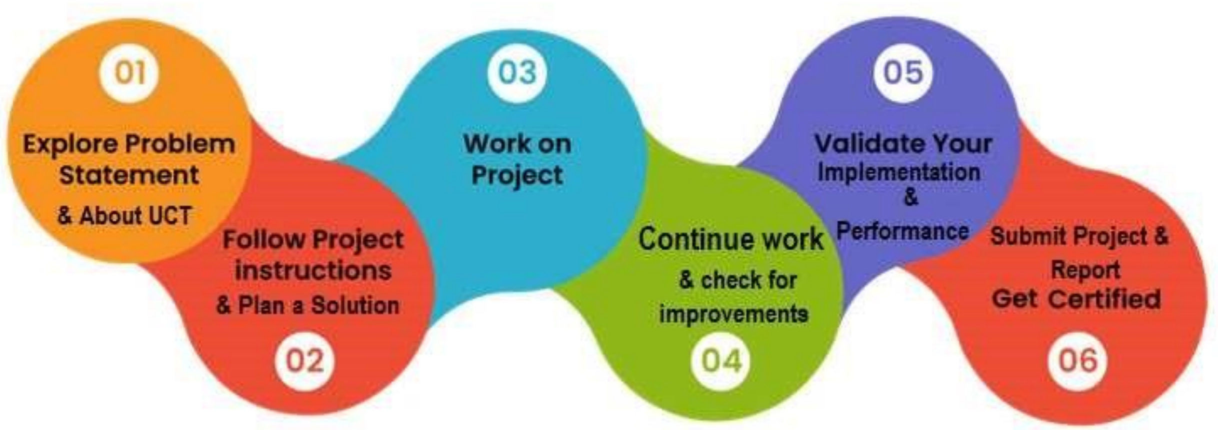
The six-week internship was a remarkable journey, filled with learning, growth, and practical experience. It provided an invaluable opportunity to apply theoretical knowledge to real-world problems, thereby bridging the gap between academia and industry. The experience was not only about professional development but also about personal growth and networking.

• The Need for Relevant Internships in Career Development

Internships play a crucial role in career development. They offer hands-on experience, help build professional networks, and provide insights into the workings of the industry. Engaging in a relevant internship helps students refine their career goals, develop essential skills, and increase their employability. It serves as a stepping stone to future job opportunities and professional success.

• Brief About My Project/Problem Statement

My project focused on Crop vs Weed Detection. The objective was to develop a system capable of accurately distinguishing between crops and weeds, an essential task for optimizing agricultural productivity. This project required a deep understanding of machine learning, image processing, and data analysis, allowing me to apply theoretical knowledge in a practical setting.



• Opportunity Given by Upskill Campus and The IoT Academy

I am deeply grateful to Upskill Campus and The IoT Academy for providing me with this opportunity in collaboration with UniConverge Technologies Pvt Ltd (UCT). Their support and resources were instrumental in making this internship a reality. The collaboration between these institutions and industry partners created a rich environment for learning and development.

• How the Program Was Planned

The internship program was meticulously planned to ensure a comprehensive learning experience. It included an orientation session, regular progress meetings, mentorship, and evaluation. The structured approach helped in setting clear expectations, providing continuous feedback, and ensuring that the learning objectives were met.

• Learnings and Overall Experience

Throughout the internship, I gained a deeper understanding of agricultural technology and the practical applications of machine learning. I developed new skills such as data preprocessing, model training, and evaluation, and enhanced my knowledge in image processing techniques. The challenges I faced taught me resilience and problem-solving skills. Interacting with professionals from the industry provided insights into the practical aspects of the field, and the experience as a whole was incredibly enriching.

• Acknowledgements

I would like to extend my heartfelt thanks to everyone who supported me throughout this internship:

Vrushti Shah, Pujan Gandhi, Hiya Shah and Pratham Shah, my team members, for their collaboration and support. UpSkill Campus and Uniconverge Technologies, the internship coordinators, for organizing and managing the program efficiently and my family and friends, for their constant encouragement.

• Message to Juniors and Peers

To my juniors and peers, I would like to emphasize the importance of internships in your academic journey. They are not just about gaining experience but also about discovering your interests, building your network, and preparing for your future career. Make the most of every opportunity, seek out experiences that challenge you, and never stop learning. Remember, the skills and connections you build during your internships will be invaluable as you progress in your career. Good luck!

2. Introduction

2.1. About UniConverge Technologies Pvt Ltd

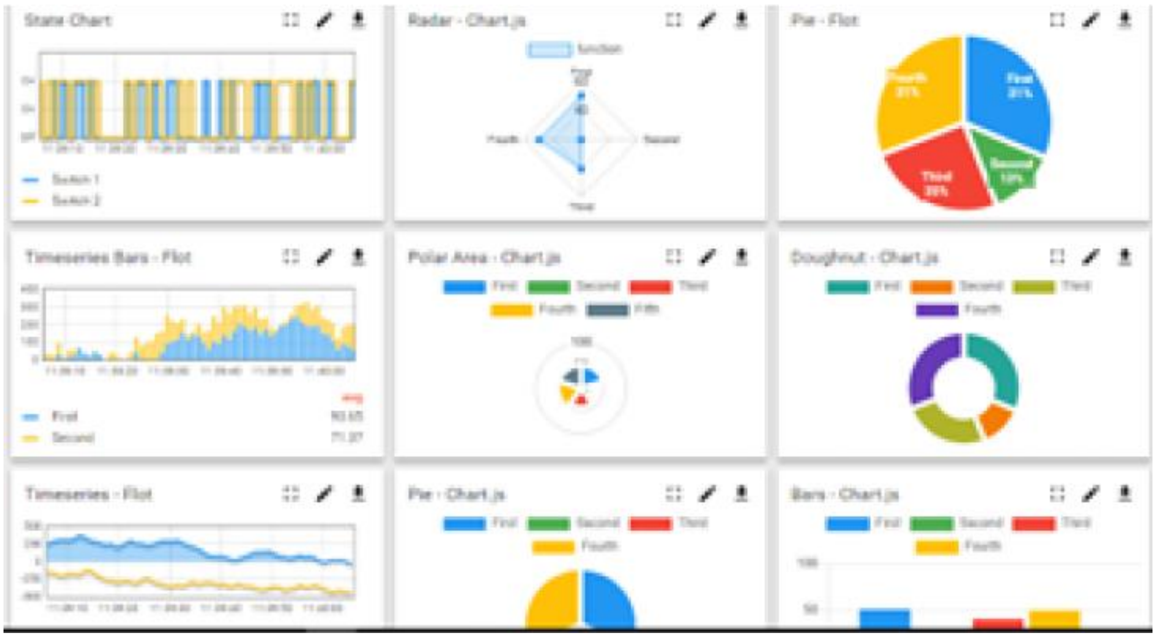
Established in 2013, UniConverge Technologies Pvt Ltd (UCT) is a pioneer in the Digital Transformation domain, dedicated to providing industrial solutions with a prime focus on sustainability and Return on Investment (RoI). UCT leverages a range of cutting-edge technologies to develop its products and solutions, including the Internet of Things (IoT), Cyber Security, Cloud Computing (AWS, Azure), Machine Learning, Communication Technologies (4G/5G/LoRaWAN), Java Full Stack, Python, and Front-end technologies.

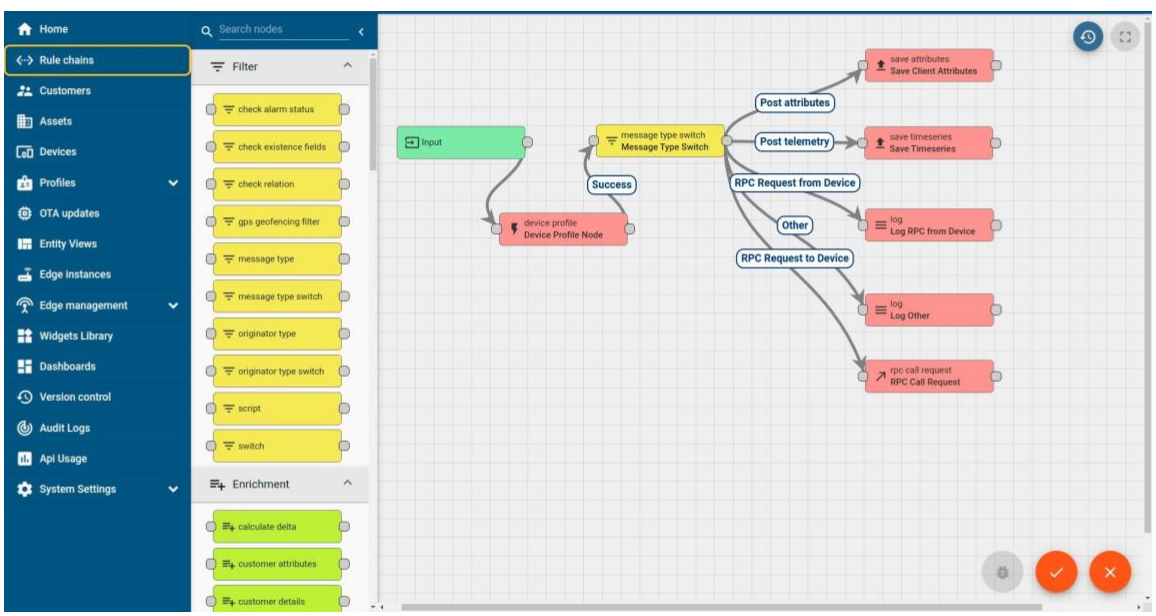
i. UCT IoT Platform ( )

UCT Insight is an IoT platform designed for the rapid deployment of IoT applications, while simultaneously providing valuable insights for processes and businesses. Built with Java for the backend and ReactJS for the front end, UCT Insight supports MySQL and various NoSQL databases.

Key features of the platform include:

- Device connectivity via industry-standard IoT protocols such as MQTT, CoAP, HTTP, Modbus TCP, and OPC UA.
- Support for both cloud and on-premises deployments.
- Customizable dashboards.
- Advanced analytics and reporting capabilities.
- Alerts and notifications.
- Integration with third-party applications such as Power BI, SAP, and ERP.
- A rule engine for automated actions.




Home
Rule chains
Customers
Assets
Devices
Profiles
OTA updates
Entity Views
Edge instances
Edge management
Widgets Library
Dashboards
Version control
Audit Logs
Api Usage
System Settings
Search nodes
Filter
check alarm status
check existence fields
check relation
gps geofencing filter
message type
message type switch
originator type
originator type switch
script
switch
Enrichment
calculate delta
customer attributes
customer details
Input
message type switch
Message Type Switch
device profile
Device Profile Node
Success
Post attributes
Post telemetry
RPC Request from Device
Other
RPC Request to Device
save attributes
Save Client Attributes
save timeseries
Save Timeseries
log
Log RPC from Device
log
Log Other
rpc call request
RPC Call Request

ii. Smart Factory Platform ( )

Factory Watch is UCT's platform tailored for smart factory needs, offering users a scalable solution for production and asset monitoring. It includes OEE (Overall Equipment Effectiveness) and predictive maintenance solutions, which can scale up to digital twins for assets.

Key features include:

- A scalable solution for production and asset monitoring.
- Predictive maintenance and OEE solutions.
- Data-driven insights to identify and improve Key Performance Indicators (KPIs).
- A modular architecture that allows users to start with basic services and scale to more complex solutions as needed.
- A unique SaaS model that saves users 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

LoRaWAN™

iii.based Solution

UCT is one of the early adopters of LoRaWAN technology, providing solutions in various domains such as
Agritech, Smart Cities, Industrial Monitoring, Smart Street Lighting, and Smart Water/Gas/Electricity Metering.

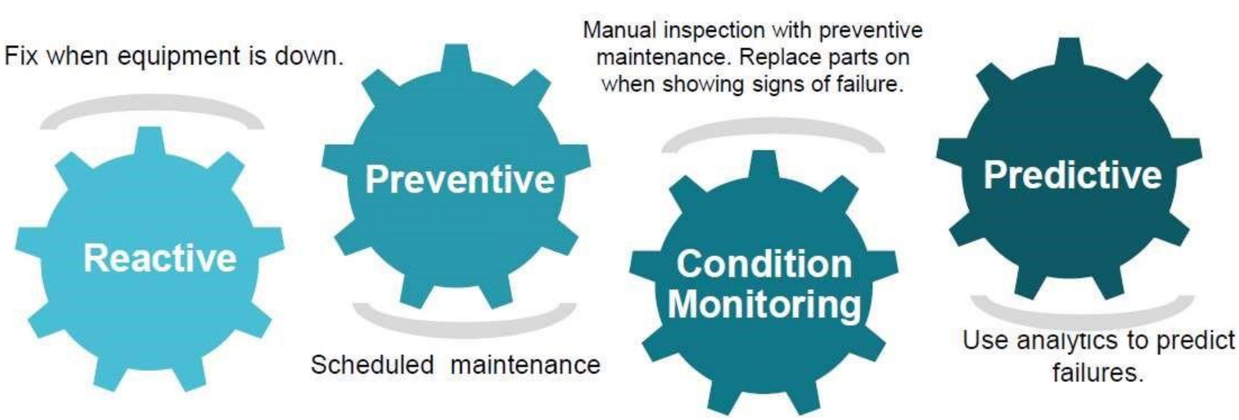
iv. Predictive Maintenance

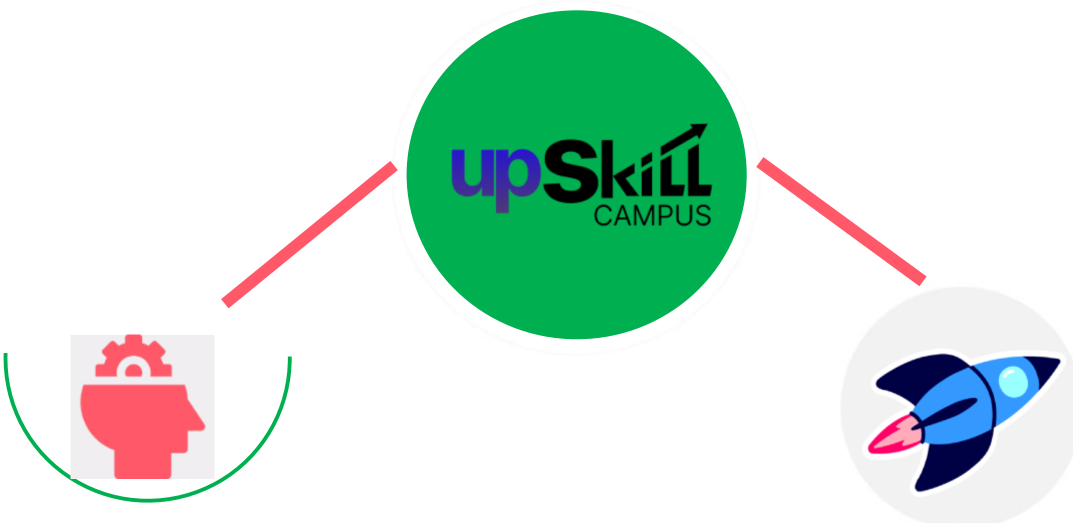
UCT offers industrial machine health monitoring and predictive maintenance solutions by leveraging embedded systems, industrial IoT, and machine learning technologies. These solutions help determine the remaining useful lifetime of various machines used in production processes, enhancing operational efficiency and reducing downtime.

By incorporating these technologies and platforms, UCT is at the forefront of driving digital transformation and sustainability in the industrial sector.

2.2. About upskill Campus (USC)

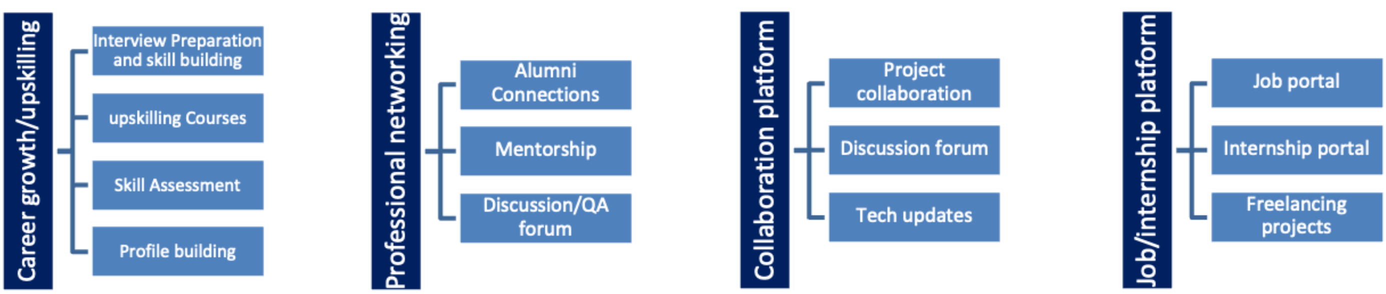
Upskill Campus (USC), along with The IoT Academy and in association with UniConverge Technologies, has facilitated the smooth execution of the complete internship process. USC is a career development platform that delivers personalized executive coaching in a more affordable, scalable, and measurable way. It is committed to helping individuals enhance their skills and advance their careers through targeted training and support.





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/



2.3. The IoT Academy

The IoT Academy is the EdTech division of UCT, running long executive certification programs in collaboration with EICT Academy, IIT Kanpur, IIT Roorkee, and IIT Guwahati in multiple domains. It focuses on providing high-quality education and training in the field of IoT and related technologies, preparing students and professionals for the challenges of the modern industrial landscape.

2.4. Objectives of this Internship program

The objectives of this internship program were to:

- Gain practical experience of working in the industry.
- Solve real-world problems.
- Improve job prospects.
- Enhance understanding of our field and its applications.
- Foster personal growth, including better communication and problem-solving skills.

2.5. References

[1] https://learn.upskillcampus.com/s/courses/661f677ed1f9ae5c9cacd78c/take

[2] https://learn.upskillcampus.com/s/courses/661f677ed1f9ae5c9cacd78c/take

[3] https://learn.upskillcampus.com/s/courses/661f677ed1f9ae5c9cacd78c/take

2.6. Glossary

Terms	Acronym
Internet of Things	IoT
Overall Equipment Effectiveness	OEE
Return on Investment	RoI
Machine Learning	ML
Communication Technologies	4G/5G/LoRaWAN
Structured Query Language	SQL
JavaScript Library for Building User Interfaces	ReactJS

2.7.

This comprehensive introduction sets the stage for understanding the context and significance of the internship program, the organizations involved, and the objectives we aimed to achieve.

3. Problem Statement

• Introduction

Weeds are a significant issue in agriculture, competing with crops for essential resources such as nutrients, water, and space. This competition often leads to reduced crop yields and overall agricultural productivity. To manage weeds, farmers commonly use pesticides. While effective, this method poses the risk of pesticide residues sticking to crops, which can be harmful to human health. Moreover, indiscriminate spraying of pesticides leads to wastage and increased costs.

• Objective

The goal of this project is to develop an intelligent pesticide spraying system that targets only weeds, thereby minimizing pesticide use on crops. This approach aims to mitigate the problems associated with pesticide residues on crops and reduce the overall consumption of pesticides.

• Proposed Solution

Our proposed system leverages advanced technologies to differentiate between crops and weeds. Once the weeds are identified, the system precisely sprays pesticides only on the weeds. This selective spraying method ensures that the crops remain largely free of pesticide residues, thus enhancing food safety and reducing environmental impact.

• Benefits

1. Enhanced Crop Safety: By avoiding pesticide application on crops, the risk of harmful residues is minimized, leading to safer food products.
2. Resource Efficiency: Targeted spraying reduces pesticide usage, lowering costs for farmers and minimizing environmental pollution.
3. Increased Crop Yields: With weeds effectively controlled and crops receiving more resources, agricultural productivity is likely to improve.

• Conclusion

Developing a system that exclusively targets weeds for pesticide application presents a sustainable and efficient solution to current weed management challenges. This innovation not only protects human health but also promotes environmental conservation and agricultural efficiency.

4. Existing and Proposed solution

Existing Solutions

1. Manual Weeding

    •Method: Physical removal of weeds by hand or using simple tools.
    •Limitations: Labor-intensive, time-consuming, and not feasible for large-scale farming.

2. Chemical Spraying

    •Method: Broad application of herbicides to fields.
    •Limitations: Non-selective, leading to pesticide residues on crops, environmental contamination, and development of herbicide-resistant weed strains.

3. Mechanical Weeding

    - Method: Use of machinery to remove weeds.
    - Limitations: Can damage crops, soil compaction issues, and high operational costs.

4. Biological Control

    - Method: Introduction of natural weed predators or pathogens.
    - Limitations: Slow process, effectiveness varies, and potential disruption to local ecosystems.

5. Integrated Weed Management (IWM)

    - Method: Combination of mechanical, biological, and chemical methods.
    - Limitations: Complex implementation, requires extensive knowledge, and not always cost-effective.

Proposed Solution

Our proposed solution is the development of an intelligent pesticide spraying system that uses advanced technologies to distinguish between crops and weeds. The system involves:

1. Weed Detection: Utilizing image processing and machine learning algorithms to identify and differentiate weeds from crops accurately.
2. Targeted Spraying: Employing precision spraying mechanisms to apply pesticides solely on detected weeds, avoiding crops.

Value Addition

1. Selective Application: Our system ensures that pesticides are only applied to weeds, significantly reducing the risk of pesticide residues on crops.
2. Resource Efficiency: By minimizing pesticide usage, the system reduces costs for farmers and lowers environmental impact.
3. Improved Crop Yields: With more nutrients, water, and space available for crops, agricultural productivity is enhanced.
4. Scalability: The system can be adapted for use in various farm sizes and types, making it versatile and widely applicable.
5. Sustainability: Reducing pesticide usage aligns with sustainable farming practices, promoting long-term agricultural health and environmental conservation.

4.1. Code submission (Github link)

 https://github.com/ABDURRAHMAAN1593/upskillcampus/blob/main/CropWeedDetection.ipynb

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

https://github.com/ABDURRAHMAAN1593/upskillcampus/blob/main/CropWeedDetection_Abdur_USC_UCT.pdf

5. Proposed Design/ Model

Design Flow of the Crop and Weed Detection Solution

1. Problem Definition and Requirement Analysis:
   - Objective: Define the goal of detecting and classifying crops and weeds.
   - Requirements: Identify hardware, software, data, and performance metrics.

2. Data Collection and Preparation:
   - Image Data Acquisition: Collect images from various sources (drones, field cameras).
   - Data Annotation: Label images for crops and weeds.
   - Preprocessing: Perform resizing, normalization, and augmentation to enhance image quality and diversity.

3. Model Selection and Development:
   - Architecture Selection: Choose appropriate CNN architectures (e.g., ResNet, EfficientNet).
   - Model Building: Implement and customize the selected model architecture.
   - Training: Train the model using the prepared dataset, applying techniques like transfer learning if necessary.

4. Model Evaluation and Optimization:
   - Evaluation Metrics: Assess model performance using accuracy, precision, recall, and F1-score.
   - Hyperparameter Tuning: Optimize hyperparameters to improve model performance.
   - Cross-Validation: Use cross-validation to ensure the model's robustness.

5. Integration and Testing:
   - Pipeline Integration: Integrate the model into a functional pipeline for real-time detection.
   - Field Testing: Deploy the model in a controlled environment to test its performance on live data.
   - User Feedback: Collect feedback from end-users (farmers) to identify areas for improvement.

6. Deployment and Scalability:
   - Edge Computing: Implement the model on edge devices for real-time field detection.

- Cloud Deployment: Use cloud services for scalability, allowing the system to handle large-scale deployments.

7. Maintenance and Iteration:
    - Monitoring: Continuously monitor model performance and update with new data to maintain accuracy.
    - Iteration: Regularly iterate on the model and pipeline based on user feedback and technological advancements.

Start, Intermediate Stages, and Final Outcome

- Start: Define the problem, gather requirements, and collect initial data.
- Intermediate Stages: Data preprocessing, model selection, development, training, evaluation, and optimization.
- Final Outcome: A deployed, scalable, and robust crop and weed detection system integrated with real-time field applications, continuously maintained and iterated upon based on user feedback and performance monitoring.

This design flow ensures a structured approach to developing an effective and practical crop and weed detection system using computer vision and machine learning.

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 :

Test Case 1: Real-Time Detection

Description: Test the system's ability to process and classify images in real-time.

- Input: Live video feed from a camera mounted on a moving vehicle.
- Expected Output: Real-time accurate classification and marking of crops and weeds. Test

Case 2: Edge Cases

Description: Test the system with edge cases such as very small or very large weed patches.

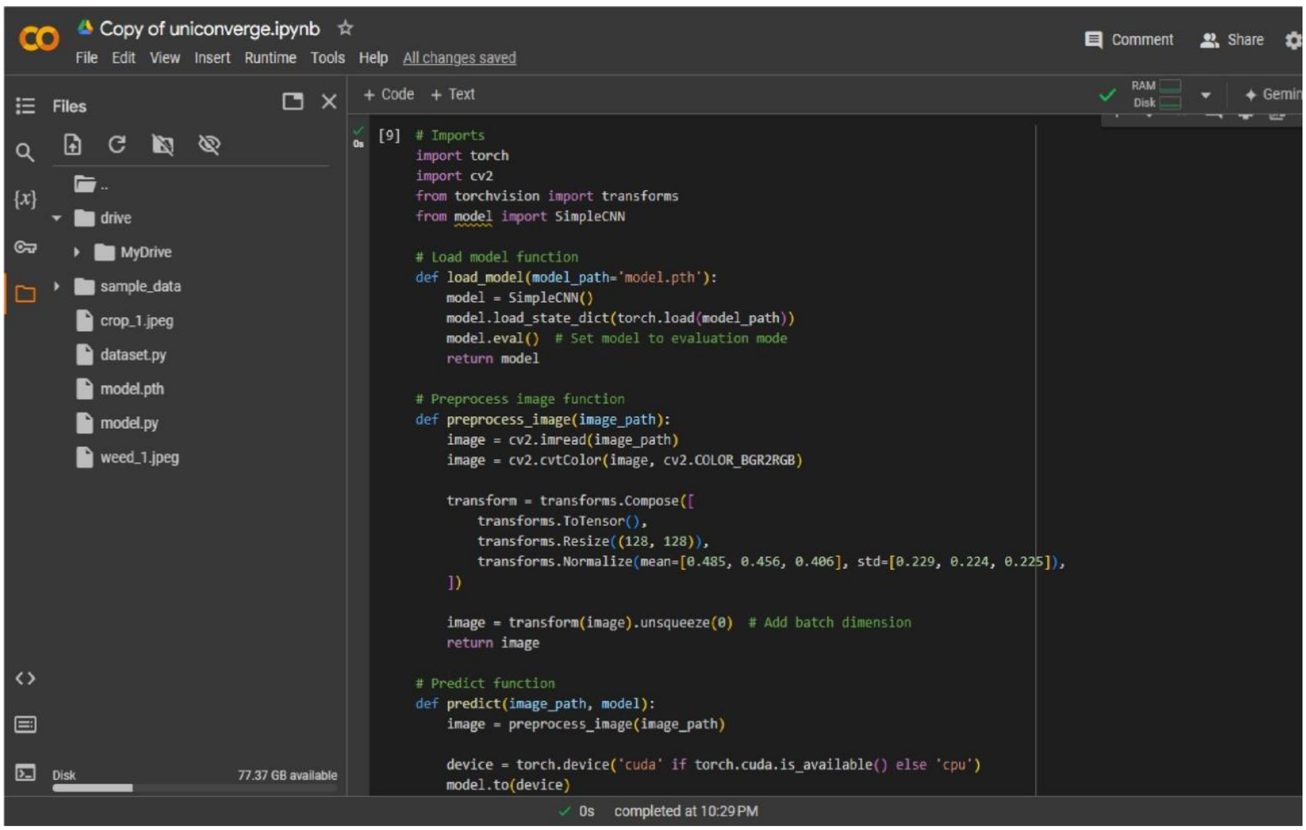
- Input: Images with extremely small or large areas of weed presence.
- Expected Output: Correct identification and classification of even the smallest and largest weed patches.

Test Case 3 : False Positives and Negatives

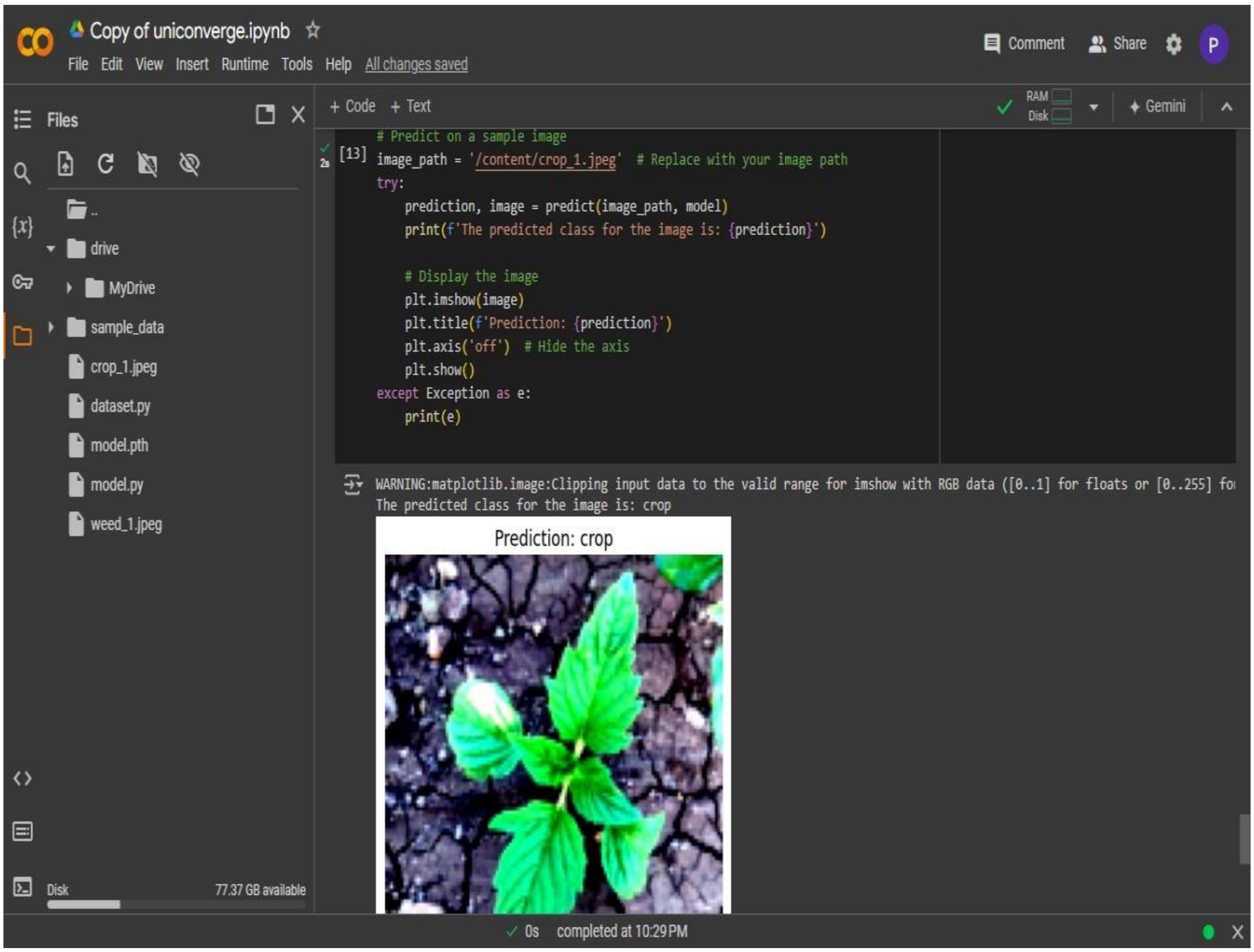
Description: Test the system to minimize false positives (weeds identified as crops) and false negatives (crops identified as weeds).

- Input: Mixed images designed to test false identification scenarios.
- Expected Output: Minimal false positives and negatives, with correct classification rates

6.2. Test Procedure :



6.3. Performance Outcome :



7. My learnings

During the crop and weed detection project using computer vision, I gained key skills in:

1. Image Data Management: Collecting and managing datasets with varying conditions.
2. Data Preprocessing: Techniques like resizing, normalization, and augmentation.
3. Feature Extraction: Using traditional and deep learning-based methods with CNNs.
4. Model Building and Optimization: Designing, training, and optimizing image classification models.
5. Model Evaluation: Using metrics such as accuracy, precision, recall, and F1-score.
6. Integration and Deployment: Implementing real-time detection and scalable deployment strategies.
7. Team Collaboration: Coordinating tasks and managing project milestones.
8. Problem-Solving: Tackling challenges and rapidly adapting to new technologies.

Career Growth Impact

This project enhanced my technical proficiency in computer vision and machine learning, provided practical experience in project lifecycle management, improved my collaborative and problem-solving skills, and positioned me as a valuable asset in the agriculture technology sector. Overall, it laid a strong foundation for a successful career in machine learning and computer vision.

8. Future work scope

Future work for the crop and weed detection project includes:

1. Advanced Models: Explore advanced architectures like Vision Transformers and ensemble methods for better performance.

2. Data Augmentation: Use GANs for synthetic data generation and advanced augmentation techniques.

3. Real-Time Processing: Implement edge computing for real-time detection and optimize model speed.

4. Multispectral Imaging: Integrate multispectral/hyperspectral data for improved differentiation.

5. Robustness: Enhance robustness with cross-domain and adversarial training.

6. Autonomous Systems: Integrate with robotic weeders and drones.

7. User Interface: Develop an intuitive interface for farmers.

8. Scalability: Implement scalable cloud solutions for large-scale deployment.