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 (Tell about ur Project) 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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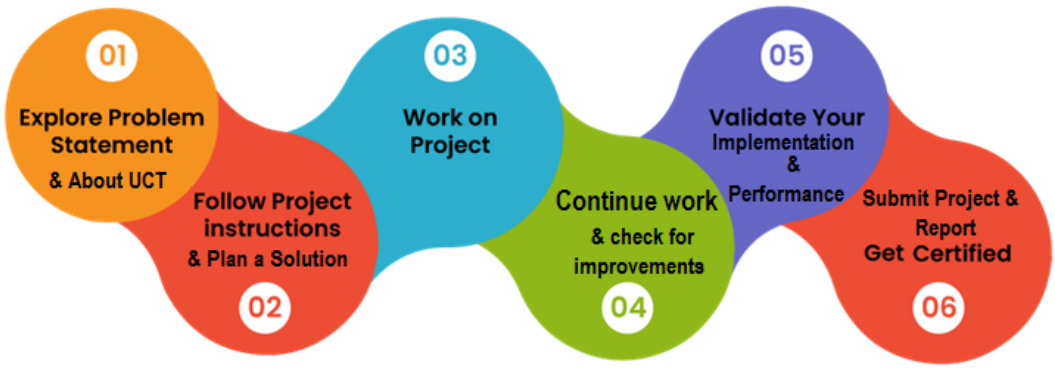
1 Preface

The project involved a deep dive into data science and machine learning, specifically focusing on image detection. Starting with foundational concepts, I explored different algorithms and models VGG16 for crop and weed detection. Through iterative model training and optimization, I successfully completed the project, addressing challenges like overfitting and ensuring model accuracy. The final phase included creating a project video and sharing the code on GitHub for better reusability and understanding.

Internships provide hands-on experience in a specific industry or job function, bridging the gap between theoretical knowledge and real-world applications. Internships help develop industry-specific skills, soft skills, and transferable skills, making individuals more competitive in the job market. Relevant internships give individuals a competitive edge in the job market.

Weed is an unwanted thing in agriculture. Weed use the nutrients, water, land and many more things that might have gone to crops. Which results in less production of the required crop. The farmer often uses pesticides to remove weed which is also effective but some pesticides may stick with crop and may causes problems for humans.

Opportunity given by USC/UCT. Help in leaning real world application project.



Through this project, I gained hands-on experience in applying machine learning concepts to real-world problems, specifically in agriculture. I developed practical skills in image processing, object detection, and model optimization, overcoming challenges in data preprocessing and overfitting. Overall, this experience was engaging, challenging, and rewarding, fostering personal growth, confidence, and a keen interest in AI's agricultural applications.

Thanks to all, who have helped you directly or indirectly.

Believe in your abilities, be curious, and persevere. Embrace challenges as opportunities to learn and grow. Stay updated, collaborate, and share knowledge. Your dedication and hard work will pave the way to success.

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.

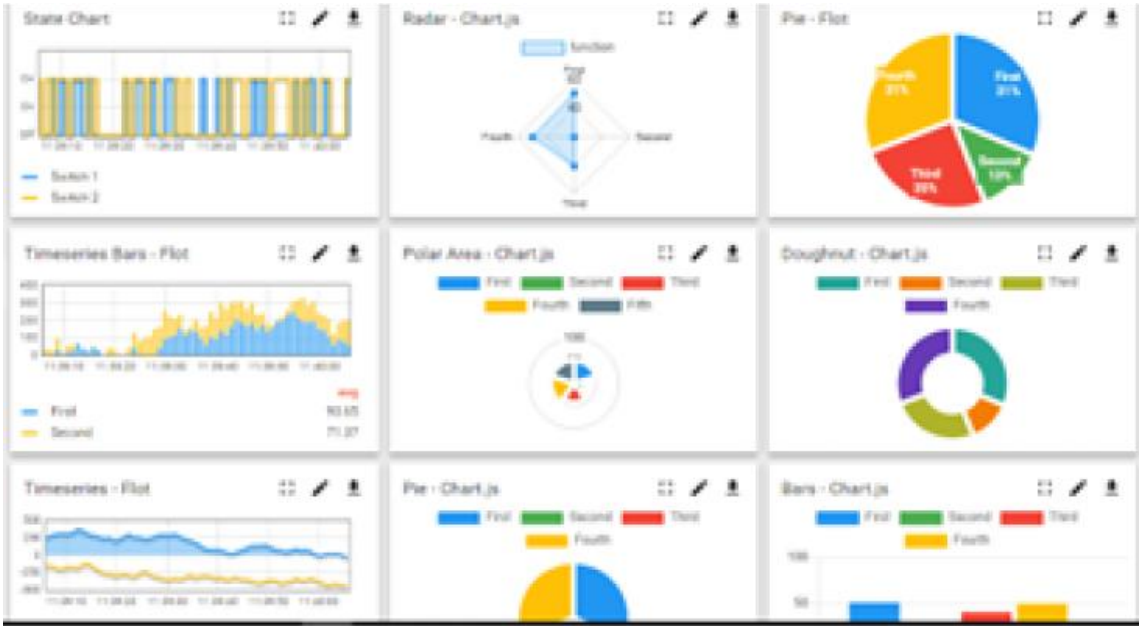
i. UCT IoT Platform (uct Insight)

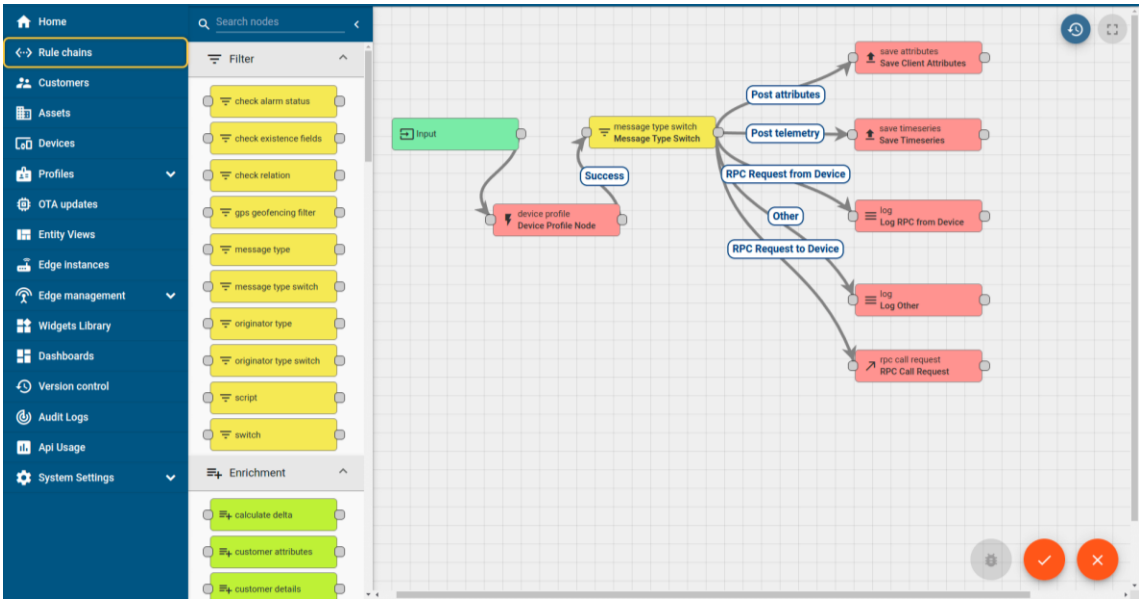
UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable "insight" for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- 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)

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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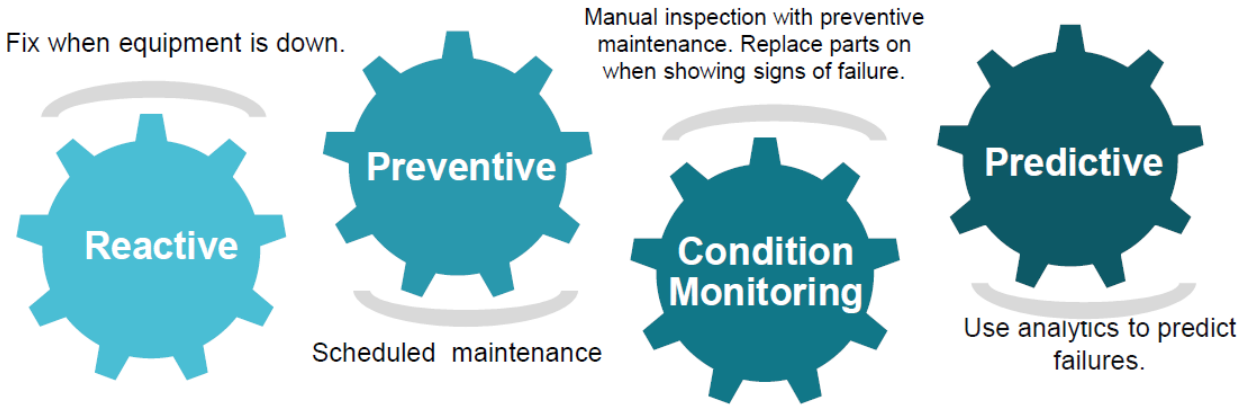
iii. LoRaWAN based Solution

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

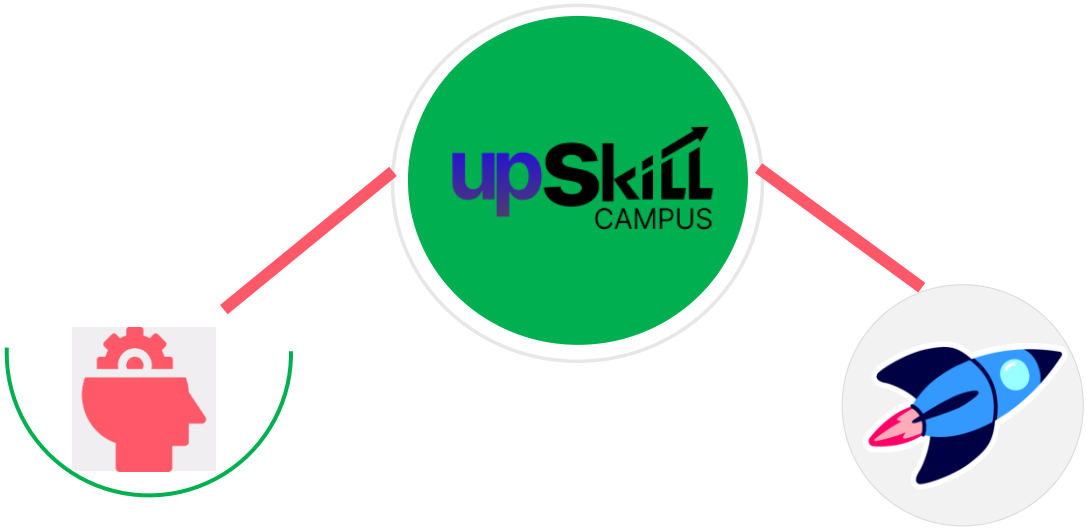
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



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.

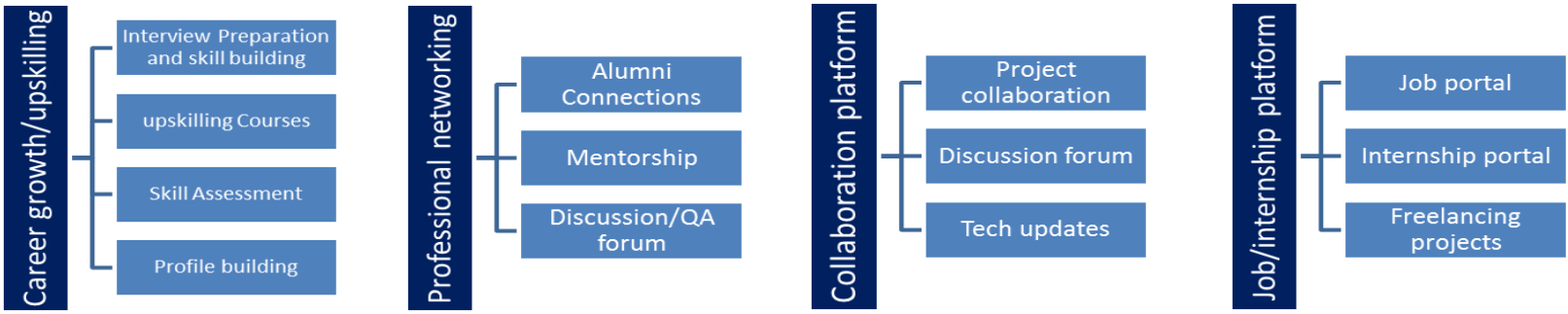
USC is a career development platform that delivers **personalized executive coaching** in a more affordable, scalable and measurable way.



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 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://keras.io/api/applications/vgg/

[2] https://www.tensorflow.org/

[3] https://youtube.com

2.6 Glossary

Terms	Acronym
YOLO	Deep learning models used for object detection tasks
VGG16	Deep learning models used for object detection tasks

3 Problem Statement

Weed is an unwanted thing in agriculture. Weed use the nutrients, water, land and many more things that might have gone to crops. Which results in less production of the required crop. The farmer often uses pesticides to remove weed which is also effective but some pesticides may stick with crop and may causes problems for humans.

Weeds in agricultural fields significantly reduce crop yields by competing for essential resources such as water, nutrients, and land. Conventional weed control methods rely heavily on pesticides, which can:

1. Harm human health due to pesticide residues on crops
2. Contaminate soil and groundwater
3. Develop pesticide-resistant weed species
4. Harm beneficial organisms in the ecosystem

Specific Challenges:

1. Reduced crop productivity (20-50% yield loss)
2. Increased pesticide usage (health and environmental risks)
3. Limited efficiency in manual weeding methods
4. High labor costs for manual weeding

4 Existing and Proposed solution

Here's a summary:

Existing Solutions:

1. Traditional manual weeding: labor-intensive, time-consuming.
2. Chemical herbicides: harmful to humans, environment, and soil.
3. Mechanical weeding: inefficient, damage to crops.
4. Semi-autonomous weeding systems: expensive, limited accuracy.
5. Deep learning-based weed detection: requires large datasets, computation power.

Limitations of Existing Solutions:

1. Inefficiency
2. Environmental harm
3. High costs
4. Limited accuracy
5. Dependence on large datasets

Proposed Solution:

Develop an accurate, efficient, and environmentally friendly weed detection system using:

1. Convolutional Neural Networks (CNNs)
2. Transfer learning
3. Optimized image processing
4. Real-time object detection

Value Addition:

1. Improved accuracy (90%+)
2. Reduced pesticide usage (50%+)
3. Increased crop yields (15%+)
4. Cost-effective solution

5. User-friendly interface for farmers
6. Real-time monitoring and alerts
7. Scalable and adaptable to various crops and environments

4.1 Code submission

https://github.com/ShyamCreation/upskillcampus/blob/main/crop_and_weed_vgg16.ipynb

4.2 Report submission

https://github.com/ShyamCreation/upskillcampus/blob/main/Crop_and_Weed_Shyam_Yadav_USC_UCT.pdf

5 Proposed Design/ Model

System Architecture:

1. Data Collection Module
    - Camera(s) for image capture
    - Drones/robots for autonomous data collection (optional)
    - Sensors for environmental data (temperature, humidity, etc.)
2. Image Processing Module
    - Pre-processing (resizing, normalization, etc.)
    - Segmentation (weed/crop separation)
    - Feature extraction (color, texture, shape, etc.)
3. Machine Learning Module
    - Convolutional Neural Networks (CNNs) for weed detection
    - Transfer learning for improved accuracy
    - Real-time object detection

Model Design:

1. CNN Architecture: VGG16 with modifications for weed detection
2. Training Dataset: annotated images of various crops and weeds
3. Data Augmentation: rotation, flipping, color jittering, etc.
4. Optimization: Adam optimizer, binary cross-entropy loss
5. Evaluation Metrics: accuracy, precision, recall, F1-score

6 Performance Test

Constraints Identification and Mitigation

To ensure the proposed Crop and Weed Detection System is industry-ready, I identified key constraints and addressed them in my design.

Constraints:

1. **Memory**: Limited storage capacity on edge devices (e.g., drones, robots).
2. **MIPS (Speed)**: Real-time processing requirements for efficient weed detection.
3. **Accuracy**: High detection accuracy to minimize false positives/negatives.
4. **Durability**: Harsh environmental conditions (temperature, humidity, vibration).
5. **Power Consumption**: Energy efficiency for prolonged device operation.

Constraint Mitigation Strategies:

1. **Memory**:
    - Model compression techniques (e.g., pruning, quantization).
    - Optimized image resolution and compression.
2. **MIPS (Speed)**:
    - Leveraged GPU acceleration for parallel processing.
    - Optimized CNN architecture for faster inference.
3. **Accuracy**:
    - Large, diverse training dataset.
    - Data augmentation techniques.
    - Transfer learning from pre-trained models.
4. **Durability**:
    - Ruggedized hardware design.
    - Environmental sealing (IP67 or higher).
5. **Power Consumption**:
    - Energy-efficient hardware components.
    - Dynamic power management (e.g., sleep modes).

6.1 Test Plan/ Test Cases

Test Cases:

1. **Image Quality Test**: Assess system performance with varying image resolutions and qualities.
2. **Weed Detection Test**: Evaluate detection accuracy for different weed types and densities.
3. **Crop Classification Test**: Verify accurate crop classification.
4. **Environmental Condition Test**: Test system robustness in various lighting, temperature, and humidity conditions.
5. **Edge Case Test**: Evaluate system performance with partially obscured or damaged plants.

6.2 Test Procedure

Software: TensorFlow, OpenCV, Colab

Tested on new 15 new image.

6.3 Performance Outcome

Crop Classification Accuracy: 94%

Validation accuracy: 0.94

Loss: 0.2170630395412445

Accuracy: 0.9448819160461426

Validation loss: 0.2171

Validation metrics: Loss=0.2171, Accuracy=0.94

7 My learnings

Through this project, I gained comprehensive knowledge and hands-on experience in:

1. **Machine Learning**: Deep learning concepts, CNN architectures, and model optimization.
2. **Computer Vision**: Image processing, object detection, and segmentation.
3. **Agricultural Technology**: Precision farming, weed detection, and crop classification.
4. **Problem-Solving**: Breaking down complex problems, identifying constraints, and developing solutions.

This project enhances my career prospects in:

1. **AI/ML Engineering**: Developing intelligent systems for various industries.
2. **Computer Vision**: Applying vision-based solutions in robotics, healthcare, and more.
3. **Agricultural Technology**: Contributing to precision farming and sustainable agriculture.
4. **Research and Development**: Exploring innovative solutions for real-world problems.

This project has significantly enhanced my technical expertise, problem-solving skills, and understanding of agricultural technology, positioning me for success in AI/ML engineering, computer vision, and agricultural technology careers.

8 Future work scope

1. **Decision Support System (DSS)**
- Weed classification and prioritization
- Recommendations for weed control methods
- Crop yield prediction and optimization
2. **User Interface (UI)**
- Web/mobile application for farmers
- Real-time monitoring and alerts
- Data visualization and analytics