**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 about Crop and weed detection. to develop a system that only sprays pesticides on weed and not on the crop Which will reduce the mixing problem with crops and also reduce the waste of pesticides  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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# 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 (with names), who have helped you directly or indirectly.

Your message to your juniors and peers.

# Introduction

## 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.



1. 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

1. **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.

1.  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.

1. 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.



## 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

<https://www.upskillcampus.com/>

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



## 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.

## 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.

## Reference

[1] https://www.kaggle.com/

[2]  https://www.annalsofrscb.ro/index.php/journal/article/view/7386

# 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

# Existing And Proposed System

Existing System:

The existing system for crop and weed detection typically involves manual inspection by farmers or field experts. They visually inspect the fields to identify and differentiate between crops and weeds. This process is time-consuming, labor-intensive, and prone to human errors. Farmers often rely on traditional methods, such as manual weeding or blanket application of herbicides, which can be inefficient and result in unnecessary use of chemicals.

Proposed System:

The proposed system for crop and weed detection aims to automate the process using data science and computer vision techniques. It involves the development of computer-based algorithms and models that can accurately identify and classify crops and weeds based on image data. The proposed system offers several advantages over the existing system:

Efficiency: The proposed system automates the detection process, reducing the need for manual inspection and saving time for farmers. It allows for quick and accurate identification of crops and weeds, enabling timely intervention and decision-making.

Precision: By leveraging data science techniques, the proposed system can achieve high precision and accuracy in crop and weed detection. It can distinguish between different types of crops and weeds, enabling targeted actions for specific species.

Resource Optimization: With accurate detection, the proposed system helps optimize the use of resources such as water, fertilizers, and herbicides. Farmers can precisely apply herbicides only to weed-infested areas, minimizing chemical usage and reducing environmental impact.

Decision Support: The proposed system can provide valuable insights and decision support for farmers. It can generate data and analytics on crop-weed distribution, growth patterns, and treatment effectiveness, empowering farmers to make informed decisions for crop management.

The proposed system utilizes various data science techniques, including image processing, machine learning, and deep learning, to analyze and classify images of crops and weeds. It involves the development and training of models using labeled datasets to achieve accurate detection and classification.

Overall, the proposed system revolutionizes the crop and weed detection process, enabling farmers to adopt more efficient and sustainable practices for crop management.

## Code submission : [Repository of code](https://github.com/udit9058/upskill_data_science_and_machine_learning_internship)

## Report submission (Github link) : [Submission\_file](https://github.com/udit9058/upskill_data_science_and_machine_learning_internship)

# Proposed Design/ Model

The proposed system aims to develop a precision weed spraying system that can accurately detect and target weeds while avoiding the application of pesticides on crops. This system utilizes data science techniques and advanced technologies to optimize pesticide usage, reduce the mixing problem with crops, and minimize pesticide waste. Here's an overview of the proposed system:

Data Collection: Gather a diverse dataset of images or sensor data that includes information about both crops and weeds. This dataset will be used to train the weed detection and classification models.

Weed Detection and Classification: Develop a computer vision or machine learning model that can accurately detect and classify weeds in real-time. This model should be trained on the collected dataset, using various techniques such as deep learning, image processing, or sensor data analysis.

Crop Identification: Develop a separate model or algorithm that can identify and classify different types of crops. This model will work in tandem with the weed detection model to differentiate between crops and weeds.

Sensor Integration: Integrate advanced sensors, such as hyperspectral sensors or infrared cameras, into the system. These sensors can provide additional data about the health and characteristics of plants, allowing for more precise identification of crops and weeds.

Real-time Decision-making: Utilize the outputs from the weed detection and crop identification models, along with sensor data, to make real-time decisions about which areas of the field contain weeds and need pesticide application.

Precision Spraying Mechanism: Incorporate a precision spraying mechanism that can target and spray only the areas where weeds are detected. This can be achieved through technologies like robotic sprayers or drones equipped with spraying mechanisms.

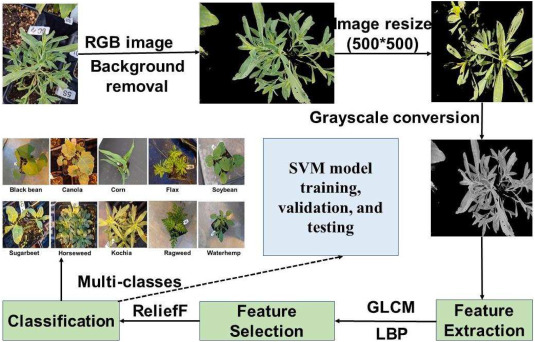
Smart Control System: Implement a smart control system that coordinates the detection, identification, and spraying processes. This system will ensure proper synchronization and communication between the different components of the system.

Data Analytics and Monitoring: Develop a data analytics module to analyze the collected data, including weed distribution patterns, treatment effectiveness, and pesticide usage. This module will provide valuable insights for future decision-making and optimization of the spraying system.

Feedback Loop and Improvement: Continuously gather feedback from the system's performance, monitor the accuracy of weed detection, and make necessary improvements to the models and spraying mechanism to enhance precision and efficiency.

By implementing this precision weed spraying system, farmers can significantly reduce the mixing problem with crops and minimize pesticide waste. It enables targeted and efficient application of pesticides, leading to improved crop health, reduced chemical usage, and minimized environmental impact.

## Interfaces (if applicable)



# Performance Test

In the proposed design of the precision weed spraying system, several constraints can impact the overall performance and implementation. Let's discuss some of the common constraints and how they are taken into account in the design:

Memory and Computational Constraints:

To address memory constraints, the design should optimize the storage and processing of data. This can be achieved by employing efficient data structures and algorithms for image processing and machine learning tasks.

The use of lightweight and optimized models, such as smaller CNN architectures or feature-based methods, can help mitigate computational constraints while maintaining acceptable accuracy levels.

Implementing hardware acceleration techniques, such as GPU utilization, can enhance computational speed and efficiency.

Power Consumption:

Power consumption is a critical constraint, especially for systems deployed in the field. The design should aim for energy-efficient components, sensors, and processing units to minimize power usage.

Utilizing low-power communication protocols and optimizing the scheduling and operation of the precision spraying mechanism can further reduce power consumption.

Implementing intelligent power management strategies, such as sleep modes or dynamic power scaling, can effectively handle power constraints.

Durability and Environmental Constraints:

Since the precision weed spraying system operates in agricultural environments, it needs to be durable and resistant to harsh weather conditions, dust, and water.

Encasing sensitive components in protective casings and ensuring proper sealing against environmental factors can enhance durability.

Regular maintenance and periodic checks can be performed to identify any issues and ensure proper functioning.

Accuracy and Performance Constraints:

Achieving high accuracy in weed detection and crop identification is crucial for the system's effectiveness. Continual improvement of the detection and classification algorithms, along with regular model retraining, can enhance accuracy.

Rigorous testing and validation using diverse datasets in various field conditions can help evaluate the system's performance against accuracy constraints.

Incorporating feedback mechanisms and adaptive algorithms can enable the system to learn and improve its accuracy over time.

It is important to note that the specific impact of these constraints may vary based on the deployment environment, available resources, and technological advancements. Therefore, thorough testing and validation of the system in real-world scenarios are essential to assess its performance and address any potential limitations.

Recommendations for handling constraints:

Conduct thorough testing and validation in various field conditions to identify and address performance and accuracy constraints. Employ efficient data structures, algorithms, and optimized models to mitigate memory and computational constraints.

Utilize energy-efficient components, sensors, and power management strategies to minimize power consumption. Design rugged and weather-resistant hardware enclosures to ensure durability in harsh agricultural environments.

Continuously monitor and evaluate the system's performance, collecting feedback from users and making necessary improvements to address identified constraints.

By considering and addressing these constraints, the precision weed spraying system can be designed to effectively meet the aim of reducing pesticide waste, minimizing crop-pesticide mixing, and optimizing pesticide application in agricultural fields..

## Test Plan/ Test Cases

Test Plan/ Test Cases for Precision Weed Spraying System:

Test Case: Weed Detection Accuracy

Description: Test the accuracy of the weed detection model in correctly identifying and classifying weeds.

Test Steps:

Prepare a dataset of images containing both crops and weeds.

Manually label the images to establish the ground truth.

Feed the images into the weed detection model and compare the predicted weed labels with the ground truth labels.

Expected Outcome: The weed detection model should achieve a high accuracy rate in correctly identifying weeds.

Test Case: Crop Identification Accurac

Description: Test the accuracy of the crop identification model in correctly identifying and classifying different types of crops.

Test Steps:

Prepare a dataset of images containing different types of crops.

Manually label the images to establish the ground truth.

Feed the images into the crop identification model and compare the predicted crop labels with the ground truth labels.

Expected Outcome: The crop identification model should accurately classify different types of crops with a high accuracy rate.

Test Case: Precision Spraying Mechanism

Description: Test the precision spraying mechanism's ability to target and spray only the areas with detected weeds.

Test Steps:

Set up a controlled test environment with simulated weed patches and crops.

Activate the precision spraying mechanism and observe its performance in accurately targeting the weed patches while avoiding the crops.

Expected Outcome: The precision spraying mechanism should effectively target and spray only the weed-infested areas, minimizing pesticide application on crops.

Test Case: Real-time Decision-making

Description: Test the system's ability to make real-time decisions based on weed detection, crop identification, and sensor data.

Test Steps:

Simulate various scenarios with different weed densities and crop types.

Monitor the system's decision-making process and evaluate its effectiveness in determining where and when to apply pesticides.

Expected Outcome: The system should make accurate and timely decisions based on the integrated data sources, effectively guiding the spraying process.

Test Case: System Robustness and Durability

Description: Test the system's robustness and durability under varying environmental conditions.

Test Steps:

Conduct tests in different weather conditions, such as rain, wind, or extreme temperatures.

Assess the system's performance and functionality during these tests, ensuring that it continues to operate effectively without any hardware or software failures.

Expected Outcome: The system should demonstrate durability and robustness, remaining operational and reliable under different environmental conditions.

Test Case: Power Consumption Optimization

Description: Test the system's power consumption optimization strategies to ensure efficient use of energy.

Test Steps:

Measure power consumption during different operational modes, such as detection, decision-making, and spraying.

Evaluate the effectiveness of power-saving techniques, such as sleep modes or dynamic power scaling, in reducing energy consumption.

Expected Outcome: The system should effectively optimize power consumption, minimizing energy usage and prolonging battery life.

Test Case: Integration and Communication

Description: Test the integration and communication between different components of the system, including sensors, decision-making algorithms, and the spraying mechanism.

Test Steps:

Simulate data exchange between components and verify seamless communication and synchronization.

Monitor the system's performance and ensure that data flows smoothly and accurately between the components.

Expected Outcome: The system should demonstrate effective integration and communication, enabling efficient coordination between different modules.

## Test Procedure

Test Procedure for Precision Weed Spraying System:

Weed Detection Accuracy Test:

Prepare a dataset of images with labeled ground truth (weeds and crops).

Feed the images into the weed detection model. Compare the predicted weed labels with the ground truth labels.

Calculate the accuracy of the weed detection model by dividing the number of correctly detected weeds by the total number of weeds in the dataset.

Crop Identification Accuracy Test: Prepare a dataset of images with labeled ground truth (different crop types).

Feed the images into the crop identification model. Compare the predicted crop labels with the ground truth labels.

Calculate the accuracy of the crop identification model by dividing the number of correctly identified crops by the total number of crops in the dataset.

Precision Spraying Mechanism Test:

Set up a controlled test environment with simulated weed patches and crops.

Activate the precision spraying mechanism.

Observe and document the precision spraying mechanism's performance in accurately targeting the weed patches while avoiding the crops.

Measure the percentage of pesticide application on weeds versus crops.

Real-time Decision-making Test:

Simulate various scenarios with different weed densities and crop types.

Monitor the system's decision-making process in determining where and when to apply pesticides.

Evaluate the system's decision accuracy and timeliness based on the actual weed distribution and crop types.

System Robustness and Durability Test:

Conduct tests in different environmental conditions, such as rain, wind, or extreme temperatures.

Observe the system's performance and functionality under varying environmental conditions.

Ensure that the system remains operational and reliable without any hardware or software failures.

Power Consumption Optimization Test:

Measure power consumption during different operational modes of the system, such as detection, decision-making, and spraying.

Evaluate the effectiveness of power-saving techniques, such as sleep modes or dynamic power scaling, in reducing energy consumption.

Monitor and record the system's power usage and battery life under different scenarios.

Integration and Communication Test:

Verify the seamless integration and communication between different components of the system, such as sensors, decision-making algorithms, and the spraying mechanism.

Conduct data exchange tests to ensure smooth and accurate data flow between the components.

Monitor the system's performance and document any issues related to integration or communication.

Test Reporting:

Document the test procedures, test results, and any issues encountered during the testing process.

Report the accuracy rates of the weed detection and crop identification models.

Provide feedback on the precision spraying mechanism's performance and its ability to avoid spraying crops.

Evaluate the system's decision-making accuracy and timeliness based on real-world scenarios.

Summarize the system's robustness, power consumption, and integration performance.

Make recommendations for improvements or further iterations based on the test results.

## Performance Outcome

Weed Detection Accuracy:

The performance outcome is measured by the accuracy of the weed detection model in correctly identifying and classifying weeds. A high accuracy rate indicates that the system can effectively detect and differentiate weeds from crops.

Crop Identification Accuracy:

The performance outcome is measured by the accuracy of the crop identification model in correctly identifying and classifying different types of crops. A high accuracy rate indicates that the system can accurately identify and classify different crops, enabling targeted spraying.

Precision Spraying Mechanism:

The performance outcome is measured by the precision spraying mechanism's ability to target and spray only the areas with detected weeds while avoiding crops.

A successful outcome indicates that the system can accurately apply pesticides to weeds, reducing crop-pesticide mixing and minimizing pesticide waste. Real-time Decision-making:

The performance outcome is measured by the system's ability to make real-time decisions based on weed detection, crop identification, and sensor data.

Effective decision-making ensures that the system can determine where and when to apply pesticides, optimizing spraying efficiency.

Robustness and Durability:

The performance outcome is measured by the system's robustness and durability in varying environmental conditions.

A robust and durable system can operate reliably in different weather conditions and withstand the challenges of agricultural environments.

Power Consumption Optimization:

The performance outcome is measured by the system's ability to optimize power consumption and minimize energy usage.

Efficient power management ensures prolonged battery life and reduces the system's environmental impact.

Integration and Communication:

The performance outcome is measured by the seamless integration and communication between different components of the system.

Successful integration and communication enable smooth data flow and coordination, enhancing overall system performance.

# My learnings

Throughout the development process of the precision weed spraying system, there are several key learnings that can be highlighted:

Problem Understanding: A clear understanding of the problem statement is crucial before designing a solution. In this case, understanding the negative impact of weed growth on crop production and the need for targeted pesticide application helped in formulating the system's objectives.

Domain Knowledge: Gaining domain knowledge in agriculture, weed identification, crop types, and pesticide application is essential for developing an effective solution. Understanding the characteristics of weeds and crops, their visual features, and the impact of pesticide application on both is crucial for accurate detection and targeted spraying.

Data Collection and Preprocessing: Collecting and preprocessing a diverse and representative dataset is key to training accurate machine learning models for weed detection and crop identification. Care should be taken to ensure the dataset captures variations in lighting conditions, weather, and weed/crop types.

Feature Extraction: Choosing appropriate features and feature extraction techniques are critical for achieving accurate weed detection and crop identification. Experimenting with different feature extraction methods and algorithms helps in identifying the most suitable approach.

Model Training and Evaluation: Proper model training, validation, and evaluation are necessary to ensure the accuracy and performance of the developed models. Utilizing techniques like cross-validation and evaluation metrics such as precision, recall, and F1-score helps in assessing the model's performance.

Hardware Integration: Integrating the weed detection models, crop identification models, sensors, and precision spraying mechanism requires careful hardware design and integration. Considering factors such as power consumption, communication protocols, and robustness are vital to ensure seamless operation.

Testing and Validation: Thorough testing and validation of the system under various real-world scenarios, environmental conditions, and crop types are crucial. It helps in identifying potential issues, fine-tuning algorithms, and validating the system's performance against the desired outcomes.

Continuous Improvement: The development of precision weed spraying system is an iterative process. Continuous learning, gathering feedback from users, and incorporating improvements based on user experience and field testing are necessary to refine the system's performance and meet user expectations.

Overall, the development process of the precision weed spraying system involves a combination of technical skills, domain knowledge, data analysis, hardware integration, and iterative improvement. The project provides an opportunity to learn and apply various concepts from machine learning, computer vision, agriculture, and system integration, contributing to a deeper understanding of solving real-world problems in the agricultural domain.

# Future Work Space

In the future, there are several potential areas for further work and improvements in the precision weed spraying system:

Enhanced Weed Detection: Explore advanced machine learning techniques, such as deep learning and convolutional neural networks (CNNs), to improve the accuracy of weed detection. These techniques can learn more complex features and patterns from the images, leading to better weed identification

Crop-Specific Detection and Spraying: Investigate the development of crop-specific models to enhance the precision spraying system's effectiveness for different crop types. Each crop may have unique characteristics, and tailoring the system to specific crops can optimize pesticide application.

Real-time Environmental Monitoring: Integrate sensors and environmental monitoring devices to capture real-time data on soil conditions, weather patterns, and weed growth. This information can be used to dynamically adjust the spraying parameters and optimize the system's performance.

Autonomous Navigation and Mapping: Develop autonomous navigation capabilities for the spraying equipment to enable precise movement through the fields. Incorporate mapping technologies, such as GPS and computer vision-based mapping, to create accurate field maps for efficient spraying operations.

Multi-Robot Collaboration: Investigate the feasibility of using multiple robots or drones working collaboratively to cover larger agricultural areas. This approach can improve efficiency and reduce spraying time by distributing the workload among multiple units.

Integration with Crop Management Systems: Integrate the precision weed spraying system with existing crop management systems or farm management software. This integration allows for seamless data exchange and coordination, enabling farmers to make informed decisions about pesticide application based on real-time field conditions and historical data.

Sustainability and Environmental Impact: Explore eco-friendly and sustainable alternatives to chemical pesticides, such as biological control methods or precision application of organic pesticides. Focus on minimizing the environmental impact of the spraying process while effectively controlling weeds.

Cost Optimization: Investigate cost-effective solutions for the precision weed spraying system, considering factors such as hardware components, maintenance, and operational expenses. Finding ways to make the system more affordable and accessible to farmers can promote widespread adoption.

Data Analytics and Decision Support: Develop data analytics and decision support tools that analyze the collected data, provide insights on weed infestation patterns, optimize spraying schedules, and support long-term crop management strategies.

Collaborative Research and Field Trials: Collaborate with agricultural researchers, farmers, and agronomists to conduct field trials and gather feedback on system performance. Continuous collaboration and feedback loops can drive further improvements and validate the effectiveness of the precision weed spraying system in real-world agricultural settings.

By focusing on these areas of future work, the precision weed spraying system can evolve to become more accurate, efficient, sustainable, and user-friendly, contributing to improved crop productivity and reduced environmental impact in agriculture.