**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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# 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 (Bhargav sir, Upskill campus, Tushar Mehra), who have helped you directly or indirectly.

Your message to your juniors and peers.

Hard work never fails. If we start learning with interest, perceiveness, have a confidence we can learn anything. There is no age limit for learning. A good learner can led his/her life with happiness as he will solve his/her own problems with suitable solution which he gain from learning.



**2 . 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**



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] Google

[2] CROP AND WEED DETECTION USING IMAGE PROCESSING AND DEEP LEARNING TECHNIQUES

Bachelor Degree Project in Production Engineering

[3] Videos provided in



## Glossary

|  |  |
| --- | --- |
| Terms | Acronym |
| Absorption | The process by which a herbicide passes from one system into another. e.g. from the soil solution into a plant root cell or from the leaf surface into the leaf cell. |
| Acid soil | Soil with a ph value <7 |
| Acropetal | Toward the apex of plant organ generally upward shoots and downward in roots. Opposite of basipetal. |
| Activation | The process by which a surface applied herbicide is moved into the soil where it can be absorbed by emerging seedlings. This is normally accomplished by rainfall, irrigation, or tillage. Activation does not imply any chemical in the active ingredient. |
| Adjuvant | Any substance in an herbicide formulation or added to the spray tank to modify herbicidal activity or application characteristics. |
| Band treatment | Applied to a linear restricted strip on or along crop rows rather than continuous over the filed area. |
| Blind cultivation | Cultivation before seeded crops emerge. |
| Bio assay | Quantitative or qualitative determination of herbicide by use of sensitive indicator plants or other biological organisms. |
| Biotic interference | The adverse effect of one organism or population in a common ecosystem on another by attracting, encouraging, or harboring one or more intermediate orgsnidmd. |
| Blind cultivation | Cultivation before seeded crops emerge. |
| Caliche | A layer near the surface, more or less cemented by secondary carbonates of CA or MG precipitated from the soil solution. It may occur as a soft then soil horizon, as a hard thick bed beneath the solum, or as a surface layer exposed by erosion. |
| Carcinogenic | Capable of causing cancer in animals. |
| Carrier | A gas, liquid, or solid substance used to dilute or usspend a herbicide during its application. |
| Chemotype | A group of organisms that produce the same profile for a particular class of chemicals such as chalcones, aurones, flavanols, etc. |
| Chiorosis | Loss of green color form foliage. |
| Chronic toxicity | The quality or potential of a substance to cause injury or illness after repeated exposure over and extended period of time. |
| Defoliant | A chemical that causes the leves to abscise from a plant |
| Desiccant | Any substance or mixture of substances used to accelerate the drying of plant tissue. |
| Dicot | Abbreviated term for dicotyledon; preferred in scientific literature over broadleaf to describe plants. |
| Diluent | Any gas, liquid or solid material used to reduce the concentration of an active ingredient in a formulation. |
| Dormancy | A loose, finely granular, or powdery condition on the surface of the soil, usually produced by shallow cultivation. |
| Edaphic | (1) Of or pertaining to the soil, (2) resulting from or influenced by factors inherent a soil or other substrate, rather than by climatic factors. |
| Emersed plant | A rooted or anchored aquatic plant adapted to grow with most of its leaf-stem tissue above the water surface and not lowering or rising with the water level. |
| Encapsulated formulation | Herbicide enclosed in capsules of material ot control the rate of release of active ingredient and thereby extend the period of activity |
| Epinasty | The stat in which more raped growth on the upper side of a plant organ or part causes it to bend or curl down ward. |
| Field capacity | The percentage of water remaining in a soil 2 or 3 after having been saturated and after free drainage has practically ceased. |
| Fined-textured soil | Consisting of or containing large quantities of the fine fractions, particularly of silt and clay. Includes clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay textural classes. Sometimes subdivided into clayey texture and moderately fine texture. |
| Green manure | A plant material incorporated into the soil while green, or soon after maturity, for improving the soil. |
| Hardpan | A hardened soil layer, in the lower A or int B horizon, caused by cementation of soil particles with organic matter or with materials such as silica, or calcium carbonate. The hardness does not change appreciably with changes in moisture content and pieces of the hard layer do no slake in water. |
| Invert emulsion | The suspension of minute water droplets in a continuous oil phase. |
| Label | The directions for using a pesticide approved as a result of the registration process. |
| Loamy soil | Intermediate in texture and properties between fine nd coarse-textured soils, includes all textural classes with the words “loam” or “loamy” as a part of the class name, such as clay loam or loamy snad. |
| Monocot | Abbreviated term for monocotyledon; preferred in scientific literature over gras to describe plants |
| Nyctinasty | A nastic movement that is associated with diurnal changes of temperature of light intensity. |
| Oncogenic | Capable of producing or inducing tumors in animals, either benign or malignant. |
| Residual herbicide | A herbicide that persists in the soil and injuries or kills germinating weed seedling for a relatively short period of time after application. |
| Residual herbicide | A herbicide that persists in the soil and injuries or kills germinating weed seedling for a relatively short period of time after application. |
| Safener | A substance that reduce toxicity of herbicide to crop plants by a physiological mechanism. |
| Susceptibility | The sensitivity to or degree to which a plant is injured by a herbicide treatment. |
| Synergist | For herbicides, a non-herbicidal compound used t increase the phytotoxicity of an herbicide by physiological mechanism. |
| Toxicology | The study of the principles or mechanisms of toxicity. |
| Teratogenic | Capable of producing birth defects. |
| Tiller or tillering | A growth stage of grasses when additional shoots are developing from the crown. |
| Xylem | The non-living tissue in plants that functions primarily to conduct water and mineral nutrients from roots to the shoot. |



# Problem Statement

In the assigned 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 for humans.

Weed plant detection is a new research problem in agricultural field which want to take help from computational science to detect unwanted growth of weed along with other crops/plants. Usually in farming when we farmers grew something due to soil property and pre available micro seeds additionally growth of weeds is there which spoil and actual outcome of farming as they affect the growth of weeds is there which spoil the actual outcome of farming as they affect the growth of planted plants. So weed detection is problem of accurately identifying the area of weeds so that specific areas can be targeted for spraying with minimum spraying on the other plants of interest. In recent years, as the world population growth, existing land and natural resources decreased, the precision agriculture is increasingly capturing more attention of the researchers. Image processing approaches could be applied to solve this problem.

# Existing and Proposed solution

Provide summary of existing solutions provided by others, what are their limitations?

Literature proposes that weeds detection method can be based on position and edge features. The weeds which are under target can easily, rapidly and accurately separated from the background. In this way we can solve many technical problems related to precise pesticide and in farmland vehicle navigations system. Usually the weeds image contains three elements of soil, crops and weeds. Therefore, the weed detection method which the literature proposed is divided in three steps, that is soil background segmentation, crop elimination and weeds extraction. The proposed approach is based on change in color of soil background, plants and crop weed pictures. These images consist of Red green and blue component. Three components (RGB) of the image are combined according to certain combination ( 2\*G-R-B) to make original image. If the image is changing gray, then the gray intensity of the green crops is increased and soil background be restrained. On the other hand, the difference of gray intensity is expanded. In this case suitable segment threshold is used. The threshold are used to segment the gray images. RGB 3-component combination method shown as follows:

F(I,j)={ 0 2G(I,j)<R(I,j)+B(I,j)

255 2.5G(I,j)-R(I,j)-B(i,j)>255

2.5G(I,j)-R(I,j)-B(i,j) other

In the formula, R(i,j), G(i,j), B(i,j) are distinguished represent the value of RGB 3-component of point (i,j). f(i,j) is the gray value after image changing gray.

After green plant is separated from soil background, the next step is to extract inter-row weeds from plant pixels. Due to the green color both the crops and weeds represent, it is difficult to separate them through color feature. There are leaf folded and occluded situation between crops and inter-row weeds, so it also have certain difficulties to identify inter-row weeds using shape or texture feature. According to the position feature that drilling crops are arranged in rows and row ledge is basically fixed, an effective approach to identify inter-row weeds of drilling crops is provided. The approach of weed detection based on position and edge feature is: Firstly, the pixel histogram method to set centerline of crop rows, through the Roberts edge detection operators the edge of crop row is marked. Then starting from the pixels of crop centerline, the pixels are determined belonging to crops or weeds through analysis according to distinguished rows both right and left, until it reaches the edge of crop row.

What is your proposed solution?

Data Collection: Gather a diverse dataset of images or videos containing both crop and weed instances in various growth stages and environmental conditions. This dataset will be used to train the detection model.

Annotation: Annotate the dataset to mark the bounding boxes or segmentation masks around each crop and weed instance. This annotation will serve as ground truth for training the model.

Deep Learning Model: Use a deep learning object detection model like Faster R-CNN, YOLO (You Only Look Once), or SSD (Single Shot Multibox Detector). These models are capable of detecting and localizing multiple objects in an image.

Transfer Learning: Pretrain the chosen object detection model on a large-scale dataset (e.g., COCO, ImageNet) to leverage learned features and improve efficiency.

Fine-tuning: Fine-tune the pre-trained model on your annotated dataset containing crop and weed images. This step helps the model adapt to the specific characteristics of your agricultural environment.

Hardware Integration: Integrate cameras or other sensors onto the spraying equipment to capture real-time images or videos of the agricultural field.

Real-time Detection: Implement the fine-tuned object detection model on the onboard computer of the spraying equipment to perform real-time detection of crops and weeds.

Decision Making: Based on the detection results, develop an algorithm to make decisions on where and when to spray pesticides. The algorithm should instruct the spraying mechanism to target only the detected weed areas while avoiding crop areas.

Safety Measures: Implement safety features to ensure that spraying occurs only when the system is confident in its detection and the equipment is appropriately positioned.

Testing and Refinement: Test the system in various agricultural fields under different conditions. Collect feedback and continuously refine the model and decision-making algorithm to improve accuracy and efficiency.

By combining deep learning-based object detection with real-time decision-making, this solution will enable targeted spraying, reducing the amount of pesticides used and minimizing the impact on crops while effectively managing weeds in the field.

What value addition are you planning?

I would like to plan

1. implementing real time crop and weed detection system can provide farmers with immediate information about the status of their fields. This enables quick decision-making and timely actions to address issues the weed infestations.

2. integrating crop and weed detection with precision agriculture technologies allows for targeted application of fertilizers, pesticides, and herbicides. This cn reduce costs and minimize environmental impact while maximizing crop yield.

## Code submission (Github link)

https://21691a31a7.github.io/UPSKILLS\_CAMPUS/

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

https://21691a31a7.github.io/UPSKILLS\_CAMPUS/

# 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.

## High Level Diagram (if applicable)

+------------------------------------+

| Crop and Weed Detection |

+------------------------------------+

| |

| |

| v

+------------------------------------+

| Image Acquisition and Preprocessing |

+------------------------------------+

| |

| |

v v

+-----------------------------+ +-------------------------+

| Crop Detection | | Weed Detection |

+-----------------------------+ +-------------------------+

| |

| |

v v

+-------------------------+

| Output and Visualization |

+-------------------------+

Figure 1: HIGH LEVEL DIAGRAM OF THE SYSTEM

## Interfaces (if applicable)

+---------------------------------+

| Crop and Weed Detection |

+---------------------------------+

| |

| |

v v

+----------------+ +----------------+

| Crop Interface| | Weed Interface|

+----------------+ +----------------+

Explanation of each component:

Crop and Weed Detection: This is the main module that coordinates the entire process of crop and weed detection. It manages the communication between different modules and oversees the overall detection system.

Crop Interface: The crop interface is a specialized interface within the crop and weed detection system that is responsible for handling crop-related functionalities. This interface interacts with the crop detection module and provides the following features:

Crop Identification: Allows users to input images or sensor data and receive information about the detected crop regions in the agricultural field.

Crop Health Assessment: Provides insights into the health status of the crops, including potential diseases, nutrient deficiencies, and growth stages.

Precision Agriculture Integration: Integrates with precision agriculture technologies to offer targeted recommendations for fertilizers and other agricultural inputs based on crop detection results.

Weed Interface: The weed interface is a dedicated interface within the crop and weed detection system that handles weed-related functionalities. This interface interacts with the weed detection module and offers the following features:

Weed Identification: Enables users to input images or sensor data and receive information about the detected weed regions in the agricultural field.

Weed Species Recognition: Identifies different weed species to provide targeted strategies for weed control and management.

Automated Weed Removal Integration: Integrates with robotic or automated systems for weed removal based on weed detection results.

The crop and weed detection system can be designed as a comprehensive platform that provides a user-friendly interface for farmers, agronomists, or agricultural researchers to access and utilize the detection results effectively. The interfaces allow users to upload images or sensor data from various sources, process the data through the detection modules, and obtain valuable information to make informed decisions about crop management and weed control strategies.

Keep in mind that the diagram provided here represents a high-level overview, and the actual implementation of the interfaces would involve detailed design and development work, integrating with hardware (such as sensors and cameras) and software components (such as image processing algorithms and machine learning models).

# 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.

## Test Plan/ Test Cases

Testing crop and weed detection systems is crucial to ensure their accuracy and reliability in real-world applications. Here are some test cases to consider:

Positive Crop Detection:

Description: Provide an image of a field with clearly identifiable crops.

Expected Outcome: The system should accurately detect and outline the crop regions in the image.

Negative Crop Detection:

Description: Provide an image without any crops.

Expected Outcome: The system should correctly identify that no crops are present in the image.

Crop Health Assessment:

Description: Input images of crops at different health stages (e.g., healthy, nutrient-deficient, diseased).

Expected Outcome: The system should be able to detect and classify the health status of the crops correctly.

Positive Weed Detection:

Description: Provide an image of a field with clearly identifiable weeds.

Expected Outcome: The system should accurately detect and outline the weed regions in the image.

Negative Weed Detection:

Description: Provide an image without any weeds.

Expected Outcome: The system should correctly identify that no weeds are present in the image.

Weed Species Recognition:

Description: Input images containing different weed species.

Expected Outcome: The system should accurately classify and identify the various weed species present in the images.

Robustness Test:

Description: Apply the system to images taken under varying lighting conditions, weather conditions, and camera angles.

Expected Outcome: The system should demonstrate consistent and accurate detection performance under different environmental conditions.

Real-Time Testing:

Description: Test the system with live video feed or continuous image stream.

Expected Outcome: The system should process and detect crops and weeds in real-time, providing timely feedback.

Precision Agriculture Integration:

Description: Integrate the system with precision agriculture technologies to provide recommendations for fertilizers and other inputs.

Expected Outcome: The system should suggest appropriate actions based on crop health and weed infestation levels.

Large-Scale Testing:

Description: Test the system on images covering a large agricultural area or from satellite imagery.

Expected Outcome: The system should scale effectively and maintain accuracy when processing data from a large area.

User Interface Testing:

Description: Evaluate the user interface for ease of use, clarity of information, and responsiveness.

Expected Outcome: The interface should be intuitive, user-friendly, and provide clear feedback on detection results.

False Positive and False Negative Analysis:

Description: Analyze cases where the system incorrectly identifies crops as weeds or weeds as crops.

Expected Outcome: The system should be optimized to minimize false positives and false negatives through continuous improvement.

Speed and Performance Testing:

Description: Measure the time taken by the system to process and detect crops and weeds in various images.

Expected Outcome: The system should demonstrate reasonable processing speed without compromising accuracy.

Remember to create additional test cases that cover specific scenarios and potential edge cases relevant to the particular crop and weed detection system being developed. These test cases will help ensure the system's robustness and effectiveness in real-world agricultural settings.

## Test Procedure

A well-structured test procedure is essential for thoroughly evaluating the performance and accuracy of a crop and weed detection system. Here's a step-by-step test procedure:

1. Test Objective:

Clearly define the objectives of the test, such as assessing the accuracy of crop and weed detection, evaluating system responsiveness, and ensuring robustness under various conditions.

2. Test Data Collection:

Gather a diverse set of test data, including images or sensor data of agricultural fields with varying crop types, growth stages, weed species, lighting conditions, and weather conditions. The dataset should cover positive and negative cases for both crop and weed detection.

3. Preprocessing:

Preprocess the test data, if necessary, to ensure uniformity and eliminate any noise or artifacts that may affect detection results.

4. Test Case Design:

Design a comprehensive set of test cases that cover different aspects of crop and weed detection. This includes positive and negative cases, edge cases, and scenarios relevant to the system's functionalities.

5. Performance Metrics:

Define the metrics for evaluating the system's performance, such as accuracy, precision, recall, F1-score, processing speed, and resource utilization.

6. Test Execution:

Execute the test cases on the crop and weed detection system using the prepared test data. Record the detection results and any relevant system outputs.

7. Evaluation:

Analyze the detection results against the expected outcomes specified in the test cases. Calculate the performance metrics to assess the system's accuracy and efficiency.

8. Robustness and Scalability:

Test the system's robustness by subjecting it to challenging conditions like varying illumination, weather changes, and different camera angles. Also, evaluate the system's scalability when processing large-scale datasets.

9. False Positive and False Negative Analysis:

Analyze the false positive and false negative cases to identify potential areas for improvement in the detection algorithm.

10. Real-Time Testing:

Test the system with live video feed or continuous image stream to evaluate its real-time processing capabilities.

11. User Interface Testing:

Evaluate the user interface for ease of use, clarity of information, and responsiveness.

12. Documentation and Reporting:

Document the test procedure, test results, and any identified issues. Generate a comprehensive test report highlighting the system's strengths and weaknesses, along with suggestions for improvements.

13. Iterative Improvement:

Based on the test results and feedback, iteratively refine the detection algorithm and system implementation to enhance accuracy and overall performance.

14. External Validation:

If possible, consider external validation by involving domain experts, farmers, or agronomists to verify the practicality and usefulness of the system in real-world agricultural settings.

It's important to conduct thorough testing at various stages of development to identify and rectify issues early on. Additionally, continuous monitoring and improvements after deployment are crucial for maintaining the effectiveness of the crop and weed detection system over time.

## Performance Outcome

The performance outcome for crop and weed detection can be evaluated using various metrics to assess the system's accuracy, efficiency, and effectiveness. Here are some key performance outcomes:

Accuracy: Accuracy measures how well the system correctly identifies crops and weeds in the given images. It is calculated as the ratio of the number of correctly identified pixels to the total number of pixels in the image.

Precision: Precision represents the ratio of true positive predictions (correctly detected crops or weeds) to the total number of positive predictions made by the system.

Recall (Sensitivity or True Positive Rate): Recall measures the system's ability to correctly detect all instances of crops or weeds in the images. It is the ratio of true positive predictions to the total number of actual crops or weeds present in the image.

F1-Score: The F1-score is the harmonic mean of precision and recall. It provides a balanced measure of the system's overall performance by considering both false positives and false negatives.

False Positive Rate (FPR): FPR represents the proportion of negative instances (pixels without crops or weeds) that are incorrectly classified as positive (crop or weed).

False Negative Rate (FNR): FNR is the proportion of positive instances (pixels with crops or weeds) that are incorrectly classified as negative.

Processing Speed: This measures the time taken by the system to process and detect crops and weeds in a given image or dataset. Faster processing speeds are preferred, especially for real-time applications.

Resource Utilization: Evaluates the system's efficiency in terms of memory usage and computational resources required for detection.

Robustness: Robustness assesses how well the system performs under various environmental conditions, such as changes in lighting, weather, or camera angles.

Scalability: Scalability refers to the system's ability to handle larger datasets or cover larger agricultural areas without compromising performance.

Weed Species Recognition Accuracy: If the system includes weed species recognition, this metric measures the accuracy of identifying different weed species correctly.

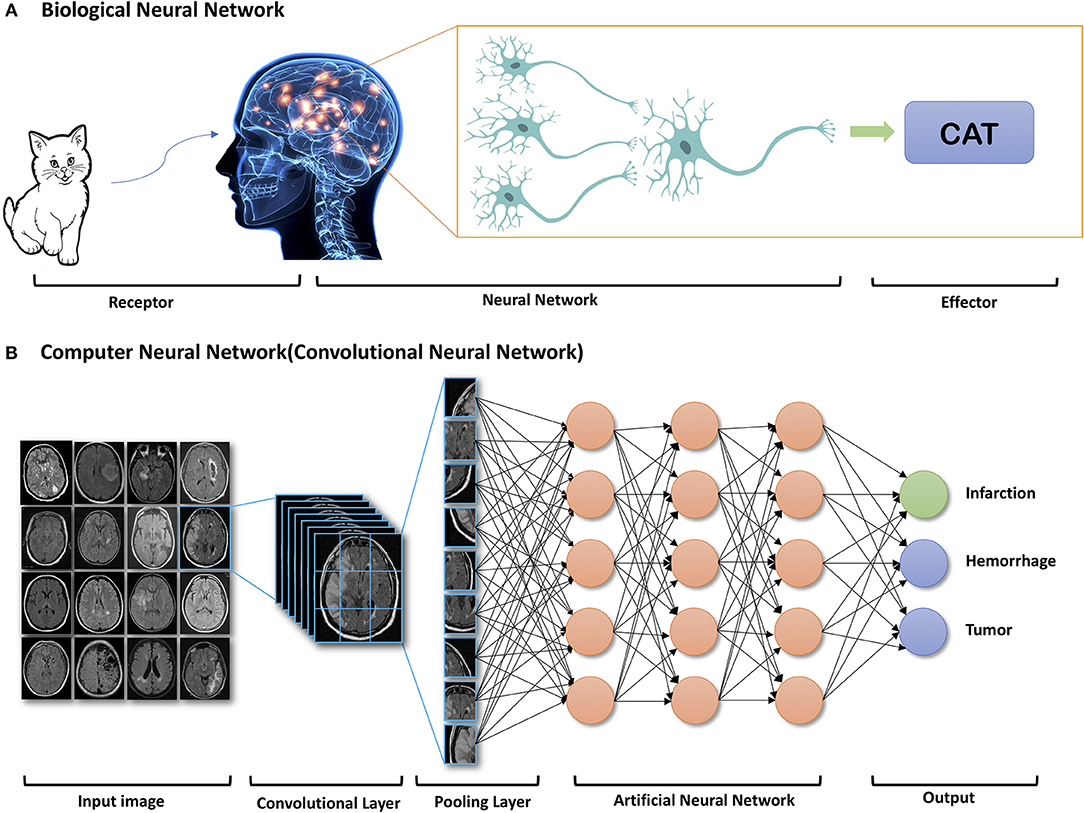
User Satisfaction: User satisfaction can be assessed through surveys or feedback from farmers or agricultural experts who use the system. It reflects the system's practicality and usefulness in real-world scenarios.

It's important to note that the performance outcomes may vary based on the specific algorithms, machine learning models, and technologies used in the crop and weed detection system. The ideal performance outcome would be a balance between high accuracy, real-time processing, and user satisfaction, ensuring that the system provides valuable insights for effective crop management and weed control in agriculture.

# My learnings

As I started with no knowledge in the domain of DS and ML. From the first days on words I started learning. I increase my knowledge day by day with new skills.

I learned about deep learning in artificial intelligence. As it is a branch of machine learning which is based on artificial neural networks. It is capable learning complex patterns and relationships within data. In deep learning, we don’t need to explicitly program everything. It has become increasingly popular due to the advances in processing power and the availability of large datasets.



[This Photo](https://www.frontiersin.org/articles/10.3389/fneur.2019.00869/full) by Unknown Author is licensed under [CC BY](https://creativecommons.org/licenses/by/3.0/)

**THE ABOVE FIGURE REPRESENTS THE STURUCTURE OF NEURONS**

Because it is based on artificial neural networks (ANNs) also known as deep neural networks (DNNs). These neural networks are inspired by the structure and function of the human brain’s biological neurons, and they are designed to learn from large amounts of data.

Deep Learning is a subfield of Machine Learning that involves the use of neural networks to model and solve complex problems. Neural networks are modeled after the structure and function of the human brain and consist of layers of interconnected nodes that process and transform data.

The key characteristic of Deep Learning is the use of deep neural networks, which have multiple layers of interconnected nodes. These networks can learn complex representations of data by discovering hierarchical patterns and features in the data. Deep Learning algorithms can automatically learn and improve from data without the need for manual feature engineering.

Deep Learning has achieved significant success in various fields, including image recognition, natural language processing, speech recognition, and recommendation systems. Some of the popular Deep Learning architectures include Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Deep Belief Networks (DBNs).

Training deep neural networks typically requires a large amount of data and computational resources. However, the availability of cloud computing and the development of specialized hardware, such as Graphics Processing Units (GPUs), has made it easier to train deep neural networks.

In summary, Deep Learning is a subfield of Machine Learning that involves the use of deep neural networks to model and solve complex problems. Deep Learning has achieved significant success in various fields, and its use is expected to continue to grow as more data becomes available, and more powerful computing resources become available**.**

**IMAGE RECOGNITION:.**

Image recognition is one of the tasks in which deep neural networks (DNNs) excel. Neural networks are computing systems designed to recognize patterns. Their architecture is inspired by the human brain structure, hence the name. They consist of three types of layers: input, hidden layers, and output. The input layer receives a signal, the hidden layer processes it, and the output layer makes a decision or a forecast about the input data. Each network layer consists of interconnected nodes (artificial neurons) that do the computation.

HOW NEURAL NETWORKS LEARN TO RECOGNIZE PATTERNS

Pattern recognition is a process of finding regularities and similarities in data using machine learning data. Now, these similarities can be found based on statistical analysis, historical data, or the already gained knowledge by the machine itself.

Before searching for a pattern there are some certain steps and the first one is to collect the data from the real world. The collected data needs to be filtered and pre-processed so that its system can extract the features from the data. Then based on the type of the data system will choose the appropriate algorithm among Classification, Regression, and Regression to recognize the pattern.

Classification. In classification, the algorithm assigns labels to data based on the predefined features. This is an example of supervised learning.

Clustering. An algorithm splits data into a number of clusters based on the similarity of features. This is an example of unsupervised learning.

Regression. Regression algorithms try to find a relationship between variables and predict unknown dependent variables based on known data. It is based on supervised learning. [2]

Features can be represented as continuous, discrete, or discrete binary variables. A feature is basically a function of one or more measurements, computed to quantify the significant characteristics of the object. The feature is one of the most important components in the Pattern Recognition system.

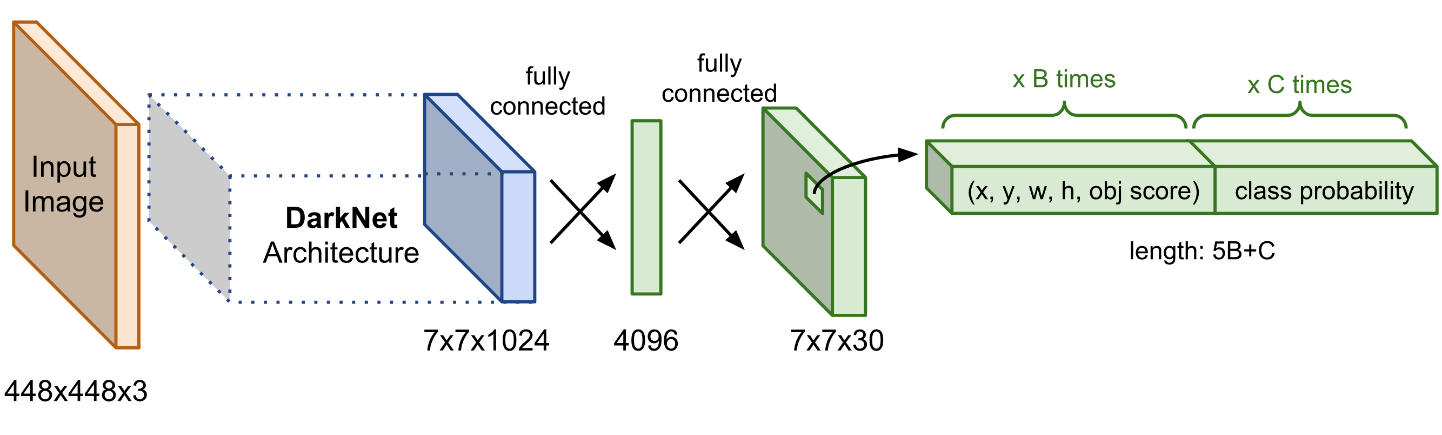
Example: consider a football, shape, size and color, etc. are features of the football.

A feature vector is a set of features that are taken together.

**I PREPARED CODE USING “YOLOV3” ALGORITHM:**

YOLOv3 (You Only Look Once, Version 3) is a real-time object detection algorithm that identifies specific objects in videos, live feeds, or images. The YOLO machine learning algorithm uses features learned by a deep convolutional neural network to detect an object

There is a ton of mathematics behind the inner working of the prediction architecture.



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Yolov3 prediction results with values above 0.1 being too large and detection accuracy is too low.

In the other versions, the way this prediction map is interpreted is that each cell predicts a fixed number of bounding boxes. Then, which ever cell contains the center of the ground truth box of an object of interest is designated as the cell that will be finally responsible for predicting the object.

# Future work scope

* Due to time limit and to balance my academics I learned only some part of image recognition and its function there are more advanced functions are there for object detection. If time permits I will like to know more things in upcoming days.