Advanced Artificial Intelligence Project

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Project: *Automated weed detection*

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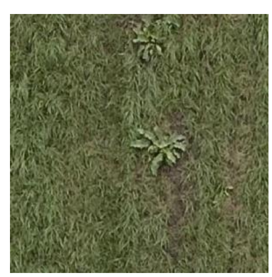
Project Overview:

This project focuses on detecting and classifying weeds in agricultural images using a deep learning approach based on the YOLO (You Only Look Once) object detection algorithm. The goal is to automate the identification of weeds in crop fields to assist farmers and agronomists in precision agriculture. The system is trained on a custom dataset of weed images and utilizes YOLOv8 for accurate and real-time detection. By integrating computer vision and deep learning techniques, this project aims to improve weed management practices and reduce the need for manual monitoring.

Dataset:

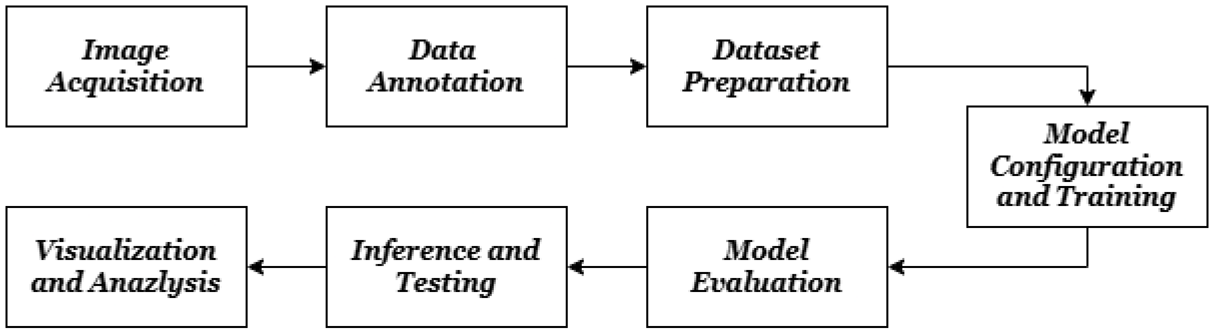
- **Content**: A varied collection of agricultural field images containing different types of weeds, annotated with bounding boxes to identify the location and type of weed present in each image.
- **Formats**: Images are primarily in JPG/JPEG or PNG format, along with annotation files in YOLO format (TXT files specifying bounding box coordinates and class labels).
- **Diversity**:
  - **Backgrounds:** Captures different soil types, lighting conditions, and crop backgrounds to improve generalization.
  - **Image Quality**: Comprises both high-resolution and lower-quality images, including occlusions, shadows, and motion blur, to simulate real-world field conditions.
  - **Annotation Format:** YOLO-formatted annotations include class IDs and normalized bounding box coordinates relative to image size.



Sequence of steps:

The following diagram represent the sequence of steps used in the project



Description of the steps:

1. **Image Acquisition**
   The process begins with acquiring input images containing weeds from a custom dataset. These images are typically collected from agricultural fields using cameras or drones and are stored in standard formats like JPG or PNG. The images are then loaded into the system using libraries like OpenCV for preprocessing and training.

2. **Data Annotation**
   Before training, each image is annotated using tools like Roboflow or LabelImg to draw bounding boxes around weed instances and assign class labels. The annotations are saved in YOLO format, which includes normalized coordinates and class identifiers.

3. **Dataset Preparation**
   The annotated dataset is split into training, validation, and testing sets. These subsets are organized according to the YOLO directory structure. A data.yaml file is created to define class names and paths to each dataset partition.

4. **Model Configuration and Training**
   A YOLOv8 model is configured using parameters such as image size, batch size, number of epochs, learning rate, and optimizer. The model is trained using the Ultralytics YOLOv8 library on the prepared dataset.

   During training:

   - Loss metrics (box loss, class loss, and objectness loss) are monitored.
   - The model weights are saved at checkpoints for evaluation.

5. **Model Evaluation**
   After training, the model is evaluated using the validation set. Key performance metrics such as:

   - Precision
   - **Recall**
   - **mAP (mean Average Precision)**

   are used to assess how well the model detects and classifies weed objects in unseen images.

6. **Inference and Testing**
   The trained model is used for inference on new or test images. YOLOv8 generates predictions by drawing bounding boxes around detected weeds and assigning confidence scores. This step validates the model's performance in real-world conditions.

7. **Visualization and Analysis**
   Detection results are visualized using bounding boxes overlaid on the original images. Plots of training/validation loss and mAP scores are generated to understand the model's learning behavior and detect any signs of overfitting.

Testing Results:

Detection result: Before

Detection result: After