EE/CprE/SE 491 - sddec23-10

Developing a Deep Learning Model to Automatically Detect Microscale Objects in Images and Videos

Week 4 Report

02/13/2023 – 02/19/2023
Client : Professor. Santosh Pandey
Group number: 10

Team Members:

Katherine Moretina
Ethan Baranowski
Chris Cannon
Matthew Kim

Past week Accomplishments

YOLO, Faster RCNN, and SSD Research- Katherine

YOLO

- Combination of region proposal algorithms and CNNs
- One stage
- SSD that uses a CNN to process an image
- Makes predictions of bounding boxes and class probabilities simultaneously
- Uses pretrained convolution layers by plugging in an averalge pooling fully connected layer
- The final fully connected layer makes predictions (class probabilities and bounding box coordinates)
- Divides image in an SxS grid
    - Each grid cell predicts bounding boxes and confidence scores for boxes
- Predicts many bounding boxes per grid
- During training, one bounding box predictor is responsible for each object
- Predictor becomes specialized in forcasting sizes, aspect rations, or classes of objects
- Non-maximum suppression is a post-processing step that can increase accuracy
- YOLO v5 uses dynamic anchor boxes to generate anchor boxes
    - Uses clustering algorithm to group ground truth bounding boxes into clusters and finds the centriod of cluster as anchor box
- YOLO v6 uses dense anchor boxes

SSD

- Also one stage
- Generally less accurate and less effective for small objects
- Two components: backbone model and SSD head
    - Backbone model usually is a pretrained image classification network for feature extraction
    - Backbone results in feature map for an input image
- Divides image into a grid and have each grid cell be responsible for detecting objects
- Each grid cell is assigned with anchor boxes
    - Predifined, and each one is responsible for a size/shape
- Uses a matching phase while training to match anchor box with bounding box of ground truth object
- The anchor box with the most overlap is responsible for preditcting object's class and location
- Zoom parameter used to specify how much the anchor box needs to be scaled wrt the grid cell
- Receptive field: the region in the input space that a particular CNN's feature is looking at

- The convolution operation allow for features of different layers represent different sizes of the region in the input image
- Apply the same feature extractor in different location in a sliding window fashion
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Fast/Faster R-CNN

- Two Stage- two passes of the image to make a prediction
    - First pass- Make initial predictions
    - Second pass- make final predictions
- Object detection model that extracts features from pre-trained CNN
- Fast R-CNN is quickly reviewed but neglects how the region proposals are generated
    - Issue solved by faster R-CNN
- 3 main steps
    - Generating region proposals
    - From each region proposal, a fixed length feature vector is extracted using image descriptors
    - Feature vector is used to assign each region proposal to either background or object classes
- Similar setup to a generic object detection pipeline
- R-CNN drawbacks
    - Multistage model, cannot train end to end
    - R-CNN depends on selective search algorithm, takes more time
    - Each region is fed independently to CNN for feature detection
        - Impossible to run real time
- ROI pooling layer splits region proposal into a grid, max pooling is applied and returns a single value
- Feature vector is as large as the number of elements in the grid

Soybean Cyst Nematode Research- Katherine

- White or yellow females on roots are the only visible sign of SCN infection

Cream-colored cysts and one nodule on soybean roots. (Sam Markell, NDSU)

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- Circular or oval shaped
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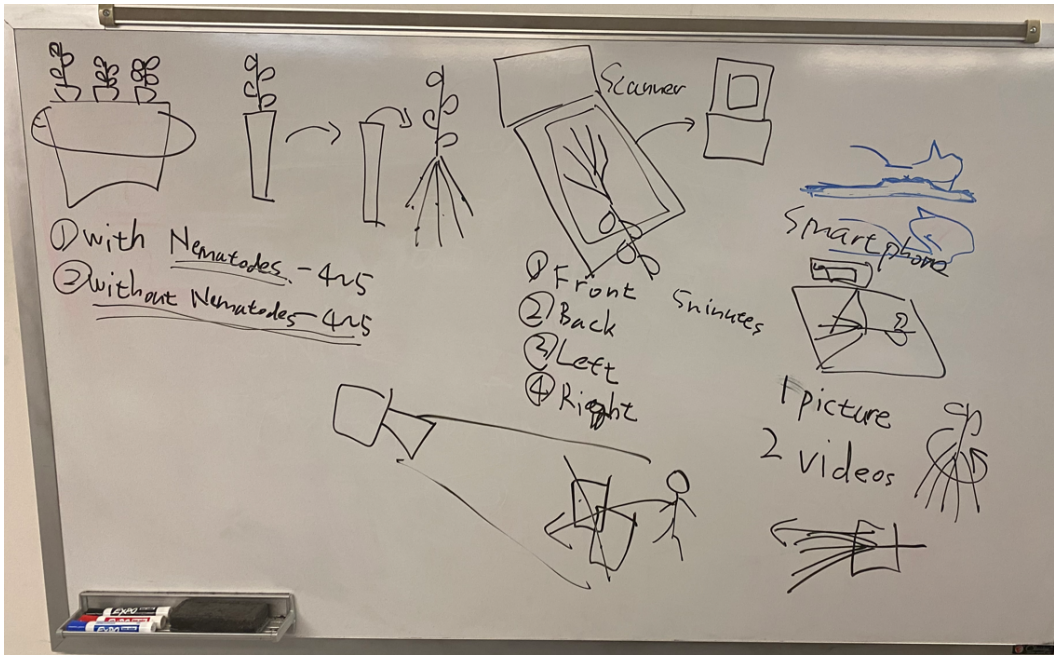
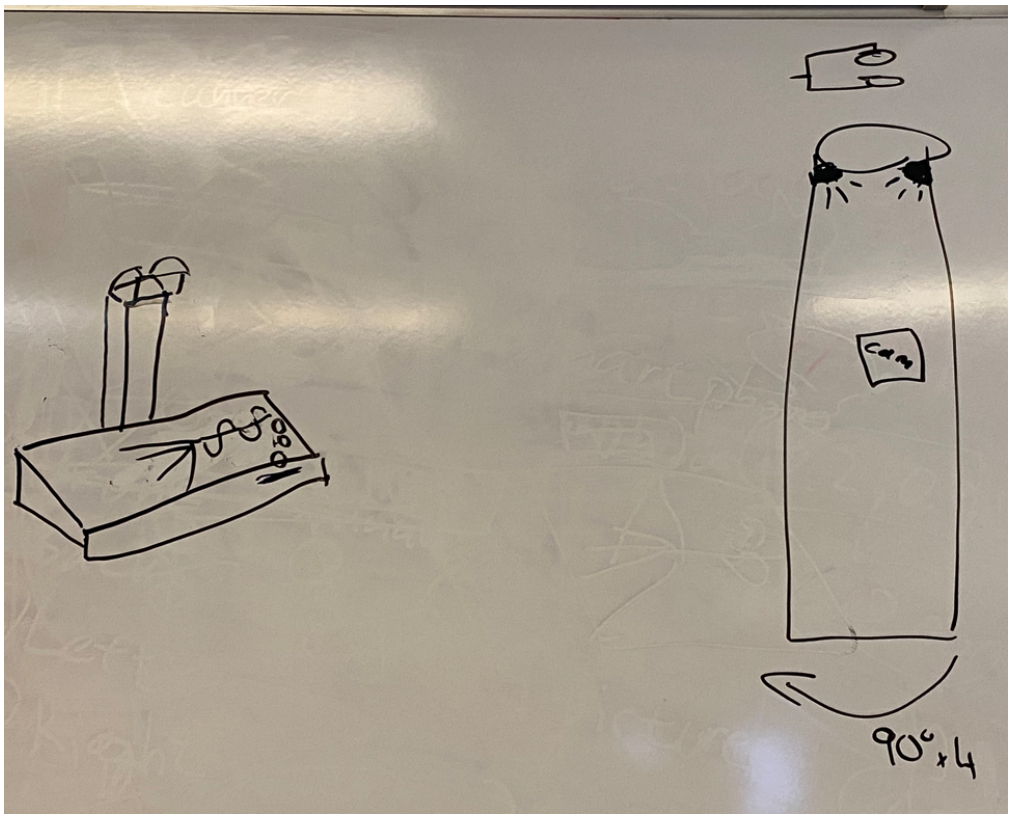
Image Processing Phase-by-Phase Diagram



Hardware System Diagram and Notes



Multiple Camera V. Single Camera

Top Down v. Standing Up.

Distance to camera from plant.

Lighting concerns

Uniform background

Canister vs platform

Clamping mechanism

- Jaws of life
- Pancake Flipper - attached to top of plant - acryllic

Individual Contributions

Member	Tasks Completed	Hours This Week	Total Hours
Katherine Moretina	Researched YOLO, Faster R-CNN, and SSD. Watched videos/read articles on cyst nematode identification. Continued to gain background on labeling methods. Attended regular meetings.	3	14
Matthew Kim	Attended regular meetings to check a phase, and further research on R-CNN and labeling tools. Also research on the labeling programs to start labeling. Also discussed hardware designs.	2	10
Chris Cannon	Attended regular meetings, tested label studio labelling software, continued background research. I also did in-depth research on YOLO, including YOLOv8	5	10
Ethan	Finished guided research task on types of machine learning algorithms. Organized regular meetings on mondays with Prof. Pandey and/or TA Yunsoo Park. Started research on different ways to label training data. Got access to image repository. Attended meetings, where Yunsoo Park	5	13

	walked us through the phases of the small object detection and discussed possible strategies.		

Plans for Coming Week

- Decide on one/multiple algorithm(s) for object detector.
- Meet with Yunsoo about soybean cyst nematode detection to start labeling pictures.
- Continue discussion on whether to implement multiple algorithms or single most applicable algorithm.
- Have Yunsoo Park walk us through coding on the lab computer.
- Setup Jupyter Notebooks server for student collaboration.