Assignment

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1. Assignment: Soybean Disease Detection Using UAV and Leaf Images

1. Dataset Exploration and Preparation

Dataset Overview:

- **Total Images**: Approximately 5,680 images.
- **Categories**:
    - **Leaf Images**: Healthy, rust, mosaic virus, septoria brown spot, frog-eye leaf spot, pest attack.
    - **UAV Images**: Healthy, rust, mosaic virus, pest attack.
- **Annotations**: Bounding boxes in YOLO format.

Preprocessing Steps: [Check research paper]

- **Image Resizing**: Resize all images to a consistent size (e.g., 640x640 pixels).
- **Normalization**: Normalize pixel values to the range [0, 1].
- **Data Augmentation**: Apply techniques like rotation, flipping, and color jittering to increase dataset variability.
- **Splitting**: Divide the dataset into training validation, and test sets. [As mentioned in research paper]

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2. Model Development

Proposed Architecture:

- **Backbone**: Utilize a Transformer-based backbone (e.g., Swin Transformer) for enhanced feature extraction.
- **Residual Connections**: Incorporate residual blocks to facilitate gradient flow and prevent vanishing gradients.
- **Multi-Scale Feature Pyramid**: Implement Feature Pyramid Networks (FPN) to detect objects at various scales.
- **Attention Mechanisms**: Integrate spatial and channel attention modules to focus on relevant features.

Loss Function:

- **Classification Loss**: Cross-entropy loss or focal loss to handle class imbalance.
- **Localization Loss**: Complete Intersection over Union (CIoU) loss for accurate bounding box predictions.

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3. Integration of Explainable AI Techniques

Chosen Technique: Eigen CAM/Grad-CAM (Gradient-weighted Class Activation Mapping)

Implementation:

1. Compute the gradients of the target class with respect to the feature maps.
2. Generate a heatmap that highlights the important regions in the image.
3. Overlay the heatmap on the original image to visualize the areas influencing the model's decision.

Purpose:

- Enhance transparency by showing which parts of the image the model focuses on.
- Assist agronomists in verifying the model's attention to relevant disease symptoms.

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4. Evaluation Metrics [Include table and all graph]

- **Evaluate your model using object detection metrics such as but not limited to included other appropriate metrics:**
    - **Mean Average Precision (mAP)**
    - **Mean Average Recall (mAR).**
    - **Precision-Recall Curve.**
    - **IoU (Intersection over Union).**
    - **F1-score for each class.**

Baseline Comparison: [Example for reference]

Model	**mAP**	**mAR**	**IoU**	**F1-Score**
YOLOv5 Baseline/other baseline architectures	0.75	0.70	0.65	0.72
Enhanced Model	0.85	0.80	0.78	0.82

(Note: Replace placeholder metrics with actual experimental results.)

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5. Write-Up Structure

1. **Introduction**:
    - Discuss the significance of early disease detection in soybean crops.
    - Introduce the dataset and its relevance to the task.
2. **Methodology**:
    - Detail the preprocessing steps undertaken.
    - Explain the model architecture and the rationale behind each component. []New architecture created how it is different from previous architectures]

    - Describe the integration of Eigen CAM/ Grad-CAM (other explainable AI techniques) and its benefits.

3. **Results**:
    - Present the evaluation metrics for both the baseline and enhanced models.
    - Include Grad-CAM visualizations to demonstrate model focus areas.
4. **Discussion**:
    - Interpret the results and compare with existing literature.
    - Highlight the advantages of the enhanced model and XAI integration.
5. **Conclusion**:
    - Summarize the findings.
    - Propose potential improvements and future directions.

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6. Submission Checklist

- **Code**:
    - Data preprocessing scripts.
    - Model training and evaluation code.
    - Eigen CAM/ Grad-CAM implementation.
- **Report**:
    - write-up as outlined above. [In research paper format]
- **Comparison Table**:
    - Performance metrics comparing the enhanced model with the baseline.

Evaluation Criteria

Criteria	Weightage (20%)
Novelty of the Architecture	
Integration of XAI Techniques	
Quality of Insights (Write-Up)	
Model Performance (Metrics)	
Code	

Guidelines:

- Focus on both technical implementation and clarity of your explanations.
- Consider how your modifications can address practical challenges in deploying the model in real-world agricultural settings.

Link:

[1] https://data.mendeley.com/datasets/hkbgh5s3b7/1

[2] https://www.sciencedirect.com/science/article/pii/S2352340925002495?utm_source=chatgpt.com

Note: Additional Dataset Option

Apart from the Soybean UAV and Leaf Image Dataset, a second dataset that can be explored is:

Source: **OPIA Maize Leaf Disease Dataset**

Description: This dataset includes images of maize (Zea mays L.) leaves captured using a camera mounted on a small unmanned aircraft system (sUAS). The dataset provides annotated images for different maize diseases, enabling researchers to build and evaluate disease detection models using aerial imagery.

Use Case: Suitable for developing models to detect diseases in maize crops using drone-based images. It can serve as a complementary dataset to test the generalizability of the proposed object detection framework across different crop types.

[1] https://ngdc.cncb.ac.cn/opia/dataset/datasets?dataId=38&utm_source=chatgpt.com