Deep Learning Course - Final Project Proposal

Transferability of photovoltaic (pv) arrays from high resolution satellite imagery data for semantic segmentation

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A.Introduction

The rapid growth of distributed solar photovoltaic (PV) arrays necessitates high-resolution data collection on their quantity and energy generation [1]. Recent advancements show that deep learning, particularly convolutional neural networks (CNN), significantly outperforms traditional methods in detecting PV arrays using high-resolution satellite imagery [2]. Additionally, domain adaptation techniques enhance the transferability of these models across different regions [3]. This project aims to develop a scalable, high-precision method for PV array detection, leveraging deep learning and domain adaptation to improve accuracy and applicability across diverse datasets.

We will use 4 semantic segmentation deep learning architectures methods that are mentioned in the paper: On the transferability of Learning Models for Semantic Segmentation for Remote Sensing Data [3]. For transfer learning and domain adaptation that are written below:

- **U-Net**: is an encoder-decoder network with skip connections designed for precise image segmentation tasks.
- **DeepLabv3+**: enhances semantic segmentation with atrous spatial pyramid pooling and a decoder module for refined results.
- **Feature Pyramid Network (FPN)**: creates a multi-scale feature pyramid to improve object detection and segmentation of various-sized objects.
- **High-Resolution Network (HRNet)**: maintains high-resolution representations and integrates multi-scale features for superior precision in segmentation and pose estimation.

B.Proposed Work And Objectives

As part of this project, our goals are:

1. To explore the different modules which are described.
2. Investigate non-trivial changes to the existing model architectures and training methods to enhance transferability further. This might include experimenting with different backbone networks or combining multiple domain adaptation strategies.
3. To compare the modules in terms of performance, training time and explainability.
4. Develop or improve and test new objective functions that could better capture the domain-specific features and improve the generalization capability of the models.

C.Code Source

Using PyTorch code in google collab environment for the implementation of this project. The code we will use and modify will be taken from:

The code is available on GitHub: GitHub Repository. (by Guixiang Zhang & Yang Tang).

D.Limitations

Our main challenge in this project is limited computational resources. Additionally, processing time and data availability may impact the efficiency and effectiveness of our models.

References

[1] Jordan M Malof, Kyle Bradbury, Leslie M Collins, and Richard G Newell. Automatic detection of solar photovoltaic arrays in high resolution aerial imagery. *Applied energy*, 183:229–240, 2016.

[2] Jordan M Malof, Leslie M Collins, Kyle Bradbury, and Richard G Newell. A deep convolutional neural network and a random forest classifier for solar photovoltaic array detection in aerial imagery. In *2016 IEEE International conference on renewable energy research and applications (ICRERA)*, pages 650–654. IEEE, 2016.

[3] Rongjun Qin, Guixiang Zhang, and Yang Tang. On the transferability of learning models for semantic segmentation for remote sensing data. *arXiv preprint arXiv:2310.10490*, 2023.