Mid-term Report: River Network Detection Project

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August 8, 2024

1 Summary of Accomplishments

1.1 Data Acquisition

- Selected appropriate Sentinel-1 data for the Amazon River Basin. Accessed relevant Sentinel-1 scenes from platforms like the Sentinels Scientific Data Hub and Copernicus web browser.
- Written a code which when given the wkt coordinates of the location, and the range of dates, it can retrieve Sentinel-1 GRD products from the Alaska Satellite Facility's website.
- The code can be used to download sentinel-1 GRD products for any location and range of dates at will, and can be used to get images for the dataset. The products downloaded can be processed using Python codes or the ESA Snap tool.

1.2 Data Pre-Processing

- Application of Orbit File to the Sentinel-1 GRD products. Conducted sensor calibration to correct for instrumental limitations.
- Reduced speckle noise through appropriate filtering techniques. Applied geometric corrections including terrain correction and geometric resampling.
- Wrote a code to get various subsets from a single product, which can be used for data augmentation, along with a code to automate the previous processes, which can also be done using the ESA Snap Tool.
- Also completed setup of the environment required to run the code.

1.3 Preliminary models and analysis

- Manipulated VV and VH bands to enhance water features. Applied thresholding techniques to segment water bodies from land.
- Started implementing algorithms for river course delineation and change detection. The first one that we implemented was K-Means Clustering, which gives acceptable results.
- Began looking into U-Net and CNN based architectures for segmentation, along with existing benchmark datasets such as S1-S2 Water Dataset, and Sen1Floods11 Datasets. Found some codes online, which we are yet to start testing.

1.4 Tools and Libraries

- Employed Python libraries for image processing (OpenCV, NumPy, SciPy, GeoPandas, Matplotlib), and automated the process of applying the aforementioned preprocessing techniques in Python.
- Utilized SNAP software for pre-processing (downloadable from ESA).

1.5 Dataset Mask Generation

1. Started work on generation of water masks for various sentinel 1 images, and also began to look into existing datasets with water masks.
2. Currently, the water masks are generated by using shapefiles on the net, which are then clipped to suit our purpose, from which we take the intersection.
3. We are looking into better shapefiles which can capture the width of the river as well, which is not captured by shapefiles currently. Only the direction of flow is captured, which renders inefficient masks.

1.6 Readings

We also looked into few of the research papers, to get to know more about the current research and progress that is happening in this domain. Most of the papers that we looked into consisted of using SAR images and doing further segmentation analysis on water bodies. Few of them also included on specialzed methods to do computation and Image processing (eg. New and improved methods of doing convolution in Neural Networks). Few of the notable research papers that we had gone through are given below:

1. Dynamic Snake Convolution [17]
2. Deep learning based semantic segmentation approach for river identification and width measurement in SAR images of Coastal Karnataka [18]
3. Water-Body Segmentation for SAR Images: Past, Current, and Future [19]
4. A Review on Multiscale-Deep-Learning Applications [20]

2 Next Steps

1. The next steps (for the post midterm period) include training models on the S1-S2 Water Dataset. We intend to use some of our techniques along with existing techniques to generate ground truths for a number of images, following which we can use data augmentation techniques to increase the size of the dataset.
2. We intend to first train some models on the Sentinel 1 data itself, using the benchmark datasets + our own images, following which we would like to look at sentinel 2 images. We aim to build upon our current progress and leverage more advanced techniques to achieve our project objectives effectively.

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