Assignment 3: Group Research Project

Title: Application of CNN Models to Remote Sensing Using Satellite Imagery

Module Weight: 70% of the Total Module Mark

Group Size: 5 Students

Submission Deadline: 28/04/2025

Project Overview

The goal of this group project is to research and develop a Convolutional Neural Network (CNN)-based solution to a specific remote sensing problem using satellite imagery. The aim is to investigate, implement, and evaluate CNN models for tasks such as classification, object detection or segmentation using satellite data. The project will involve exploring how CNN models can be applied to process, analyse, and derive insights from multi-spectral satellite images, addressing challenges such as high data volume, spatial resolution, and multi-channel data. The focus will be on designing, training, and evaluating CNN architectures for the selected task, as well as presenting the results effectively.

Key Objectives

1. **Problem Identification**: Identify a specific problem in remote sensing that can be solved using CNN models. Example topics include:
    - Land cover classification
    - Change detection (e.g., deforestation, urban expansion)
    - Crop type identification
    - Cloud masking in optical imagery
    - Disaster assessment (e.g., flood mapping, wildfire monitoring)
2. **Dataset Collection and Preprocessing**:
    - Identify and obtain a suitable satellite imagery dataset (e.g., Sentinel, Landsat, or commercial datasets).
    - Perform necessary preprocessing steps, such as normalization, augmentation, or splitting into training/validation/test sets.
3. **Model Design and Implementation**:
    - Design and implement a CNN model tailored to the selected problem.
    - Utilize baseline models (e.g., pre-trained CNN architectures such as ResNet, DenseNet, ShiftNet, SqueeseNet, etc.) or develop a custom model, if required.
4. **Evaluation**:
    - Evaluate the model using appropriate metrics (e.g., accuracy, precision, recall, IoU, etc.).
    - Assess and document the model's strengths and limitations in solving the problem.
5. **Research Contribution**:
    - Explore how the model performance could be improved, for example, through hyperparameter tuning, advanced architectures (e.g., EfficientNet, Faster R-CNN, YOLO, SSD, U-Net), or additional data augmentation techniques.

6. **Report and Presentation**:
    - Produce a detailed report summarizing the research, methodology, results, and conclusions.
    - Prepare a final presentation to communicate the findings and demonstrate the practical application of the solution.

Deliverables

1. **Research Report**
    - Maximum of 15 pages (excluding references).
    - Sections to include:
        - Abstract
        - Introduction
        - Literature Review
        - Methodology (problem definition, dataset, model design, training approach)
        - Results and Analysis (including tables, graphs, and visualizations), followed by Discussion
        - Conclusions (summarizing key points, emphasizing the significance of the findings, and providing a final perspective)
        - References
2. **Code and Documentation**
    - Submit all code, ensuring proper organization, readability, and documentation.
    - Include a `README.md` file explaining how to run the code and reproduce the results.
3. **Final Presentation**
    - A 10-minute group presentation video.
    - Content Focus: Clearly summarize the problem, methodology, key results, and potential future work.

Assessment Criteria

1. **Research and Problem Definition (15%)**
    - Clarity and originality of the problem statement.
    - Evidence of understanding the challenges in applying CNNs to remote sensing tasks.
2. **Methodology and Implementation (25%)**
    - Suitability of dataset selection and preprocessing.
    - Effectiveness of CNN model design and training approach.
3. **Results and Evaluation (20%)**
    - Quality and accuracy of results based on selected metrics.
    - Depth of analysis, including identification of limitations and improvements.
4. **Report Quality (20%)**
    - Structure, coherence, and clarity of the report.
    - Critical reflection and literature integration.
5. **Presentation and Teamwork (20%)**
    - Quality and delivery of the presentation.
    - Evidence of collaborative effort and individual contributions.

Project Timeline

- **Week 1-2**: Group formation and initial discussions
- **Week 3-4**: Problem selection, dataset acquisition and preprocessing
- **Week 5-6**: Model design and initial implementation
- **Week 7-8**: Model training and evaluation
- **Week 9**: Report writing, code documentation and presentation video preparation.
- **Week 10**: Finalisation of deliverables and submission

Support and Resources

- **Computer Classes and Lectures:** Provide foundational knowledge on CNN models, the Python-based framework **PyTorch**, and applications in **satellite remote sensing**.
- **Datasets:** Utilize platforms such as **Sentinel Hub, Google Earth Engine, or Kaggle** to access relevant satellite imagery datasets.
- **Tools:** Implement and experiment using **Google Colab, Jupyter Notebook, and other cloud-based or local development environments**.

Expectations

All group members are expected to contribute equally to the project. Peer evaluations will be considered in the final grading. Academic integrity must be upheld throughout the project. Any use of external resources must be properly cited.

AI Policy

You should not use any AI tools to create any of the gradable content/component in this assignment. However, you may use AI tools to help you check for grammatical and spelling errors. Any failure to comply with this rule will be considered as a case of plagiarism, and you will be referred to the plagiarism officer for the appropriate sanctions.