

SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

Research Proposal

Student Name	A.I.Hewarathna	Student Index Number	17APC3081
Research Topic	Deep Learning Approach For Detecting Deforestation And Predicting Highly Threatened Areas		
Supervisor(s)	Mr P.Vigneshwaran, Mr J. Charles		

Agreement

I ...A.I.Hewarathna..., willing to submit the following Proposal format and I am confirming that this topic is a novel research and I am aware of the consequences occurs in the case of plagiarism found.

.....
Signature

.....24/06/2023.....

Date

Background (max of 2 pages)

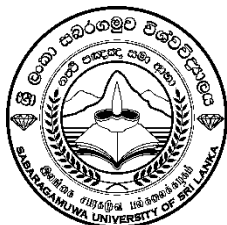
Deforestation is the permanent removal or destruction of forests or woodland regions, generally for agriculture, urbanisation, logging, or the extraction of natural resources. It is a major environmental concern with far-reaching implications for ecosystems, climate change, and biodiversity. Causes of Deforestation, One of the primary drivers of deforestation is the increase in agricultural activity, mainly commercial agriculture. For large-scale cultivation, such as cattle ranching, soybean plantations, and palm oil production, forests are frequently removed. Legal and illicit logging both contribute to deforestation. Trees are felled for their timber, which is utilized in various sectors including building, furniture, and paper manufacturing. The clearance of forests is frequently required for the development of highways, dams, mines, and other infrastructure projects. Furthermore, the expansion of metropolitan areas, as well as the demand for housing and industrial space, contribute to deforestation.

Impacts of Deforestation, A diverse range of plant and animal species can be found in forests. Deforestation degrades habitats and disturbs ecosystems, resulting in biodiversity loss. Many species, even those that are threatened, rely on forests for survival. Forests have an important part in climate regulation. Through photosynthesis, trees absorb carbon dioxide (a greenhouse gas) and emit oxygen. Deforestation increases greenhouse gas emissions, which contributes to global warming and climate change. Local populations and indigenous peoples who rely on forests for their livelihoods, food, and cultural activities may suffer as a result of deforestation. It has the potential to cause displacement, the loss of traditional knowledge, and socioeconomic instability. Tracking changes in forest cover is important for several reasons, Forests are home to a large amount of the world's biodiversity. Monitoring changes in forest cover allows us to determine how much habitat is being lost or fragmented. We can identify areas of high biodiversity value that require conservation attention and take suitable measures to safeguard fragile species by tracking these changes. Forests provide numerous ecosystem services that are critical to human well-being. Water regulation, soil conservation, pollination, nutrient cycling, and the provision of food, fuel, and medicine are examples of these services. Monitoring forest cover allows us to better understand the impact of deforestation on these services and to make more informed decisions about sustainable land use planning and natural resource management.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

Forests are inextricably related to long-term development goals such as poverty reduction, food security, and rural livelihoods. Tracking changes in forest cover allows researchers to identify areas where deforestation is occurring rapidly and where interventions are needed to encourage sustainable land use practices, strengthen governance, and assist local communities that rely on forest resources. Forests are inextricably related to long-term development goals such as poverty reduction, food security, and rural livelihoods. Tracking changes in forest cover allows researchers to identify areas where deforestation is occurring rapidly and where interventions are needed to encourage sustainable land use practices, strengthen governance, and assist local communities that rely on forest resources. The creation of early warning systems for forest fires, illicit logging, and encroachment is made possible by the timely detection of forest cover changes by satellite imaging and remote sensing. These devices can assist authorities in responding rapidly, preventing additional degradation, and enforcing forest-protection legislation. Understanding the status of our forests, their role in the environment, and their impact on human cultures requires observing changes in forest cover. It serves as a foundation for conservation initiatives, sustainable development planning, and informed decision-making to guarantee forest ecosystems' long-term health and resilience.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

Literature Review (max of 5 pages)

Sang and Nguyen Duc Minh (2018)[1] developed an approach to areal picture segmentation employing fully convolutional network architecture with ResNet101 as their backbone. In their redesigned network, they additionally used an additional upsampling skip connection. Rather than using traditional RGB (three-channel colour) photographs as input, the proposed models utilised DSM (digital surface model) and nDSM (normalized digital surface model) data. One of their primary goals is to discover a solution to the disparate appearance of artificial and natural items. Hengshuang Zhao et al. (2017) use their pyramid pooling module to investigate the capability of global context information through different-region-based context aggregation. They presented a PSPNet (pyramid scene pooling network). Their goal is to produce high-quality results while analyzing scenes.

Satyam Mohla et al. (2020)[2], AmazonNET is a neural network that extracts burn patterns from multimodal remote sensing photos. The network is made up of UNet, which is a well-known encoder decoder design with skip links that are extensively used in biomedical segmentation. To segment burn scars, the proposed framework employs stacked RGB-NIR channels. Tengfei Bao et al. (2020), The authors presented a feature pyramid module (FPM) and a global attention mechanism module (GAMM) for detecting changes in high-resolution pictures in their research article. The FPM is intended to improve the extraction of semantic information during the feature extraction process, whereas the GAMM is focused on learning image differences. The authors created a dual pyramid attention network (DPANet) specifically for supervised change detection in bi-temporal high-resolution pictures to use these modules. They trained the network with pairs of fixed-size images and obtained a binary pixel-level detection result. The authors proved that their method beats existing deep learning-based approaches and various unsupervised algorithms in terms of change detection accuracy in extended experiments utilizing diverse datasets.

Ying Chen et al. (2019)[3-15], The primary purpose of this work is to detect and localize pixel-level changes in photographs collected at the same location across time. The authors suggest an end-to-end solution based on conditional Generative Adversarial Networks (GANs). They hope to increase the accuracy of the change detection procedure by lowering the difference between the expected and predicted label distributions by using GANs. In particular, the authors employ a conditional GAN network in their research. This network has been trained to generate synthetic images that are similar to the target images. They can discover and emphasize regions where major changes have happened by comparing the generated photos to the actual images. The scientists hope to improve classification results for dense change detection in satellite pictures by using this approach. They concentrate on closing the gap between the expected and predicted distributions of labels, hence enhancing the accuracy and reliability of their change detection model.

David John and Ce Zhang (2022)[16], The authors of this paper constructed and analyzed a deep learning network named Attention U-Net. The Sentinel-2 sensor's satellite imagery was used to perform semantic segmentation. The major goal was to detect instances of deforestation in two South American forest biomes: the Amazon Rainforest and the Atlantic Forest. The authors compared the performance of Attention U-Net to that of many other deep learning models, including U-Net, Residual U-Net, ResNet50-SegNet, and FCN32-VGG16. These models were tested on three separate datasets: the three-band Amazon, the four-band Amazon, and the Atlantic Forest. The authors hoped to determine the most effective strategy for detecting deforestation in the selected forest biomes by examining and comparing the outcomes of various models. To determine the model's capacity to reliably detect deforested areas within satellite data, criteria such as segmentation accuracy, precision, and recall were assessed.

Michael Yeung et al. (Michael Yeung)[17, 18], The Focus U-Net is a new deep neural network developed by the academics behind this work. This network includes a unique module known as the Focus Gate, which integrates spatial and channel-based attention mechanisms. The goal of this module



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

is to promote selective learning of polyp-related aspects. Polyps are abnormal growths in the colon. The researchers made many architectural changes to improve the performance of the Focus U-Net. They added short-range skip connections and deep supervision, which improves information flow inside the network and promotes greater learning. In addition to the network architecture, the researchers introduced the Hybrid Focal loss, a new compound loss function. The purpose of this loss function is to address the problem of class imbalance in image segmentation tasks. It combines aspects from two existing loss functions, the Focal loss and the Focal Tversky loss, to more efficiently address the class imbalance. Overall, this work proposes a comprehensive method that incorporates attention processes, architectural changes, and a customised loss function to improve performance in polyp identification and segmentation tasks. The contributions of the researchers aim to improve the performance and accuracy of medical image analysis systems.

LU XU et al. (2019)[19], The authors of this study present a method for detecting changes in high-resolution remote sensing photos that combine pixel-level and object-level analysis. Their research aims to solve the difficulties of salt and pepper noise and false detections that are widespread in pixel-level and object-level change detection approaches, which can complicate image segmentation. To accomplish this, the scientists combine multidimensional features from high-resolution remote sensing photos with random forest classifiers to classify and identify pixel-level changes. The upgraded U-net network is then used to conduct semantic segmentation on the post-phase remote sensing image, yielding object-level segmentation findings. The next step is to combine the results of pixel-level change detection and object-level segmentation to determine the image's changing and unaffected parts. The scientists want to increase the accuracy and reliability of the change detection procedure by integrating these two levels of analysis. In summary, the authors offer a complete approach for detecting changes in high-resolution remote sensing photos that use both pixel-level and object-level information. Their solution combines feature integration, classifier-based pixel-level analysis, semantic segmentation with an enhanced U-net network, and result fusion to identify changing and unchanged areas in an image.

Kostiantyn Isaienkov et al. (2020)[20], The authors focus on using multitemporal data sources, such as Copernicus Sentinel-2, to improve monitoring capabilities of the Earth's surface and environmental dynamics, notably in forest plantations, in this study. Their mission is to detect deforestation in the forest-steppe zone. To do this, the authors present a basic U-Net model tailored exclusively for deforestation identification. They train and test the model with their own dataset, which was derived from Sentinel-2 imagery of the Kharkiv region in Ukraine, encompassing an area of 31,400 square kilometres. In addition to the baseline model, the authors propose many models that can handle time-dependent images effectively. This means that these models can use numerous sequential photos as input for the segmentation model, allowing for a more in-depth investigation of forest changes over time. The fundamental contribution of this study is the development of a baseline model for detecting forest change in Ukraine, with a special emphasis on the forest-steppe zone. Furthermore, the authors enhance the segmentation model's capabilities by including the capacity to use consecutive photos in the baseline model. Overall, the goal of this study is to enhance the field of deforestation detection by integrating multitemporal data sources and offering an improved model capable of analyzing forest changes in Ukraine's forest-steppe zone.

Katherine James and Karen Bradshaw (2019)[21], The authors of this work offer a novel way to improve the performance of picture segmentation models. They present a weight map-based loss function that tackles the issue of low confidence in the annotation at object edges. They hope to limit the detrimental impact of ambiguous annotations by down-weighting the contribution of these edge pixels to the total loss. The authors experiment with numerous combinations to discover the best design for the weight map. They perform their experiment using an aerial imaging collection focusing on vegetation, with the explicit objective of distinguishing one genus of shrub from other land cover types. The authors compare the performance of their weight map-based loss function to that of the inverse class frequency weighted binary cross-entropy loss. They discover that the weight map-based loss outperforms the binary cross-



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

entropy loss through their study. In fact, it improves the F1 score, a typical criterion for evaluating segmentation models, by 4%. Overall, the author's contribution is to provide a weight map-based loss function that effectively solves the issues of ambiguous annotations at object edges in picture segmentation tasks. Their findings illustrate the superiority of this strategy over typical loss functions, demonstrating its potential to improve the performance and accuracy of segmentation models in a variety of applications.

Fahad Lateef and Yassine Ruichek (2019)[22-34], The writers of this work suggest a detailed survey of numerous methodologies employed in a certain subject. Their primary goal is to give a systematic study of these methods by classifying them into ten distinct classes based on their underlying structures. This classification facilitates a better understanding of the common principles used in various strategies. The authors also provide an overview of the publicly accessible datasets that were utilized to evaluate various approaches. This information provides vital insights into the datasets used for performance evaluation and allows researchers to more effectively compare and duplicate results. The research also looks at the assessment matrix that is typically used to assess the accuracy of various methods. The authors offer insight into the common criteria used to analyze the performance of various methodologies by addressing this evaluation matrix. Furthermore, the authors go into individual methodologies, closely scrutinizing their designs to understand how they accomplished the given results. This examination provides insights into the inner workings of various methods and aids in identifying the critical components that contribute to their effectiveness. Finally, the authors wrap up their survey by emphasizing unresolved issues in the sector and suggesting potential remedies. By resolving these issues, researchers can pave the path for future advances in the field. Overall, this study provides a thorough review that categorizes methodologies, provides an overview of datasets, discusses assessment criteria, examines specific architectures, and tackles open issues. It is a great resource for scholars interested in understanding and improving the topic by providing a comprehensive overview of current research and identifying future paths.

Yan He et al. (2023)[35], The authors presented a data augmentation strategy for increasing the training data for forest remote sensing photos in this research. They hoped to improve the diversity and variability of the training dataset by changing the spatial distribution of these photos, which could lead to better performance of machine learning models. In addition, the authors proposed a segmentation network tailored to high-resolution forest remote-sensing photos. Their network concentrated on two major aspects: extracting multi-scale detailed features and exploiting feature information from satellite photos in the NIR (Near-Infrared) band. To address the first point, the network was designed to capture features at various scales, allowing for the extraction of fine-grained and coarse-grained information from images. This multi-scale feature extraction can help in accurately differentiating different forest sections and capturing the photos' rich characteristics. Concerning the second point, the authors stressed the relevance of adding information from satellite photos' NIR band. The NIR band has useful information on vegetation, and by combining it with the other input data, the network may obtain a better understanding of the forested areas. The scientists hoped to create a segmentation network capable of effectively identifying forest sections in high-resolution remote-sensing pictures by combining these strategies. Their contributions include a data augmentation strategy for spatial distribution modification as well as the merging of multi-scale information to boost the network's performance in forest segmentation tasks.

Yirong Yuan et al. (2023)[36] The authors of this study suggest a model for ultra-high-precision semantic segmentation. The model is divided into three sections: the local branch, the surrounding branch, and the global branch. Each branch is responsible for extracting different types of information from the supplied data. The model is built with a two-level fusion technique to achieve great precision in segmentation outcomes. The local and neighbouring branches collaborate in the low-level fusion process to acquire high-resolution fine structures in the input data. This enables the model to identify intricate details and subtle boundaries in the segmented regions with accuracy. The model gathers global



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

contextual information from downsampled inputs during the high-level fusion phase. This information gives the model a richer knowledge of the input data, allowing it to incorporate larger-scale patterns and context while segmenting. The model can make more informed judgements regarding the boundaries and interactions between distinct semantic regions by including global context. The suggested model achieves ultra-high precision in semantic segmentation due to the integration of the local, surrounding, and global branches, as well as the two-level fusion process. It captures fine-grained minutiae as well as global context, resulting in accurate and exact segmentation results. The original design of the model architecture and the implementation of the two-level fusion mechanism, which fulfils the demand for high precision in semantic segmentation tasks, are the contributions of this work. The uses local, surrounding, and global information.

Muhammad Talha et al[37], the authors propose an enhanced U-Net architecture called Attention Dense U-Net (ADU-Net) for pixel-wise classification of satellite imagery. They introduce dense decoder connections and an attention mechanism to improve the model's performance. Additionally, the authors investigate the impact of different upsampling strategies in the decoder part of the U-Net architecture. To assess the effectiveness of their proposed models, the authors conduct evaluations on the Gaofen Image Dataset (GID). This dataset focuses on landcover classification and comprises five classes: built-up areas, forests, farmlands, meadows, and water bodies. By incorporating dense decoder connections and an attention mechanism, the ADU-Net architecture aims to enhance the accuracy of pixel-wise classification in satellite imagery. The authors' evaluations on the GID dataset provide insights into the performance of their proposed models and allow for comparisons between different upsampling strategies. Ultimately, their work contributes to advancing the field of satellite image analysis and landcover classification.

Junxiao Wang et al[38], the authors introduce a novel model called the Orientation Attention Network (OANet) for accurate segmentation of ground objects in images. The OANet is designed to learn both orientation features and global semantic features to improve the segmentation performance. The authors first propose an Asymmetrical Convolution (AC) technique to capture the directional anisotropy of objects. This technique helps in understanding the orientation characteristics of objects in the image. By incorporating AC, the model gains insights into the preferred directions or orientations of different objects. Additionally, the authors develop an Orientation Attention Module (OAM) to enhance the intrinsic geometric features of objects. The OAM consists of two branches with stacked asymmetrical convolutions along the coordinate axis. This allows the model to selectively focus on features that are most relevant for accurate segmentation. The OAM dynamically adapts and chooses the features that contribute the most to the segmentation task. By combining the AC and OAM, the OANet model can effectively learn orientation features and global semantic features, which are crucial for precise segmentation of ground objects. This approach improves the model's ability to capture the geometric properties and distinctive characteristics of objects in the image, leading to more accurate segmentation results. The proposed OANet contributes to the advancement of segmentation techniques and can have potential applications in various fields, such as object recognition, scene understanding, and autonomous systems.

Xingjian Gu et al[39], In this study, the researchers explore the combination of Convolutional Neural Networks (CNNs) and Transformers, two powerful models commonly used in computer vision tasks. They propose a novel model called Adaptive Enhanced Swin Transformer with U-Net (AESwin-UNet) specifically designed for remote sensing segmentation. The motivation behind this work lies in the Transformer's ability to capture long-range dependencies in data, which can be beneficial for computer vision tasks. To leverage the strengths of both CNNs and Transformers, the researchers introduce AESwin-UNet, which adopts a hybrid Transformer-based U-shaped Encoder-Decoder architecture with skip connections. By incorporating the U-Net structure, AESwin-UNet can effectively extract both local and global semantic features from remote sensing data. This allows the model to capture fine-grained details as well as the broader context, enabling accurate segmentation of objects in the images. The



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

hybrid architecture combines the feature extraction capabilities of CNNs with the long-range dependency modeling of Transformers. This synergistic combination enhances the model's performance in remote sensing segmentation tasks, where precise identification and delineation of objects are crucial. Overall, the proposed AESwin-UNet model represents an innovative approach to remote sensing segmentation by leveraging the advantages of both CNNs and Transformers. It provides a promising direction for advancing the field and improving the accuracy of segmentation in remote sensing applications.

In this research[40], the authors introduce a new model called UNetFormer for real-time urban scene segmentation. The model combines the power of Transformers and the popular UNet architecture to achieve efficient and accurate segmentation results. To enable real-time segmentation, the authors focus on designing an efficient decoder using Transformers. The Transformer-based decoder allows the model to effectively capture complex spatial dependencies in the urban scene data. By incorporating Transformers, which are known for their ability to model long-range dependencies, the model can capture both local and global information necessary for accurate segmentation. For the encoder part of the UNetFormer, the authors select a lightweight architecture called ResNet18. This choice ensures computational efficiency while maintaining a good balance between model complexity and performance. To improve the attention mechanism of the decoder, the authors develop an efficient global-local attention mechanism. This mechanism enables the model to consider both global context and local details, ensuring accurate segmentation of urban scenes. By combining the UNet architecture with Transformers, the UNetFormer model offers real-time segmentation capabilities for urban scenes. It effectively leverages the strengths of both architectures, enabling the model to capture complex spatial dependencies and achieve accurate segmentation results. The proposed UNetFormer model represents a significant contribution to the field of urban scene segmentation, providing a promising approach for real-time segmentation with a focus on efficient global-local attention modeling.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

Gaps in Existing Research – Detailed Study (max of 2 pages)

The shortage of high-quality and adequate satellite image datasets specifically specialized for forest cover change detection and deforestation identification is one of the key issues in this research. Existing datasets may lack the essential temporal resolution, spatial coverage, or ground truth labels for accurate analysis and model training. It is critical to manage and build comprehensive datasets that represent the numerous aspects of forest cover changes at multiple sizes and time intervals, such as deforestation, reforestation, and forest degradation. The availability of such datasets will allow researchers to more effectively create and test algorithms and models, resulting in more accurate and reliable detection of forest cover changes.

Attention techniques have shown tremendous promise in recent years for increasing the performance of deep learning architectures. Integrating attention-based techniques into U-Net designs can aid in the identification of deforestation and forest cover changes by highlighting relevant geographical and temporal elements in satellite data. However, there is a research gap in investigating the applicability of attention-based U-Net architectures in the context of detecting changes in forest cover. Investigating how attention can be efficiently included into the U-Net architecture and how it improves the identification of changes in forest cover over time would lead to more accurate and reliable detection systems.

Another significant research gap is the scarcity of comparison studies evaluating various U-Net architectures, such as attention and focus-based processes, as well as lightweight models in the domains of forest cover change detection and deforestation identification. In terms of computational complexity, memory needs, and accuracy, many U-Net versions and lightweight models offer trade-offs. Understanding the differences in performance between various architectures and models is critical for picking the best method based on the specific restrictions and objectives of forest cover change detection activities. Comparative studies can shed light on each architecture's strengths and drawbacks, providing insights into their efficacy, computing efficiency, and adaptability.

Addressing these research gaps in forest cover change detection and deforestation identification would help to develop more accurate, efficient, and dependable systems of monitoring and managing forest resources. Researchers can make significant advances in the field by acquiring or curating high-quality satellite image datasets, investigating attention-based U-Net architectures with sequential images, and conducting comparative studies of various U-Net architectures and lightweight models.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

Problem Statement and Research Questions

The issue statement revolves around detecting deforestation and tracking forest cover reduction using deep learning segmentation approaches, with a focus on forecasting highly vulnerable areas of the forest that are prone to deforestation. The study intends to compare the performance of semantic segmentation methods based on the U-Net architecture, maybe with modifications, using a freshly developed benchmark satellite image dataset. The key research questions are understanding how to properly and effectively identify vulnerable forest areas, as well as studying the use of satellite image sequences to train the segmentation model. Deforestation is a major threat to the ecosystem and biodiversity, thus detecting and monitoring it is critical for conservation efforts. Deep learning-based semantic segmentation approaches provide promising answers by allowing pixel-level classification of satellite images, allowing for exact identification of deforestation and forest cover loss. The U-Net architecture, which is well-known for its efficiency in image segmentation tasks, serves as a solid foundation for our study.

The first research question focuses on forecasting forest threats. This entails creating and training a deep learning model capable of identifying regions with a high chance of deforestation. The program can distinguish between different land cover classes and identify regions where the forest is at risk by utilizing semantic segmentation approaches. This prediction can help with proactive conservation planning and intervention in crucial areas to prevent or limit deforestation.

The second research topic focuses on how to train the segmentation model using a sequence of satellite photos. The model may capture changes and trends in forest cover over time by integrating a temporal dimension, such as using photos acquired at regular intervals across time. This allows for the detection of gradual or incremental deforestation as well as the identification of regions that are regularly threatened. The study will look into the most effective ways to use sequential satellite photos to train the segmentation model and increase its prediction skills, such as employing recurrent or convolutional recurrent neural networks.

A benchmark satellite image dataset will be produced expressly for the job of deforestation detection and forest cover reduction tracking in order to evaluate the performance of several semantic segmentation approaches based on the U-Net architecture. This dataset will include high-resolution satellite photos of various forested regions, together with ground truth labels indicating deforested areas. Researchers can discover the most effective technique for properly predicting vulnerable areas of the forest and detecting deforestation by analyzing the performance of multiple variations of the U-Net design, including potential alterations or upgrades.

The project seeks to contribute to the development of robust and accurate deep learning-based systems for deforestation identification and forest cover reduction tracking by addressing these research objectives. The findings can assist environmental authorities, conservationists, and legislators make informed judgments and undertake focused actions to preserve and protect important forest ecosystems.

Research Questions:

RQ1: how to collect sequential satellite images?



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

RQ2: what are the modified U-Net architectures that will use in the study?
RQ3: how to predict highly threatened areas of forest to deforestation?
RQ4: how the model evaluation should do?



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

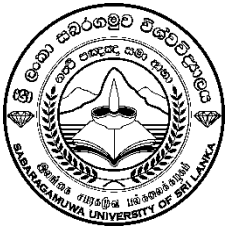
Research Objectives and Goals

To provide a methodical technique for gathering successive satellite photos (RQ1). This goal is to develop a mechanism for collecting satellite images at regular intervals, assuring enough temporal coverage and uniformity in data acquisition. The goal involves concerns for data preprocessing, picture registration, and managing time-series data in the context of detecting forest cover change and identifying deforestation. To investigate and propose improved U-Net designs appropriate for the study (RQ2). This goal entails studying potential U-Net architectural modifications and additions that can increase its efficiency in detecting deforestation and tracking forest cover decline. It seeks to find changes such as attention processes, focus-based mechanisms, or other architectural alterations that can improve the model's ability to capture essential spatial and temporal aspects.

To create predictive models that reliably identify highly endangered forest regions at risk of deforestation (RQ3). This goal focuses on training and refining deep learning models based on the modified U-Net architectures chosen. The algorithms should properly interpret satellite photos and identify places prone to deforestation, taking both spatial and temporal information into consideration. The goal is to improve the prediction accuracy and dependability of the models through feature extraction, model training, and optimization strategies. To create a suitable model evaluation framework for evaluating the performance of the produced models (RQ4). This goal is to create evaluation criteria and processes for objectively evaluating the prediction capabilities of trained models. It entails developing validation procedures, identifying acceptable performance criteria (such as accuracy, precision, and recall), and conducting comparative analyses to assess the efficacy of various modified U-Net designs in forecasting highly vulnerable forest regions.

- To provide guidelines and best practices for collecting sequential satellite images suitable for forest cover change detection and deforestation identification.
- To propose modified U-Net architectures that leverage attention or focus-based mechanisms to improve the model's ability to capture relevant spatial and temporal features.
- To develop accurate and reliable predictive models that can identify highly threatened areas of the forest prone to deforestation.
- To establish a comprehensive model evaluation framework that enables objective assessment and comparison of different modified U-Net architectures in predicting highly threatened areas of the forest.

The project hopes to contribute to the progress of deep learning-based techniques for detecting deforestation and tracking forest cover decline by achieving these research objectives and goals. The study's findings can help environmental organizations, legislators, and conservationists



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

make informed decisions and put proactive measures in place to reduce deforestation and protect endangered forest areas.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

Proposed Research Method

Data Collection

The data for this study will be gathered by utilizing Google Earth's historical image function to create a sequential image dataset covering a specified area of interest over numerous years. Google Earth's historical imagery is a significant resource for gaining access to satellite photographs recorded at various time points, allowing for the investigation of temporal changes in the chosen location. The target area, which could be a forested region or an area prone to deforestation, will be defined as the first phase in the data collection process. The researcher will determine the geographic coordinates or borders of the area and then use Google Earth's historical imaging tool to collect satellite photos captured at various time intervals. The collection can represent the temporal progression of forest cover changes and deforestation by accessing photos from different years. Following the collection of the sequential image dataset, basic image pre-processing activities will be done to assure data quality and consistency. This includes activities like a color correction to adjust for differences in lighting conditions between photos. Image augmentation techniques, such as rotation, flipping, or scaling, can also be used to improve the dataset and boost the diversity and robustness of the training samples. In addition, more precise pre-processing processes will be performed to prepare the dataset for segmentation. This entails creating ground truth labels or masks that indicate the deforested areas in the photos. These labels can be obtained through a variety of methods, including hand annotation, existing deforestation maps, and remote sensing techniques. Additional pre-processing procedures may be undertaken to normalize the picture data, address data imbalance, and apply spatial transformations unique to the segmentation task in order to train the segmentation models effectively. To standardize the photos and assure compliance with the chosen deep-learning framework, techniques such as resizing, cropping, and normalization may be used.

Methodology

This study's methodology takes a methodical approach to achieve the established research goals and objectives, which are led by a set of hypotheses. The following is an overview of the methodology:

- The study begins by explicitly stating the research goals and objectives, which include building accurate and reliable predictive models for detecting severely threatened forest zones at risk of destruction.
- Data collection, The study will collect successive satellite photos adequate for detecting forest cover change and identifying deforestation. The collecting procedure and the selection of appropriate satellite images are critical to ensuring the availability of trustworthy and relevant data for the study.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

- Pre-processing steps, Satellite images are pre-processed to improve their quality and usability for study. To assure consistency and accuracy in future analysis, pre-processing may involve tasks such as picture calibration, normalization, noise reduction, and geometric correction.
- Sets for training, validation, and testing, The pre-processed photos are separated into sets for training, validation, and testing. The training set is used to train the models, the validation set for tuning hyper parameters and evaluating model performance, and the test set for reporting final performance metrics.
- Model construction, Using the training set, models based on modified U-Net architectures are developed. This entails putting the proposed changes into action and fine-tuning the hyper parameters to improve the model's performance. The validation set is used to refine the models iteratively and identify the best-performing architecture.
- Evaluation of performance, The performance of each model is evaluated using selected metrics such as accuracy, precision, recall, or F1 score. These metrics quantify how effectively the models perform in identifying severely vulnerable forest regions at risk of deforestation.
- Model comparison, The performance of various models is evaluated in order to determine the most effective architecture. Statistical analysis is performed to identify the significance of any detected differences and the model with the best forecasting ability.
- A rigorous and systematic approach is used throughout the technique, with each stage aimed to contribute to the attainment of the study aims. The approach includes hypothesis testing, diligent data gathering, rigorous pre-processing, and extensive model construction and evaluation to ensure the study's conclusions are reliable and accurate.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

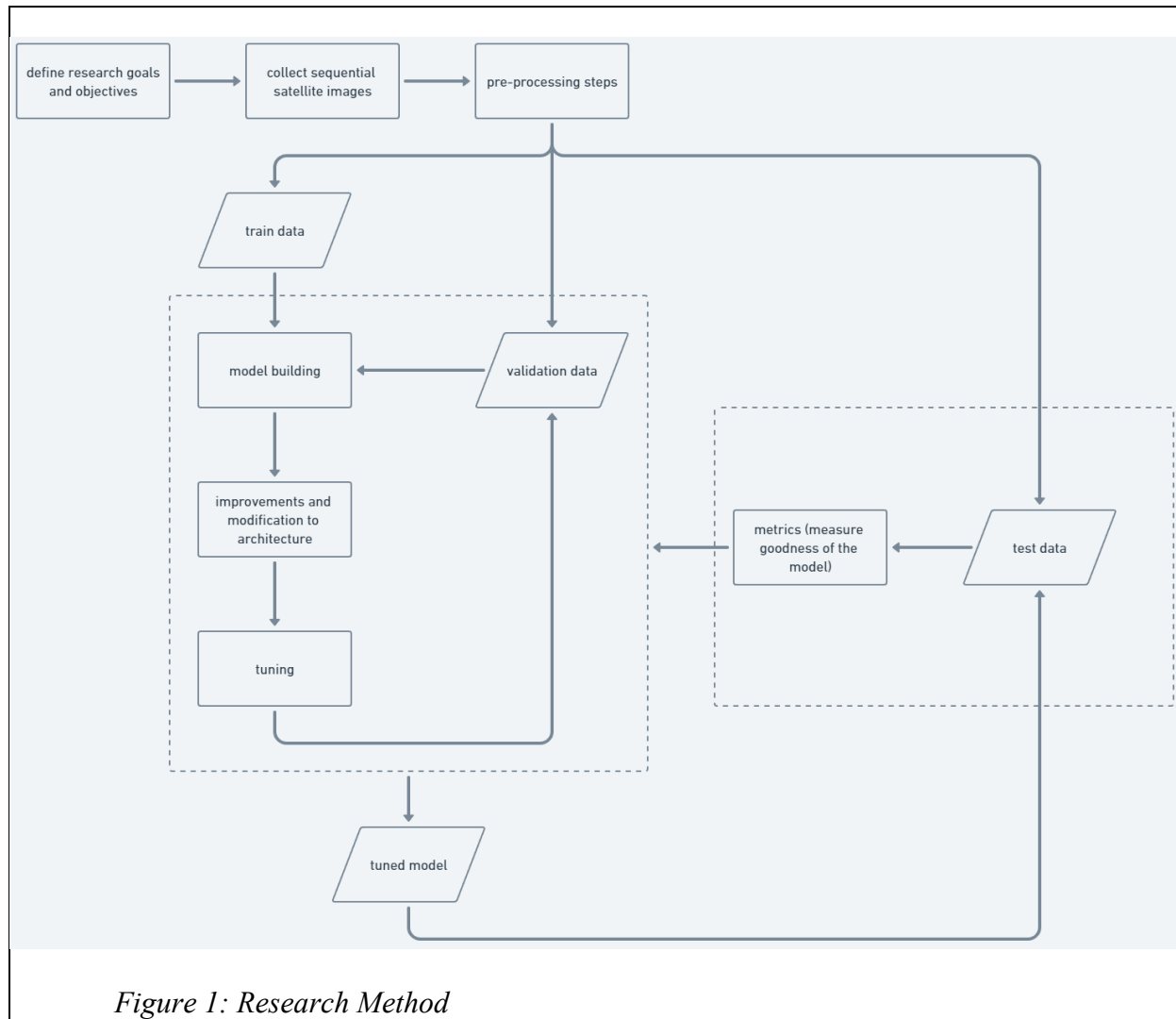


Figure 1: Research Method



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

Expected Outcome

The study's research goals concentrate on developing predictive algorithms capable of accurately identifying extremely endangered forest zones at risk of destruction. Several major variables that contribute to achieving this goal are included in the predicted outcomes. To begin, the study intends to train and refine deep learning models using modified U-Net architectures specifically designed for this purpose. These models will use both spatial and temporal information to analyse satellite images and accurately identify areas prone to deforestation. Using feature extraction, model training, and optimization procedures, the goal is to improve prediction accuracy and dependability.

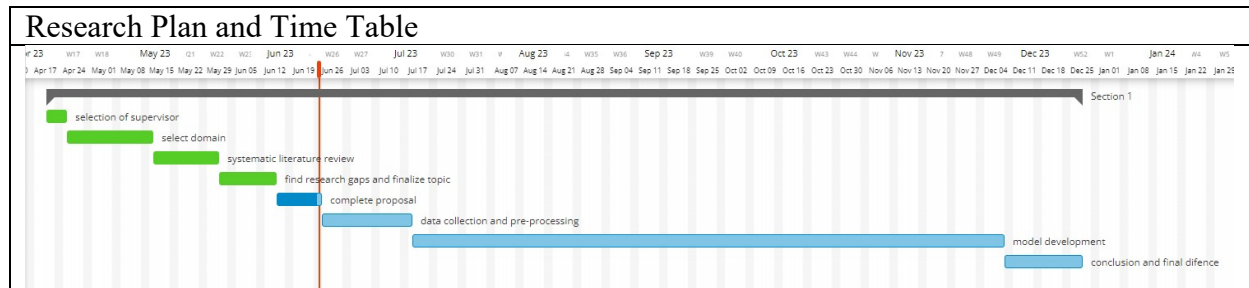
The project attempts to provide a suitable model evaluation framework in order to evaluate the performance of the produced models. This entails developing evaluation criteria and techniques to objectively analyze the trained models' prediction capabilities. Acceptable performance requirements will be specified, such as accuracy, precision, and recall. Comparative analyses will also be performed to evaluate the effectiveness of several modified U-Net designs in anticipating extremely sensitive forest zones. Furthermore, the study seeks to give standards and best practices for obtaining consecutive satellite pictures adequate for detecting forest cover change and identifying deforestation. This requires creating methods for gathering and arranging the data required to effectively train and evaluate the models. Researchers and practitioners will benefit from a consistent approach to data collection and analysis by creating these standards.

In addition, the project intends to propose improved U-Net topologies that make use of attention or focus-based techniques. These changes will increase the model's ability to collect relevant geographical and temporal characteristics, hence improving its effectiveness in identifying severely vulnerable forest areas prone to destruction. Finally, the study aims to create precise and trustworthy predictive models capable of identifying and forecasting highly vulnerable forest areas. The main goal is to achieve high accuracy and reliability in order to assure the models' effectiveness in supporting deforestation prevention and mitigation efforts. The work intends to produce a new dataset in addition to statistically analyzing several U-Net-based designs and their performance in consecutive satellite pictures. This dataset will be instrumental in training and evaluating the models, contributing to the overall outcomes of the study.

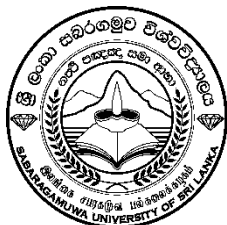
In summary, the predicted outputs of this research include the creation of accurate and trustworthy prediction models, the building of a comprehensive model evaluation framework, the publication of data-gathering recommendations, and the proposal of updated U-Net architectures. These outcomes aim to improve the identification of highly vulnerable forest regions at risk of deforestation, allowing for proactive conservation and sustainable management initiatives.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems



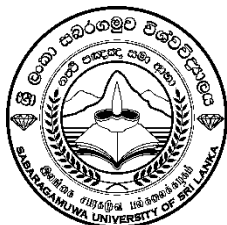
Proposed Budget



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

References (Minimum 40 Related References to the Topic) (IEEE format)

- [1] D. V. Sang and N. D. Minh, "Fully Residual Convolutional Neural Networks for Aerial Image Segmentation," presented at the Proceedings of the 9th International Symposium on Information and Communication Technology, Danang City, Viet Nam, 2018. [Online]. Available: <https://doi.org/10.1145/3287921.3287970>.
- [2] S. Mohla, S. Mohla, A. Guha, and B. Banerjee, "Multimodal Noisy Segmentation based fragmented burn scars identification in Amazon Rainforest," 2020.
- [3] Y. Chen, X. Ouyang, and G. Agam, "ChangeNet: Learning to Detect Changes in Satellite Images," presented at the Proceedings of the 3rd ACM SIGSPATIAL International Workshop on AI for Geographic Knowledge Discovery, Chicago, IL, USA, 2019. [Online]. Available: <https://doi.org/10.1145/3356471.3365232>.
- [4] J. Liu, M. Gong, K. Qin, and P. Zhang, "A Deep Convolutional Coupling Network for Change Detection Based on Heterogeneous Optical and Radar Images," *IEEE Transactions on Neural Networks and Learning Systems*, vol. 29, no. 3, pp. 545-559, 2018, doi: 10.1109/TNNLS.2016.2636227.
- [5] M. Gong, X. Niu, P. Zhang, and Z. Li, "Generative Adversarial Networks for Change Detection in Multispectral Imagery," *IEEE Geoscience and Remote Sensing Letters*, vol. 14, no. 12, pp. 2310-2314, 2017, doi: 10.1109/LGRS.2017.2762694.
- [6] Y. Chen, X. Ouyang, and G. Agam, "MFCNET: End-to-End Approach for Change Detection in Images," 2018.
- [7] L. Bruzzone and F. Bovolo, "A Novel Framework for the Design of Change-Detection Systems for Very-High-Resolution Remote Sensing Images," *Proceedings of the IEEE*, vol. 101, no. 3, pp. 609-630, 2013, doi: 10.1109/JPROC.2012.2197169.
- [8] L.-C. Chen, G. Papandreou, I. Kokkinos, K. Murphy, and A. L. Yuille, "Deeplab: Semantic image segmentation with deep convolutional nets, atrous convolution, and fully connected crfs," *IEEE transactions on pattern analysis and machine intelligence*, vol. 40, no. 4, pp. 834-848, 2017.
- [9] O. Ronneberger, P. Fischer, and T. Brox, "U-net: Convolutional networks for biomedical image segmentation," in *Medical Image Computing and Computer-Assisted Intervention—MICCAI 2015: 18th International Conference, Munich, Germany, October 5-9, 2015, Proceedings, Part III* 18, 2015: Springer, pp. 234-241.
- [10] M. Mirza and S. Osindero, "Conditional generative adversarial nets," *arXiv preprint arXiv:1411.1784*, 2014.
- [11] P. Luc, C. Couprie, S. Chintala, and J. Verbeek, "Semantic segmentation using adversarial networks," *arXiv preprint arXiv:1611.08408*, 2016.
- [12] R. Li *et al.*, "DeepUNet: A deep fully convolutional network for pixel-level sea-land segmentation," *IEEE journal of selected topics in applied earth observations and remote sensing*, vol. 11, no. 11, pp. 3954-3962, 2018.
- [13] S. Ioffe and C. Szegedy, "Batch normalization: Accelerating deep network training by reducing internal covariate shift," in *International conference on machine learning*, 2015: pmlr, pp. 448-456.
- [14] I. Demir *et al.*, "Deepglobe 2018: A challenge to parse the earth through satellite images," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops*, 2018, pp. 172-181.
- [15] J. S. Deng, K. Wang, Y. H. Deng, and G. J. Qi, "PCA-based land-use change detection and analysis using multitemporal and multisensor satellite data," *Int. J. Remote Sens.*, vol. 29, no. 16, pp. 4823-4838, 2008, doi: 10.1080/01431160801950162.
- [16] J. David and Z. Ce, "An attention-based U-Net for detecting deforestation within satellite sensor imagery," *International Journal of Applied Earth Observation and Geoinformation*, vol. 107, p. 102685, 2022, doi: <https://doi.org/10.1016/j.jag.2022.102685>.
- [17] Y. Michael, S. Evis, S. Carola-Bibiane, and R. Leonardo, "Focus U-Net: A novel dual attention-gated CNN for polyp segmentation during colonoscopy," *Computers in Biology and Medicine*, vol. 137, p. 104815, 2021, doi: <https://doi.org/10.1016/j.compbiomed.2021.104815>.
- [18] V. Mnih, "Machine learning for aerial image labeling," University of Toronto, 2013.
- [19] L. Xu, W. Jing, H. Song, and G. Chen, "High-Resolution Remote Sensing Image Change Detection Combined With Pixel-Level and Object-Level," *IEEE Access*, vol. 7, pp. 78909-78918, 2019, doi: 10.1109/ACCESS.2019.2922839.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

- [20] K. Isaienkov, M. Yushchuk, V. Khramtsov, and O. Seliverstov, "Deep Learning for Regular Change Detection in Ukrainian Forest Ecosystem With Sentinel-2," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 14, pp. 364-376, 2021, doi: 10.1109/JSTARS.2020.3034186.
- [21] K. James and K. Bradshaw, "Segmenting objects with indistinct edges, with application to aerial imagery of vegetation," presented at the Proceedings of the South African Institute of Computer Scientists and Information Technologists 2019, Skukuza, South Africa, 2019. [Online]. Available: <https://doi.org/10.1145/3351108.3351124>.
- [22] L. Fahad and R. Yassine, "Survey on semantic segmentation using deep learning techniques," *Neurocomputing*, vol. 338, pp. 321-348, 2019, doi: <https://doi.org/10.1016/j.neucom.2019.02.003>.
- [23] S. Ren, K. He, R. Girshick, and J. Sun, "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks," 2015. [Online]. Available: https://proceedings.neurips.cc/paper_files/paper/2015/file/14bfa6bb14875e45bba028a21ed38046-Paper.pdf.
- [24] S. Liu, L. Qi, H. Qin, J. Shi, and J. Jia, "Path aggregation network for instance segmentation," in *Proceedings of the IEEE conference on computer vision and pattern recognition*, 2018, pp. 8759-8768.
- [25] A. Salvador *et al.*, "Recurrent neural networks for semantic instance segmentation," *arXiv preprint arXiv:1712.00617*, 2017.
- [26] H. Fan, X. Mei, D. Prokhorov, and H. Ling, "Multi-level contextual rnns with attention model for scene labeling," *IEEE Transactions on Intelligent Transportation Systems*, vol. 19, no. 11, pp. 3475-3485, 2018.
- [27] J. Long, E. Shelhamer, and T. Darrell, "Fully convolutional networks for semantic segmentation," 2015.
- [28] G. Nanfack, A. Elhassouny, and R. O. H. Thami, "Squeeze-SegNet: a new fast deep convolutional neural network for semantic segmentation," in *Tenth International Conference on Machine Vision (ICMV 2017)*, 2018, vol. 10696: SPIE, pp. 703-710.
- [29] P. Bilinski and V. Prisacariu, "Dense Decoder Shortcut Connections for Single-Pass Semantic Segmentation," presented at the The IEEE Conference on Computer Vision and Pattern Recognition (CVPR), June, 2018.
- [30] L.-C. Chen, Y. Zhu, G. Papandreou, F. Schroff, and H. Adam, "Encoder-decoder with atrous separable convolution for semantic image segmentation," in *Proceedings of the European conference on computer vision (ECCV)*, 2018, pp. 801-818.
- [31] D. M. Vo and S.-W. Lee, "Semantic image segmentation using fully convolutional neural networks with multi-scale images and multi-scale dilated convolutions," *Multimedia Tools and Applications*, vol. 77, no. 14, pp. 18689-18707, 2018/07/01 2018, doi: 10.1007/s11042-018-5653-x.
- [32] A. Paszke, A. Chaurasia, S. Kim, and E. Culurciello, "Enet: A deep neural network architecture for real-time semantic segmentation," *arXiv preprint arXiv:1606.02147*, 2016.
- [33] T. Pohlen, A. Hermans, M. Mathias, and B. Leibe, "Full-Resolution Residual Networks for Semantic Segmentation in Street Scenes," 2017.
- [34] L. Ke *et al.*, "Segment Anything in High Quality," *arXiv preprint arXiv:2306.01567*, 2023.
- [35] Y. He, K. Jia, and Z. Wei, "Improvements in Forest Segmentation Accuracy Using a New Deep Learning Architecture and Data Augmentation Technique," *Remote Sensing*, vol. 15, no. 9, p. 2412, 2023. [Online]. Available: <https://www.mdpi.com/2072-4292/15/9/2412>.
- [36] Y. Yuan, J. Cui, Y. Liu, and B. Wu, "A Multi-Step Fusion Network for Semantic Segmentation of High-Resolution Aerial Images," *Sensors*, vol. 23, no. 11, p. 5323, 2023. [Online]. Available: <https://www.mdpi.com/1424-8220/23/11/5323>.
- [37] T. Muhammad, A. B. Farrukh, G. Sajid, and Z. Hamza, "ADU-Net: Semantic segmentation of satellite imagery for land cover classification," *Advances in Space Research*, 2023, doi: <https://doi.org/10.1016/j.asr.2023.05.007>.
- [38] W. Junxiao, F. Zhixi, J. Yao, Y. Shuyuan, and M. Huixiao, "Orientation Attention Network for semantic segmentation of remote sensing images," *Knowledge-Based Systems*, vol. 267, p. 110415, 2023, doi: <https://doi.org/10.1016/j.knsys.2023.110415>.
- [39] G. Xingjian, L. Sizhe, R. Shougang, Z. Hengbiao, F. Chengcheng, and X. Huanliang, "Adaptive enhanced swin transformer with U-net for remote sensing image segmentation," *Computers and Electrical Engineering*, vol. 102, p. 108223, 2022, doi: <https://doi.org/10.1016/j.compeleceng.2022.108223>.



SABARAGAMUWA UNIVERSITY OF SRI LANKA
FACULTY OF COMPUTING
DEPARTMENT OF COMPUTING & INFORMATION SYSTEMS
BSc DEGREE PROGRAMME IN COMPUTING AND INFORMATION SYSTEMS
IS 42853 Research Project in Information Systems

- | | |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [40] | W. Libo <i>et al.</i> , "UNetFormer: A UNet-like transformer for efficient semantic segmentation of remote sensing urban scene imagery," <i>ISPRS Journal of Photogrammetry and Remote Sensing</i> , vol. 190, pp. 196-214, 2022, doi: https://doi.org/10.1016/j.isprsjprs.2022.06.008 . |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Any Other Relevant Information