

### Mukesh Patel School of Technology Management & Engineering

**Log Book for Capstone Project**

**Department :** IT

**Program :** B.Tech

**Semester :** 7th

**TITLE OF THE PROJECT :** Skin Lesion Segmentation Using Deep Learning

Name of the Faculty Mentor: Prof. Pravinkumar Landage

**STUDENT DETAILS**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **NAME** | **ROLL NO.** | **CONTACT** |
| **Student 1** | Khushi Patil | A216 |  |
| **Student 2** | Anannya Londhe | A242 |  |
| **Student 3** | Pallavi Dangane | A246 | 9022893656 |

Name of group members:

|  |  |  |  |
| --- | --- | --- | --- |
| **Roll No.** | **Name** | **Sign(Students)** | **Grades(By Faculty Mentor)** |
| A216 | Khushi Patil |  |  |
| A242 | Anannya Londhe |  |  |
| A246 | Pallavi Dangane |  |  |
|  |  |  |  |

|  |
| --- |
| Week No: 1 |
| Date of Reporting: |
| From 18/07/2024 to 24/07/2024 |
| Work carried out: |
| The first week was dedicated to selecting a meaningful and impactful topic for our capstone project. After exploring several ideas, we decided to focus on "Skin Lesion Segmentation Using Deep Learning." This topic addresses an important need in dermatology for reliable and accessible diagnostic tools, especially for early detection of skin cancer, where accurate identification of lesions can significantly improve patient outcomes. With this in mind, we set the project’s core objective: to develop a deep learning model capable of accurately segmenting skin lesions from images, ultimately supporting early diagnosis and aiding healthcare professionals.  To ensure an organized approach, we defined clear goals and broke down the project into specific phases, each with targeted milestones. We assigned roles within the team according to each member’s expertise, allowing us to utilize individual strengths effectively. The initial planning phase involved creating a timeline for each project stage, dividing tasks into weekly objectives to keep the project on track. Additionally, we identified essential software resources, including Python and relevant deep learning libraries like TensorFlow and Keras, which would be instrumental in developing and implementing the model.  Toward the end of the week, we scheduled a meeting with our project supervisor to discuss our approach, confirm the scope, and gather feedback on our plan. This initial consultation helped refine our objectives and provided a strong foundation for moving forward. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 2 |
| Date of Reporting: |
| From 25/07/2024 to 31/07/2024 |
| Work carried out: |
| In the second week, our focus was on understanding the foundational research surrounding skin lesion segmentation and gathering relevant data for our project. We began by conducting an in-depth review of research papers on skin lesion segmentation, examining various approaches and the common challenges faced in this field. This review helped us gain insights into the importance of segmentation in early skin cancer detection and familiarized us with current trends in deep learning models used for medical image analysis. We identified key challenges in lesion segmentation, such as variations in lesion shape, color, and boundary precision, and explored the metrics typically used to evaluate segmentation models, including the Dice Coefficient and Intersection over Union (IoU).  Alongside the literature review, we acquired the PH2 dataset, which is frequently used in segmentation research due to its high-quality, annotated dermoscopic images. Our goal this week was not yet to dive into specific model architectures but to understand the dataset’s structure and requirements. We reviewed sample images to get a sense of the dataset’s complexity and the types of lesions it includes. This initial data exploration allowed us to outline essential preprocessing tasks, such as resizing and normalization, which would later help standardize the inputs.  This week provided a deeper theoretical understanding of our project’s objectives and informed our approach to dataset preparation. We also discussed our findings with the project supervisor, who offered valuable insights on the data and research direction, setting the stage for model implementation in the coming weeks. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 3 |
| Date of Reporting: |
| From 01/08/2024 to 07/08/2024 |
| Work carried out: |
| In the third week, we focused on securing the dataset that would serve as the foundation for our project. After reviewing various options, we selected the PH2 dataset, a widely recognized resource in medical imaging research, specifically curated for skin lesion analysis and melanoma detection. This dataset provides high-resolution dermoscopic images with expert annotations, making it highly suitable for training and evaluating segmentation models.  Once we acquired the dataset, we examined its structure to understand the range of lesion types and the quality of annotations provided. Reviewing sample images helped us identify potential challenges, such as the variability in lesion shapes, colors, and borders, all of which could impact the segmentation accuracy. We also checked the consistency and resolution of the images to ensure compatibility with our planned preprocessing steps and model requirements.  With the dataset in hand, we began outlining a preprocessing plan tailored to the dataset's specific characteristics. This plan included steps like resizing to a standard input size, applying normalization to stabilize pixel values, and performing data augmentation to enhance diversity. These preprocessing techniques would allow us to standardize the data, helping the model generalize better to different lesion characteristics. By the end of the week, we had a comprehensive preprocessing pipeline ready, setting the stage for model implementation in the following weeks. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 4 |
| Date of Reporting: |
| From 08/08/2024 to 14/08/2024 |
| Work carried out: |
| In the fourth week, we focused on securing the dataset that would serve as the foundation for our project. After reviewing various options, we selected the PH2 dataset, a widely recognized resource in medical imaging research, specifically curated for skin lesion analysis and melanoma detection. This dataset provides high-resolution dermoscopic images with expert annotations, making it highly suitable for training and evaluating segmentation models.  Once we acquired the dataset, we examined its structure to understand the range of lesion types and the quality of annotations provided. Reviewing sample images helped us identify potential challenges, such as the variability in lesion shapes, colors, and borders, all of which could impact the segmentation accuracy. We also checked the consistency and resolution of the images to ensure compatibility with our planned preprocessing steps and model requirements.  With the dataset in hand, we began outlining a preprocessing plan tailored to the dataset's specific characteristics. This plan included steps like resizing to a standard input size, applying normalization to stabilize pixel values, and performing data augmentation to enhance diversity. These preprocessing techniques would allow us to standardize the data, helping the model generalize better to different lesion characteristics. By the end of the week, we had a comprehensive preprocessing pipeline ready, setting the stage for model implementation in the following weeks. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 5 |
| Date of Reporting: |
| From 15/08/2024 to 21/08/2024 |
| Work carried out: |
| In the fifth week, we decided on the primary models for our skin lesion segmentation project: U-Net and Fully Convolutional Networks (FCN). After reviewing several model architectures, we selected these two due to their strong performance in medical image segmentation tasks, specifically their ability to handle the pixel-level precision required for accurate lesion boundary delineation.  We focused on understanding the architectural strengths of both models. U-Net, known for its encoder-decoder structure with skip connections, allows for high-resolution segmentation, making it particularly effective for capturing fine details in skin lesion images. FCN, on the other hand, is efficient at handling image segmentation by transforming fully connected layers into convolutional layers, which aids in preserving spatial information throughout the process.  By the end of the week, we outlined initial configurations for both models, setting up the groundwork for implementing and fine-tuning them in the coming weeks. This decision marks a crucial step forward in our project, aligning our methodology with the project’s objectives of achieving high segmentation accuracy on the PH2 dataset. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 6 |
| Date of Reporting: |
| From 22/08/2024 to 28/08/2024 |
| Work carried out: |
| In the sixth week, we focused on implementing the Fully Convolutional Network (FCN) model for skin lesion segmentation. As we began fine-tuning various hyperparameters, including learning rate, batch size, and the number of epochs, we noticed that the training process was taking longer than expected. To address this, we consulted our supervisor, who suggested decreasing the batch size to allow for faster convergence and more effective learning over a greater number of epochs. Following this guidance, we adjusted the batch size and resumed training, which improved the model’s efficiency without compromising performance.  We also refined our data augmentation techniques to introduce more variations in lesion shapes and appearances, enhancing the model's ability to generalize across diverse lesion characteristics. By the end of the week, we had an optimized FCN model configuration that showed promising initial results, setting the stage for further evaluations and improvements. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 7 |
| Date of Reporting: |
| From 29/08/2024 to 04/09/2024 |
| Work carried out: |
| In the seventh week, we implemented the U-Net architecture for skin lesion segmentation. We began by defining the U-Net model structure in Python, focusing on essential components such as the encoder-decoder paths and skip connections, which enable high-resolution segmentation by preserving spatial details across layers.  The model was configured to accept RGB images as input and produce binary segmentation masks that identify lesion areas. Within this setup, we implemented convolutional blocks to capture intricate spatial features critical for accurate segmentation. Skip connections were also integrated to retain fine-grained details during the upsampling process, which helps in maintaining precise boundary detection in the segmented output.  Key parameters, including learning rate, batch size, and optimizer type, were initialized following best practices in segmentation tasks. We compiled the model using the Adam optimizer and Dice loss function to enhance focus on overlap between the predicted and ground truth masks. Finally, we established a testing framework to evaluate the U-Net’s performance, preparing the model for training and further experimentation in the upcoming weeks. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 8 |
| Date of Reporting: |
| From 05/09/2024 to 11/09/2024 |
| Work carried out: |
| In the eighth week, we concentrated on validating the U-Net model’s performance by conducting accuracy checks with a reserved portion of the dataset. This validation setup allowed us to objectively evaluate the model on unseen data and ensure its robustness. We measured key accuracy metrics, including Dice Coefficient, Intersection over Union (IoU), precision, recall, and overall accuracy, to assess the model’s segmentation effectiveness.  To improve segmentation accuracy in areas with fine details, we refined boundary processing techniques and tracked the model’s performance across multiple validation runs. We also experimented with adjusting batch sizes and validation split ratios, observing how these changes impacted validation accuracy. By the end of the week, we compiled the results into a summary report, which will serve as a basis for further evaluation and feedback. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 9 |
| Date of Reporting: |
| From 12/09/2024 to 18/09/2024 |
| Work carried out: |
| In the ninth week, we conducted a comprehensive comparison between the U-Net and FCN models to evaluate their effectiveness in skin lesion segmentation. We extended testing across a diverse range of images from the dataset to assess each model’s consistency and accuracy across different lesion types. Segmented outputs were compared with ground truth masks, and we closely analyzed how each model handled varying lesion shapes and textures.  We paid particular attention to challenging cases with irregular lesion boundaries to better understand the models’ limitations. For each test image, we calculated performance metrics—including Dice Coefficient, IoU, precision, recall, and accuracy—to build a comprehensive accuracy profile for both models. Documenting common error patterns helped us identify areas where each model could be further refined. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 10 |
| Date of Reporting: |
| From 19/09/2024 to 25/09/2024 |
| Work carried out: |
| In the tenth week, we focused on the final evaluation of the U-Net and FCN models based on key performance metrics. We recalculated metrics such as Dice Coefficient, Intersection over Union (IoU), precision, and recall to obtain accurate, finalized results for each model. This comprehensive metric analysis allowed us to determine which model performed best overall for skin lesion segmentation.  We also conducted a comparative analysis to assess improvements in segmentation accuracy achieved through previous training and adjustments. Particular attention was given to boundary precision, as accurate delineation of lesion edges is critical in medical imaging. All final metrics were meticulously logged and documented in tabular form for inclusion in the project report.  Following these evaluations, we reviewed the results with our supervisor to confirm the model’s readiness for practical application. With the model performance validated, we initiated steps to prepare for deployment, ensuring the model’s reliability and effectiveness for real-world use. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 11 |
| Date of Reporting: |
| From 26/09/2024 to 02/10/2024 |
| Work carried out: |
| In the eleventh week, we began working on a graphical user interface (GUI) to support the deployment of our model, aiming to create an accessible and user-friendly experience. We explored different design options and frameworks suitable for a smooth interface, focusing on a layout that would allow healthcare professionals to easily interact with the model and view segmentation results.  We concentrated on initial setup and basic functionality, including setting up image upload features and defining a preliminary layout for displaying segmentation results. Testing across multiple platforms was also initiated to ensure compatibility, with further refinements planned as we progress with the GUI development.  This week’s work marked the beginning of the GUI implementation, which will continue to evolve in the coming weeks as we work toward a complete, polished interface. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 12 |
| Date of Reporting: |
| From 03/10/2024 to 09/10/2024 |
| Work carried out: |
| In the twelfth week, we focused on the final testing and validation phases to ensure the model's robustness and readiness for deployment. We conducted comprehensive testing on the complete dataset, evaluating the model’s performance across various lesion shapes, skin tones, and edge cases to confirm its consistency and reliability.  We recalculated all key performance metrics, including Dice Coefficient, IoU, precision, and recall, to verify final accuracy levels. Additionally, we documented any residual errors and limitations observed during testing for future reference. Cross-validation was performed to check for overfitting, ensuring that the model generalizes effectively across different data subsets.  The week concluded with a final review session with our supervisor, who approved the project for completion, marking it ready for reporting and documentation. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 13 |
| Date of Reporting: |
| From 10/10/2024 to 16/10/2024 |
| Work carried out: |
| In the thirteenth week, we focused on adjusting the model's hyperparameters, such as learning rate, batch size, and dropout rates, in order to balance overfitting and underfitting. After a series of controlled tests, we observed improvements in the model's generalization capability, particularly on challenging lesion images where boundaries were difficult to distinguish.  We also conducted a thorough comparison of the model’s segmentation results with ground truth masks and performed a detailed error analysis. This enabled us to identify specific lesion characteristics (like size, texture, and irregular borders) where the model’s performance varied. Based on these findings, we made targeted adjustments to the model’s architecture, particularly in the convolutional layers, to improve its precision for these complex cases.  By the end of the week, our model showed enhanced stability and reliability across multiple datasets, laying a strong foundation for the final testing phase in the coming weeks. Documentation was updated to reflect all modifications and test results, ensuring a comprehensive record of our progress. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 14 |
| Date of Reporting: |
| From 17/10/2024 to 23/10/2024 |
| Work carried out: |
| In the fourteenth week, we focused on drafting the final project report and documenting the results. We began by outlining the structure of the report, ensuring a clear and logical flow between sections. Key sections included an introduction, methodology, results, error and limitation analysis, and a future scope outline.  The methodology section was carefully documented, detailing each phase of the project, including data preprocessing, model training with U-Net and FCN, and the design of the graphical user interface (GUI). We also compiled quantitative results, visual outputs, and example images to showcase the model’s performance and illustrate how it handled different types of lesions.  In the error and limitation analysis section, we documented any model limitations and potential sources of error observed during the testing phases, helping to set realistic expectations for future improvements. We also outlined potential future directions, such as expanding the dataset or refining the model for use in other medical imaging applications.  The draft report was reviewed by the team, ensuring all sections were clear and complete. Supervisor feedback was integrated into the document to enhance its quality and coverage of technical details, setting the stage for final submission in the coming weeks. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |

|  |
| --- |
| Week No: 15 |
| Date of Reporting: |
| From 24/10/2024 to 30/10/224 |
| Work carried out: |
| In the fifteenth week, we focused on finalizing the project report and preparing the presentation for project submission. We conducted a thorough review of the final report, ensuring that all sections were accurate, coherent, and aligned with the project's objectives. The report was carefully examined for clarity and completeness before submission to the project supervisor.  Alongside the report, we developed a presentation that summarized the key aspects of the project, including the goals, methodology, key findings, and contributions. We designed a visually engaging slide deck, incorporating charts, diagrams, and images of the segmentation results to enhance the presentation and aid in explaining the work.  To ensure smooth delivery, we practiced the presentation with team members, refining timing, clarity, and our responses to potential questions. Once the report was finalized and reviewed, we submitted it to the supervisor. The presentation was then delivered, emphasizing the project’s impact, the accuracy of the model, and its potential applications in dermatology.  Finally, we reflected on the entire project, documenting lessons learned and considering potential avenues for future exploration. This week marked the completion of the project, setting the stage for final submission and evaluation. |
| Faculty Remark |
|  |
| Faculty Signature with date |
|  |