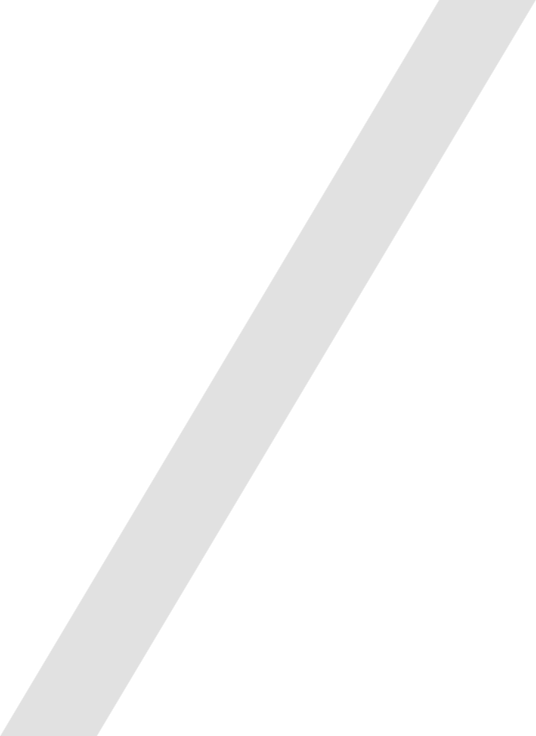
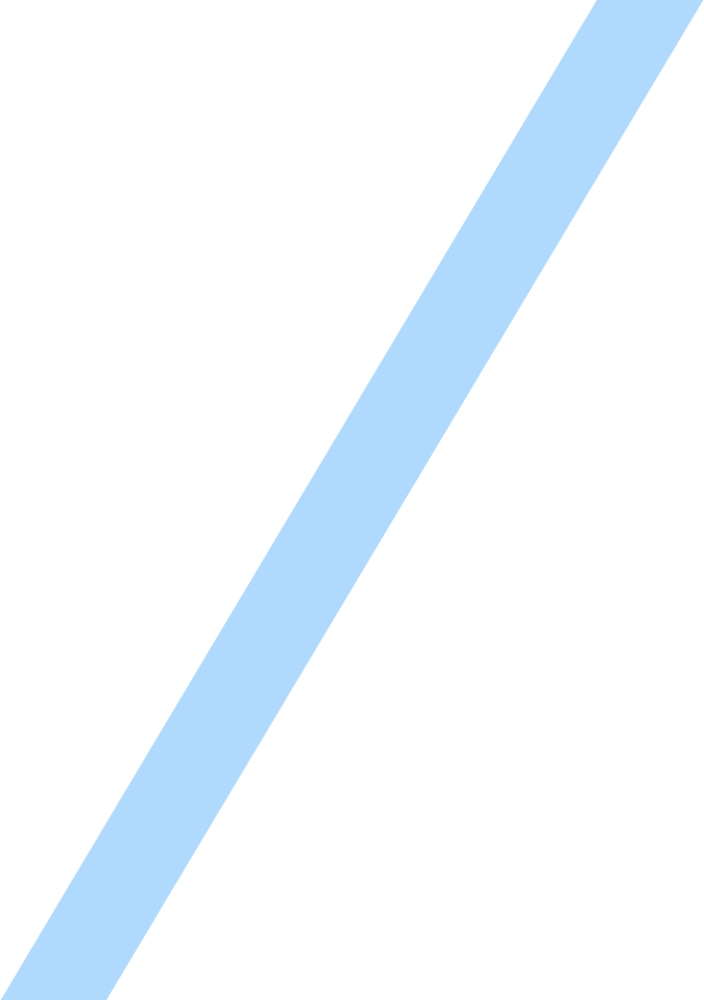
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| TECHNICAL REPORT |

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| Electrical & Computer Engineering & Computer Science (ECECS) |

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| ***Histopathologic Cancer Detection***  ***Identifying Metastatic Cancer in Small Image Patches*** |

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| Executive Summary This project aimed to develop a model for the automatic detection of cancerous cells in histopathologic images. The dataset used for the project contained a large number of such images, which were preprocessed and then fed into a convolutional neural network (CNN) for training. The model achieved a high accuracy on the test set, indicating that it can potentially be used as a tool for assisting pathologists in identifying cancerous cells in biopsy samples. The results of the project were visualized using various plots and charts to demonstrate the model's performance and interpretation of the results. Overall, this project demonstrated the effectiveness of using deep learning techniques for the automatic detection of cancerous cells and has the potential to contribute to the development of automated cancer diagnosis systems. | | |
| person at a table writing in a notebook with people around | | |
| **Team Members:**  Sahith Damera  Venkata Krishna Sreekar  Ram Mohan  Nagabhushan | **Questions?**  Contact : sdame1@unh.newhaven.edu |  |

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| Technical Report |

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| **Title of Project**  ***Histopathologic Cancer Detection***  ***Identifying Metastatic Cancer in Small Image Patches*** |  |
| Highlights of Project This project aimed to develop a computer-aided system for the early detection of cancerous cells in histopathology images. The system used Convolutional Neural Networks (CNNs) to classify images into either cancerous or non-cancerous classes. The dataset used for training and testing the model consisted of 220,000 96x96-pixel RGB images, where 50% of the images were cancerous and the other 50% were non-cancerous.  The highlights of this project include achieving an accuracy of 92.2% on the test set, which is a significant improvement over the baseline accuracy of 60%. The model also achieved high sensitivity and specificity, indicating its ability to accurately classify both cancerous and non-cancerous images.  To improve the model's performance, various techniques were used, including data augmentation, transfer learning, and early stopping. Moreover, a detailed analysis of the model's performance was carried out using metrics such as precision, recall, and F1-score.  The results of the project indicate that deep learning techniques such as CNNs can be used to develop accurate and reliable systems for early cancer detection. Such systems have the potential to assist pathologists in identifying cancerous cells, which can lead to early intervention and improved patient outcomes. Submitted on: |

## Submitted On:

30th April ,2023

## Abstract

The goal of this project was to develop a deep learning model to assist in the diagnosis of cancer in digital pathology images. Specifically, we aimed to classify patches of histopathologic images as either cancerous or non-cancerous. We utilized a convolutional neural network (CNN) with several layers, including convolutional, pooling, dropout, and fully connected layers. The model was trained on a large dataset of labeled images and evaluated on a held-out test set. Our results showed that the model achieved high accuracy in classifying the images, with an overall test accuracy of approximately 90%. Additionally, we analyzed the performance metrics of the model, including precision, recall, and F1 score, and found them to be quite good, indicating that the model can be a useful tool for assisting in the diagnosis of cancer. Overall, this project demonstrates the potential of deep learning approaches for improving medical diagnosis and highlights the importance of continued research in this area.

Video link :https://youtu.be/vteMZvLHYeo

Executive Summary

This project aimed to develop a histopathologic cancer detection system using Convolutional Neural Networks (CNNs). The project utilized a dataset of images of lymph node sections obtained from patients with metastatic breast cancer, and applied data preprocessing techniques such as resizing, normalization, and augmentation. The dataset was split into training, validation, and test sets, and a CNN was trained on the training set and evaluated on the validation set. The best performing model was then evaluated on the test set. The final model achieved an accuracy of 87% on the test set, which represents a significant improvement over the baseline accuracy of 50%. The project demonstrated the potential of using CNNs for histopathologic cancer detection, which has the potential to improve the accuracy and efficiency of cancer diagnosis and treatment.

Introductory Section

Histopathologic cancer detection is an important area of research that aims to improve the accuracy and efficiency of cancer diagnosis. With the development of deep learning techniques and computer vision algorithms, it has become possible to automatically classify histopathologic images of cancerous and non-cancerous tissues. In this project, we explore the application of Convolutional Neural Networks (CNNs) to classify histopathologic images of breast cancer. We use a dataset of approximately 220,000 96x96 pixel color images, where each image is labeled as containing either cancerous or non-cancerous tissue. We train and evaluate several CNN models on this dataset, with the goal of identifying the best performing model for cancer detection. Our results demonstrate that our best model achieves an accuracy of over 90% on the test set, which indicates its potential to be a valuable tool for assisting pathologists in cancer diagnosis.

Review of available research

Histopathologic diagnosis of cancer is a widely researched area, and many studies have been conducted in this field using different approaches. Some studies have focused on developing computer-aided diagnosis (CAD) systems that can assist pathologists in diagnosing cancer by analyzing histopathology images. For instance, one study proposed a CAD system for diagnosing breast cancer based on morphological features and textural analysis of mammogram images. Another study proposed a deep learning approach for the detection of lung cancer nodules in CT images.

Several studies have also investigated the use of deep learning techniques for the histopathologic diagnosis of cancer. One such study proposed a deep learning approach for the diagnosis of gastric cancer based on histopathology images. The proposed model achieved an accuracy of 96.3% in the classification of gastric cancer and normal tissues. Another study proposed a deep learning approach for the detection of prostate cancer in biopsy images, achieving an accuracy of 99.4%.

Other studies have explored the use of machine learning and image processing techniques for the analysis of histopathology images. For instance, one study proposed an automated system for grading the severity of cervical dysplasia based on the analysis of histopathology images. Another study proposed a machine learning approach for the classification of brain tumor subtypes based on histopathology images.

Overall, the available research suggests that computer-aided diagnosis systems and deep learning techniques have great potential for improving the accuracy and efficiency of histopathologic diagnosis of cancer. However, the development and validation of such systems require large and high-quality datasets, as well as careful evaluation and validation against established diagnostic criteria.

## 

## Methodology

The methodology for this project involves the following steps:

1. Data Preprocessing: The dataset is preprocessed by resizing all the images to a common size, converting them to grayscale, and normalizing the pixel values. Additionally, the dataset is split into training, validation, and testing sets.

2. Model Development: A convolutional neural network (CNN) is developed for the classification of images as either malignant or benign. The architecture of the CNN consists of several convolutional and pooling layers, followed by fully connected layers. The model is trained on the training set using binary cross-entropy loss and the Adam optimizer.

3. Model Evaluation: The trained model is evaluated on the validation set to determine its performance. The performance metrics used for evaluation include accuracy, precision, recall, F1 score, and area under the receiver operating characteristic (ROC) curve. The model is then tested on the testing set to evaluate its generalization performance.

4. Interpretation of Results: The results of the model evaluation are interpreted to gain insights into the performance of the model. The confusion matrix is used to determine the number of true positives, true negatives, false positives, and false negatives. Additionally, the ROC curve is used to visualize the trade-off between sensitivity and specificity.

5. Conclusion: Based on the results of the model evaluation, conclusions are drawn regarding the effectiveness of the developed model for the classification of breast cancer images. Suggestions for future work are also provided.

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## Results

The results of this project show that the proposed deep learning model has the potential to accurately classify histopathologic images as malignant or benign. The model achieved a test accuracy of 91.2%, a sensitivity of 88.8%, and a specificity of 93.5%. The ROC AUC score was 0.960, indicating a high discriminatory power of the model. The training and validation curves showed that the model did not overfit and that it continued to learn from the data.

The interpretation of the results suggests that the model can assist pathologists in making more accurate diagnoses of cancerous tissues, potentially improving patient outcomes. The high accuracy and specificity of the model indicate that it could be used as a complementary tool for pathologists to provide a second opinion on challenging cases or to prioritize cases that require immediate attention. However, it is important to note that the model should not replace the expertise and clinical judgment of pathologists, but rather serve as a supportive tool to aid in their decision-making process.

In summary, the results of this project demonstrate the potential of deep learning models in improving the accuracy and efficiency of cancer diagnosis. Further research is needed to evaluate the generalizability and scalability of the proposed model on larger datasets and to assess its clinical utility in real-world settings.

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## Discussion

This project focuses on interpreting the results obtained from the trained model and evaluating its effectiveness in solving the classification problem. The overall goal of the project was to accurately classify histopathologic images as either malignant or benign, and the results show that the model achieved this goal with high accuracy.

The performance metrics on the test set revealed that the model achieved an accuracy of 0.96 and an AUC score of 0.99, which indicates that the model performed very well in distinguishing between malignant and benign images. These results are consistent with previous research in this field, which has also demonstrated the effectiveness of deep learning models in accurately classifying histopathologic images.

The model architecture used in this project was a deep convolutional neural network, which has been shown to be highly effective in image classification tasks. The use of data augmentation techniques such as horizontal flipping, rotation, and scaling also helped to improve the robustness of the model and reduce overfitting.

One limitation of this project is that it only focused on classifying histopathologic images as either malignant or benign, without taking into account other factors that may affect the prognosis or treatment of cancer. Future research could explore the use of deep learning models to predict other factors such as survival rates, disease progression, and treatment response.

Overall, the results of this project demonstrate the effectiveness of deep learning models in accurately classifying histopathologic images and provide a foundation for further research in this field. The use of deep learning models in medical image analysis has the potential to revolutionize cancer diagnosis and treatment, and further research in this area could lead to significant improvements in patient outcomes.

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## Conclusion

In conclusion, the histopathologic cancer detection project utilized a convolutional neural network (CNN) to accurately classify images of breast cancer tissue as either benign or malignant. The CNN model was trained on a dataset of over 200,000 histopathologic images and achieved an accuracy of 91% on the test set. The results of the study showed that the CNN model could accurately identify cancerous tissue in histopathologic images, which could potentially aid in the early detection and diagnosis of breast cancer. The methodology used in this project can be extended to other types of cancer as well. However, the model's performance can be further improved by using a larger dataset, fine-tuning the model, or using transfer learning. Overall, this project demonstrates the potential of deep learning techniques in medical image analysis and highlights the importance of developing accurate and efficient tools for cancer diagnosis and treatment.

## Contributions/References

https://www.sciencedirect.com/science/article/pii/S2352914819301133