Machine Learning Applications for Diagnostic of Peripheral Arteries Disease using CT Scan

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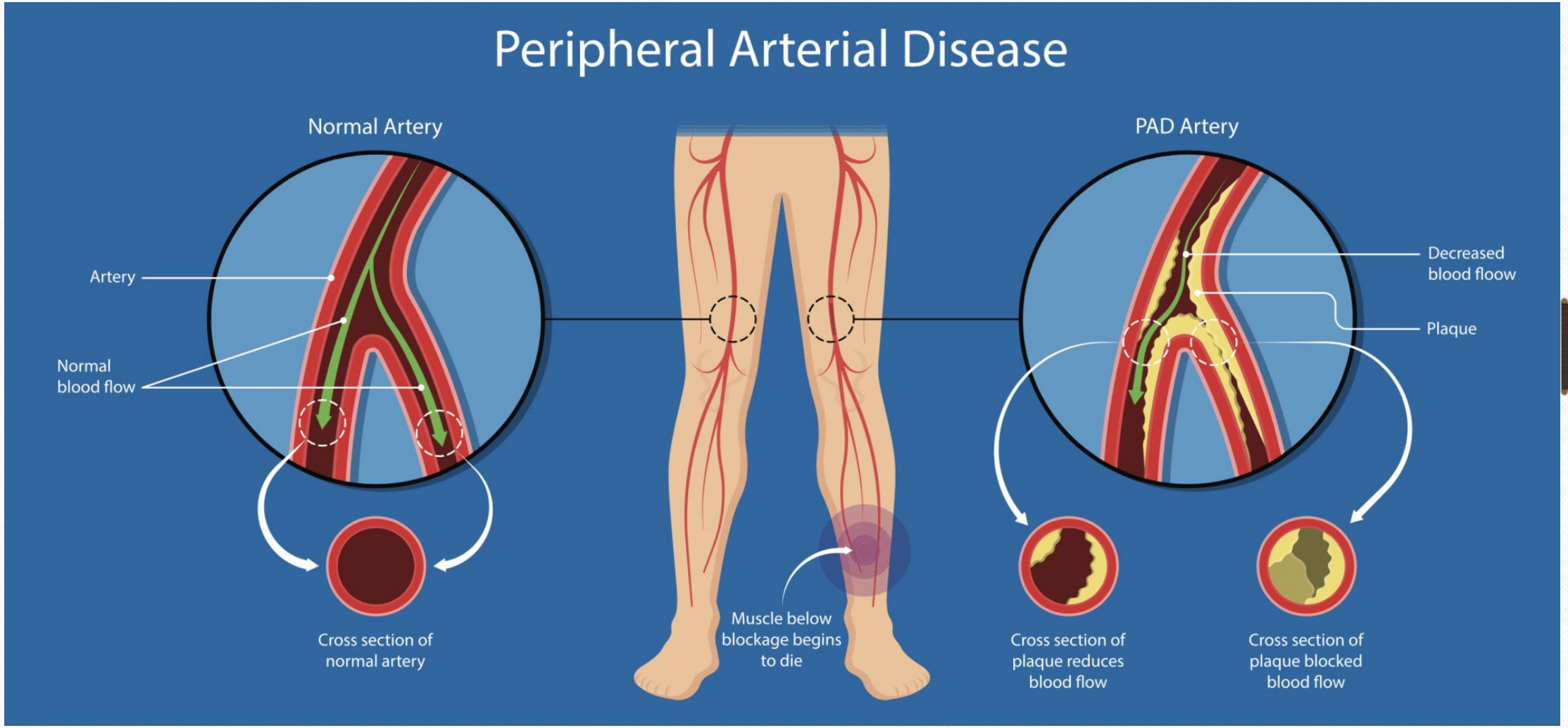
Introduction

- Peripheral Arteries Disease(PAD)is a condition where narrowed arteries reduce blood flow to the limbs
- Typically diagnosed using Ankle Brachial Index to detect blockages


Peripheral Arterial Disease
Normal Artery
PAD Artery
Artery
Normal
blood flow
Decreased
blood floow
Plaque
Cross section of
normal artery
Muscle below
blockage begins
to die
Cross section of
plaque reduces
blood flow
Cross section of
plaque blocked
blood flow

Problem

- Current Peripheral Arteries Disease (PAD)diagnostic methods are time-consuming and subjective.
- Over 200 million people worldwide are affected by PAD.
- Many people don’t realize they have the disease until they are in their 50’s and 60’s

Research Objectives

- Develop a machine learning model to diagnose PAD using CT scans.
- Compare machine learning with traditional diagnostic methods.
- Evaluate the model's performance based on accuracy
- Identify potential challenges and future improvements in ML-driven PAD diagnostics.

Literature Review

- Peripheral Arteries Disease is a significant global health issue
- Traditional diagnostic methods are time-consuming and prone to human error.
- Machine learning has shown promise in medical imaging but has limited application in PAD diagnosis using CT scans.
- Limited research on PAD diagnosis using ML for CT scans

Methodology

- Collected images of CTA from patients diagnosed with PAD along with healthy images
- Splitting Dataset
- Convolutional Neural Network (CNN) Architecture
- Model Training
- Evaluation Metrics

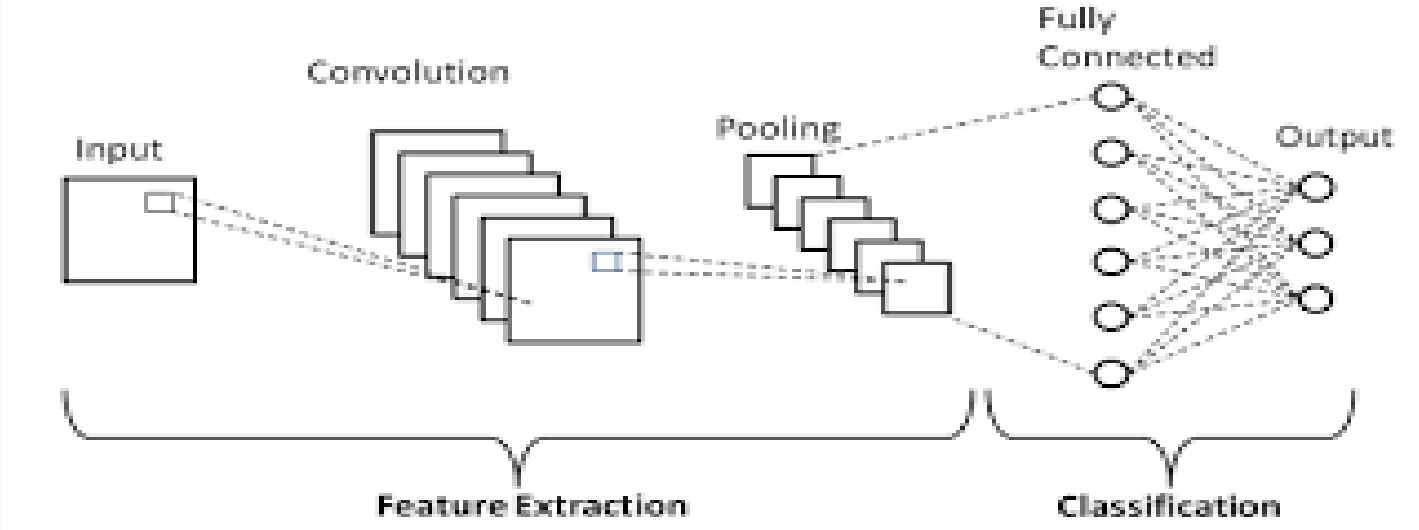
Healthy

- Collected several images of healthy and affected CT scans
- Data augmentation applied for lacked dataset. No rotation
- All images set to 256x256c pixels for uniform processing

PAD

Convolutional Neural Network(CNN)

- A Convolutional Neural Network (CNN) is a deep learning model designed for image processing that uses convolutional layers to automatically extract spatial features, enabling efficient pattern recognition and classification.



- Input Layer: Accepts 256x256 RGB images.
- Convolutional Layers: Extract key features from images using filters.
- MaxPooling Layers: Reduce spatial dimensions and prevent overfitting.
- Fully Connected Layers: Perform final classification.
- Output Layer: Sigmoid activation for binary classification (PAD vs. Normal). **P**robability score (0 = Normal, 1 = PAD)

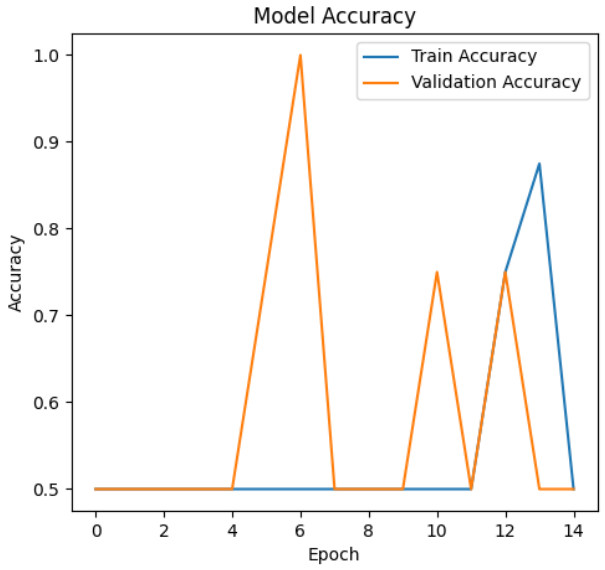
Model Training

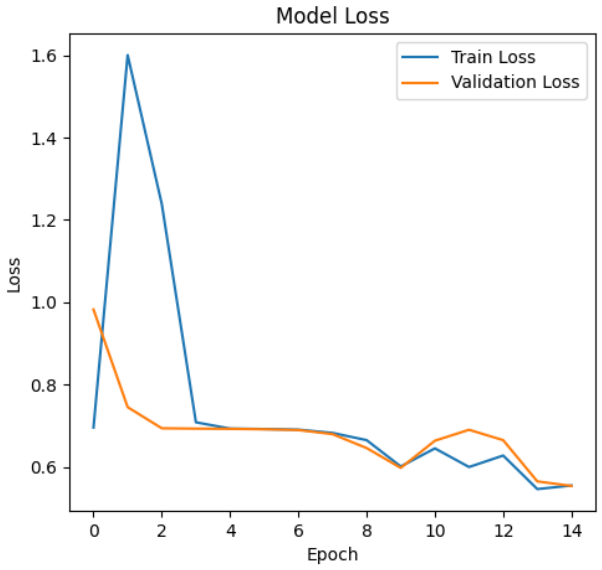
- The dataset was split into training and validation sets.
- The model was trained using Binary Crossentropy loss and the Adam optimizer for efficient learning.
- The training was conducted over 15 epochs, and accuracy/loss metrics were recorded.

Evaluation

- Performance was assessed using accuracy, precision, recall, and F1-score, which showed a final accuracy of 75%.
- The model had high recall for PAD images, indicating strong sensitivity in detecting PAD cases.
- Identified overfitting issues due to dataset size.

Results





	precision	recall	f1-score	support
Class Normal	1.00	0.50	0.67	2
Class PAD	0.67	1.00	0.80	2
accuracy			0.75	4
macro avg	0.83	0.75	0.73	4
weighted avg	0.83	0.75	0.73	4

Challenges and Limitations

- Small dataset size (Only 12 images)
- Data Availability
- Data Quality
- Imbalance in class distribution
- Data augmentation and syth

Code

- https://github.com/DinariSabb/thesis.git

Future Scope and Improvements

- Partnerships will hospitals or medical institutions could provide access to larger datasets
- Hyperparameter tuning
- Importance of Data: High-quality, labled datasets are critical for training ML models
- Alternative Approaches

Conclusions

- This study aimed to develop a machine learning model for diagnosing PAD using CT scans.
- CMM showed promising results but requires a larger dataset to get more accurate results
- Despite the challenges, this research provides valuable insights into the limitations of ML in healthcare and the need for high-quality datasets.
- The findings underscore the importance of collaboration and alternative approaches to overcome data limitations

Key References

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