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Foot Ulcer Detection Using Machine Learning

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ABSTRACT*:* Diabetes patients frequently develop foot ulcers, which can have serious consequences and raise healthcare expenses. For the purpose of avoiding problems and enhancing patient outcomes, early detection and prompt action are essential. Automating the detection of foot ulcers and facilitating early diagnosis and treatment are two areas where machine learning approaches have demonstrated considerable promise. This literature review intends to highlight the methods utilized, datasets used, and performance metrics attained in the available studies on the detection of foot ulcers using machine learning algorithms. The review also points out present difficulties, evaluates the studies' limits, and suggests areas for further investigation. The use of technology is an effort to develop unique, cost-effective, and user-friendly diabetic foot diagnostic methods for patients and medical professionals. In this study, a deep neural network model called VGG19 is suggested for the early diagnosis and prognosis of diabetic foot ulcers.

KEYWORDS - Foot Ulcer, datasets, VGG19, Machine Learning, Diabetes.

I. INTRODUCTION

People with diabetes frequently experience significant foot ulcers, especially those who have extended periods of poor blood glucose control. Foot ulcers can cause serious infections, tissue damage, and in severe cases, even amputation if untreated. Early detection and prompt action are therefore essential to stop future problems and enhance patient outcomes.

Recent developments in machine learning methodologies have completely changed the diagnostics industry. Automating the identification and diagnosis of many diseases has demonstrated to have enormous potential when used in conjunction with machine learning algorithms, robust datasets, and cutting-edge computational capacity. One such area where machine learning shows promise for enhancing patient care and lessening the workload on healthcare professionals is the diagnosis of foot ulcers.

The purpose of this study is to investigate how machine learning can be used to identify foot ulcers. Machine learning techniques can identify patterns and features related to foot ulcers by employing massive datasets made up of clinical and imaging data, allowing accurate and early identification. This strategy may help medical personnel diagnose patients quickly, provide prompt treatment, and stop subsequent consequences.

II. RELATED WORKS

Following a thorough literature review, we have chosen a few notable works and have listed them below:

Sudarvizhi et al [1] Using a method known as a load cell, detected and examined foot ulcers. The foot mat has sensors inside called load cells. SVM was used to analyze sensor data, and it nearly achieved 94.6% correctness and 95.2% specificity.

H. Kaur, et.al [2] have examined and predicted patients' diabetes using a variety of techniques based on machine learning. This study created trends and predicted patterns for diabetes and healthy people using data from the American Indian diabetes dataset. They employed numerous methods, including the Support Vector Machine (SVM) and KNN.

Petel et al [3] To identify and categorize the DFU wound, Patel et al concentrated on medical image processing. picture preprocessing, picture segmentation, extraction of features, textural detection, and image classification are the four processes in the foot ulcer detection system.

Kasbekar et al [4] A technique for determining the risk of foot diabetes ablation. The diabetic foot patient dataset is used to construct single C5.0 and enhanced C5.0 boosting techniques. Following a comparison of these methods,

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enhanced C5.0 performed better, achieving an accuracy rate of 96% on test data. Only two situations in the sample were incorrectly classified, which is the lowest error percentage.

Pushpaleela et al. [5] SVM, naive Bayes, KNN, C4.5, and decision-tree categorization approaches were all taken into account when estimating DFU in kind-2 diabetic patients. The dataset was obtained from a hospital and is based on real-life information. SVM has outperformed the other algorithms, with an accuracy of 92.22%.

Sneha and Gangil [6], Early diabetes diagnosis was carried out by the UCI machine learning repository is where the dataset was obtained. Based on the dataset's attribute values' correlations, a feature selection procedure is carried out. The accuracy was up to 82.3%.

III. PROBLEM STATEMENT

Diabetes often causes serious complications like foot ulcers, which can cause serious morbidity if they are not identified and treated very away. To stop foot ulcers from getting worse and to enhance patient outcomes, early detection and treatments are essential. The key Challenges in the problem domain are:

1. How to identify the foot Ulcer stage with the given image of the foot?
2. How to classify the image into normal or abnormal?

In the solution domain, the following methods are existing: Efficient Net, VGG16, Google Net, and other CNN models etc. However we are using VGG19 method in this project. Further, Currently, a lot of foot ulcer detection is done manually by medical staff, which can be time-consuming and subjective.

IV. DESIGN AND IMPLEMENTATION

Here it contains two different phases one is Training phase and Testing phase. The process of teaching a machine learning model on a dataset to discover patterns, correlations, and underlying structures in the data is referred to as the training phase. The evaluation of a learned algorithm's efficacy on unobserved data is referred to as the testing step in machine learning.

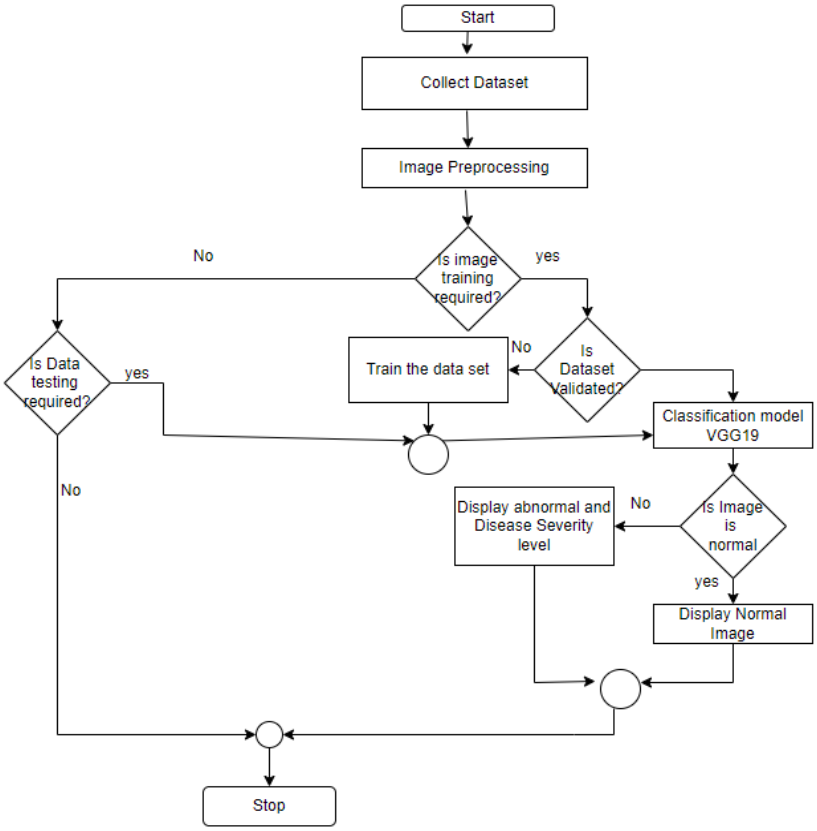

Figure 1: Block Diagram of Proposed Methodology

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Collection of Dataset: Take pictures of both healthy and ulcerated feet to create a dataset of foot photographs. The machine learning model will be trained and tested using this dataset.

Image Preprocessing: The obtained foot photos were preprocessed to improve their quality and get rid of any noise or artifacts. Typical preprocessing methods include noise removal, normalization, and scaling.

splitting of Dataset: The training set and the validation set should be separated from the preprocessed and feature-selected dataset. The validation set is used to modify the model's hyper parameters and evaluate the model's performance while the training set is used to train the machine learning model.

Training: During the machine learning training phase, a model that can make predictions or choices based on fresh, unused data is trained using a labeled dataset. In this step we are going to train the data. For Training the images, we use VGG19 model to Train the dataset.

VGG19: A network of convolutional neural networks with 19 layers is called VGG-19. The database maintained by ImageNet contains an untrained version of the network that has been trained on more than a million photos. The network that has not been trained can categorize photos into 1000 different object categories, including several animals, a keyboard, a mouse, and a pencil. As a result, the network now has comprehensive visualizations of features for a range of photos. The network supports photos with a dimension of 224 by 224.

Here we use different Libraries such as Keras to train the images, and numpy it is a number array to concert the images into number format, os to mention the path, cv2 to resizing an images and matplotlib.

Classification: The classifier, which is typically a collection of fully connected layers, is then fed the collected characteristics. After analyzing the features, the classifier gives probabilities to various classes or categories. In this instance, it would establish whether a foot ulcer was present or not.

Testing the image: In the Testing phase the first step is to test the images that we are trained this also contains many techniques like preprocessing and so on.

Output: The final step of the testing phase is generating output. Depending on the particular comparison metrics and criteria applied, the results of comparing two model files can differ. The system generates an output prediction indicating whether or not a foot ulcer is discovered based on the categorization results.

V. RESULTS AND DISCUSSION

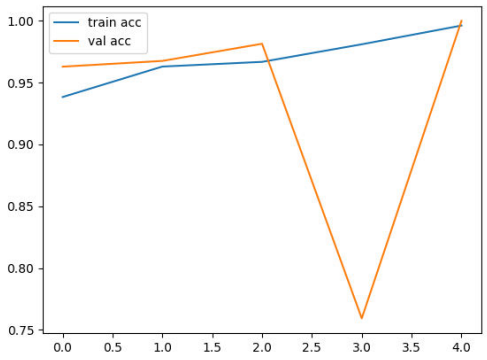

Figure 2 : Accuracy Graph

An accuracy graph in machine learning often illustrates how well a model performs across a variety of evaluation criteria, including accuracy, precision, recall, F1-score, and any other pertinent measure. The graph is frequently used to evaluate and contrast the effectiveness of several models, or the same model with different parameters.

The above graph shows the accuracy of the model's performance. The accuracy of the VGG19 model was increased as we increased the epochs size. With the epoch value of five we can attain the accuracy of 99% and 95% during training and validation phase.

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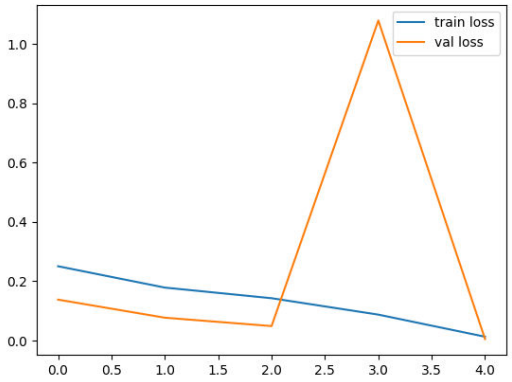

Figure 3: Loss Graph

A loss graph, sometimes referred to as a loss curve or training curve, is a visual representation of how a model's loss or error changes over the training process in machine learning. Typically, the loss is calculated as the difference between the model's anticipated output and the actual target value.

The above Loss graph shows that loss percentage of the model's performance is low that is the loss percentage is 0, when compare to other model.

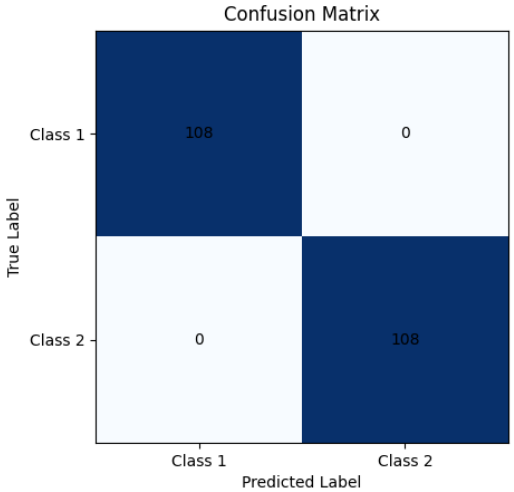

Figure 4: Confusion Matrix

A confusion matrix provides a concise summary of the anticipated outcomes of a categorization operation. The confusion matrix has two classes: normal (healthy foot) and abnormal (diabetes foot).

In the above graph, we have given 5 epochs. Out of 108 abnormal and normal foot images all the images are trained properly and it shows the accurate result. 0 indicates that no such images are trained improper. For the five epoch only it shows the accurate result of 99%.

Comparison of accuracy between VGG19 and ALEX NET Algorithm:

VGG19 and Alex Net are both well-known CNN architectures that have been widely used for various computer vision tasks, including image classification**.** For foot ulcer prediction specifically, it is essential to have access to the specific dataset used and the implementation details to compare the performance of VGG19 and AlexNet accurately. The

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performance can vary depending on factors such as the size and quality of the dataset, data preprocessing techniques, hyper parameter tuning, and the evaluation metrics used.

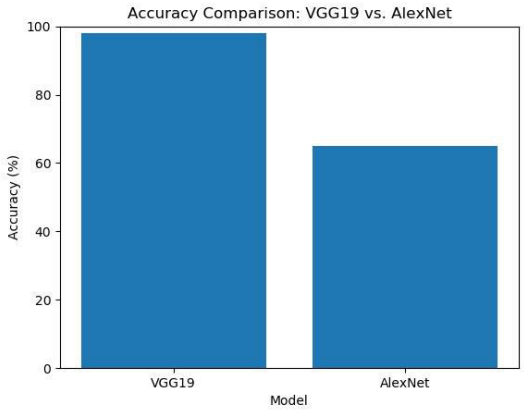
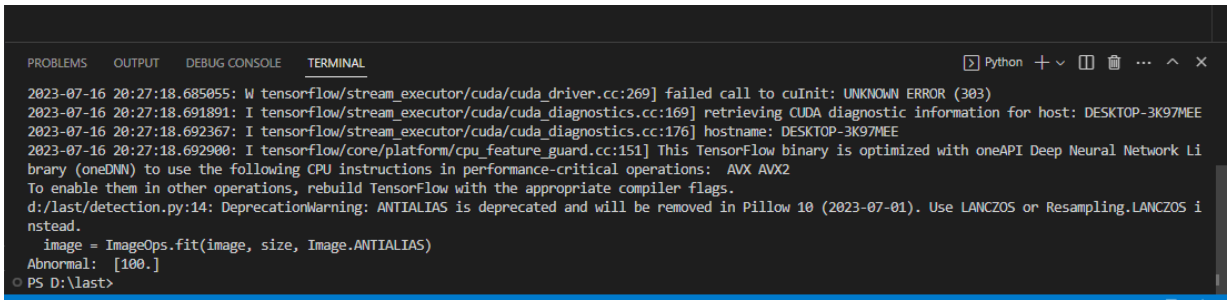


Figure 5: Accuracy Comparison

Here the above graph shows that the comparison of Accuracy between two models that is VGG19 and Alex Net, and it clearly shows that VGG19 model shows better performance than Alex Net. As VGG19 algorithm shows 99% accuracy and Alex Net shows the 65 % of accuracy.

output:



The above figure shows the output of the project; it predicts that whether the trained image is having foot ulcer or it is a healthy foot

VI. CONCLUSION AND FUTURE WORK

Around the world, diabetes is a condition that affects the majority of people. It is essential to accurately forecast diabetic foot ulcer disease because it is a serious consequence of diabetes. Early detection and prompt treatment could prevent the diabetic patient from losing any leg tissue. The advantages of using machine learning for foot ulcer detection include increased accuracy, reduced human error, and improved efficiency in diagnosis. These systems can process large amounts of data quickly and provide real-time results, enabling healthcare professionals to make informed decisions promptly. For the automatic classification of captures of diabetic feet into normal (healthy skin) and abnormal (DFU), deep neural network models are used. We have done the comparison between VGG19 and Alex net .The use of the VGG19 algorithm for foot ulcer detection using machine learning shows promising results. Foot ulcers are a common and serious complication for individuals with diabetes, and early detection is crucial to prevent further complications and improve patient outcomes. This study shows that on a series of images depicting diabetic foot ulcers, the VGG19 model shows highest accuracy.

The classification and prediction of diabetic foot ulcers should be expanded in the future to include neuropathy, ischemia, Charcot arthroplasty, and osteomyelitis.

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