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Classifying Diabetic Foot Ulcers Using Data Augmentation Techniques

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Abstract: ***Diabetes is a severe health complication one of which is a Diabetic Foot Ulcer. It is an open sore or wound often observed in diabetic patients who require a careful treatment plan. The most common option is still based on the disease's symptoms and indications because of its large transcendence, which is associated to a higher incidence and expensive and limited diagnostic trials. As a result, the attending physician completes a questionnaire using both its own observation and supporting instrumental measurements (it could be method but not so sure). The above mentioned questionnaire will serve as the basis for the diagnosis, which will also be determined by the consultant's experience and the criteria. Unfortunately, the preceding dependency is unacceptable for some factors, such as the laceration (injury or wound) and location. Therefore, this project is focused on developing a diabetic foot ulcer detection system that helps to identify diabetic foot by developing a suitable feature extraction and classification algorithm. Along with the classification algorithms, the use of Digital image processing techniques helps to improve the quality of images for accurate detection. The number of photos available for training had to be increased with data augmentation for each approach, and false positives had to be eliminated using postprocessing. Hence, with the use of digital image processing techniques, this study aims to establish a new link in the evaluation of the diabetic foot.***
Keywords: Machine Learning (ML), Diabetic Foot Ulcer (DFU), Convolutional Neural Networks (CNN), Classification algorithm, Support Vector Machine (SVM), Digital Image Processing

I. INTRODUCTION

Diabetic Foot is a common chronic complication in type-2 diabetes where the body either does not produce enough insulin, or it resists insulin. Infection of a Diabetic Foot Ulcer frequently leads to limb amputation, causing significant morbidity, psychological distress and reduced quality of life and life expectancy. The development of ulcer healing progress must be periodically monitored, something that clinicians currently do manually. Neurologic, Vascular and Foot pressure examinations are the current clinical examination methods for Diabetic Foot Ulcers. These trails take a long period to start a treatment plan that may result in several complications as mentioned. There is an immediate need for an easy and effective inspection technique. So, it is essential to develop a technological solution capable of transforming current screening practices that has the potential to significantly reduce clinical time burdens.

II. PROBLEM STATEMENT

According to figures that have been made public, diabetes-related wounds of which there were over 71 000 in India in 2018 are the main reason for non-traumatic lower limb amputations. Additionally, it is estimated that treating diabetic foot ulcers costs Rs. 15000 per person per year. The cost of treating diabetes was predicted to be 245 billion in 2018 and is projected to rise in the years to come. Hence to overcome the issues of inaccurate prediction of type of wounds, inaccuracy in query results, delayed diagnosis and treatment plan, and some other complications, a new detection system is to be developed which would be cost effective, available to everyone remotely and high accuracy of detection.

III. LITERATURE SURVEY

1) In "*A Low-Cost Smart Insole for Diabetic Foot Prevention*" by Mohamed Anouar Bencheikh, Samir Boukhenous, describes the system as consisting of an instrumented insole with cutting-edge sensors that allow the quantification of plantar pressure at critical points with a high risk of ulceration. The insole also includes temperature and humidity sensors.
2) A virtual platform for usage on a Web site dedicated to diabetic foot is presented in "*Computational support system for early diagnosis of diabetic foot*" by I. A. Torres, L. Leija, A. Vera, and H. Maldonado. The platform is made to be simple to use and allows for effective communication from a general server to multiple PCs that are linked by a medical network.

3) Sergej Sosunkevi presents an elaborate pilot version of a method in "*Assessment of Multimodal Reactions on Specific Stimulation Tests for Revealing Early Risk of Diabetic Foot*" that allows to test the hypothesis that specific stimulation tests and analysis of synchronous multimodal time dependences of physiological signals can reveal the early risk of diabetic foot and determine the type of damage.
4) B G Sudha's article, "*Statistical Analysis of Surface Temperature Distribution Pattern in Plantar Foot of Healthy and Diabetic Subjects Using Thermography*," examined the infrared thermal images of 62 diabetic and 20 healthy subjects to find temperature distribution patterns that could indicate diabetic foot complications.
5) A Multiphysics simulation employing 3D finite element modelling from medical images is shown in "*3D Multilayer Foot Model based on CT Medical Imaging Processing for the Investigation of the Diabetic Foot Complication*" by Rafael, Bayareh, and Mancilla. In order to obtain a surface temperature distribution for each tissue layer, a preliminary time-dependent simulation must be run.

IV. PROPOSED APPROACH

A new detection system is proposed which detects the diabetic foot ulcers with the use of machine learning algorithms like CNN and SVM that gives 95% accuracy by taking the diabetic foot images as input and predicts the output by diagnosing the image as the normal and abnormal skin. Convolutional Neural Networks (CNN): A Convolution Neural Network (CNN) is a class of artificial neural networks where connections between nodes form a graph along a temporal sequence. It can display temporal dynamic behaviour as a result of this. Derived from feed forward neural networks, CNNs can use their internal state (memory) to process variable length sequences of inputs. Support Vector Machine (SVM): To detect an ideal- hyperplane for different distinct examples in a high dimensional space is the main process of the SVM. To fulfill this model there is more than one hyperplane. This process depends upon the bolster vector where the information lies nearest on the closed surface and coordinating with the ideal choice surface. Classification is done by putting the input vectors into a high dimensional space and constructing the hyperplane to separate the data. This approach is mostly used to resolve non-convex, unconstrained minimization problems and quadratic programming problems.

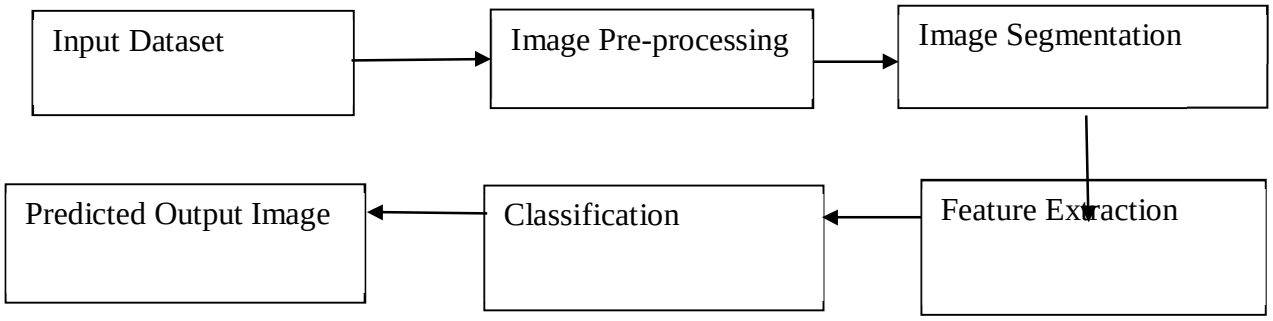
A. Advantages of Proposed System

1) A clear image of wound is obtained.
2) Overlapping of images is avoided so that images are compared in a better way.
3) Accurate diabetic wound can be predicted.
4) A cost-effective and a good healthcare treatment plan is provided with the early detection of diabetic wounds.
5) Process the input data more effectively and efficiently than other comparative Convolutional Neural Network Architectures. Early diagnosis of diabetic foot ulcer is done instead of periodic monitoring of the foot ulcer.

V. REQUIREMENT ANALYSIS

1) Processor: i5 (required for fast execution)
2) Ram: 4 GB (min) ,8 GB for best performance.
3) Hard disk: 500GB.
4) Graphic card: 2GB.
5) Programming language: Python
6) Database: MY SQL

VI. SYSTEM ARCHITECTURE



VII. MODULE DESCRIPTION

A. *Image Acquisition Image*

Acquisition is the process of collection of images. We had performed a refined search on the dataset of many object images.

B. *Image Pre-processing*

Image pre-processing includes converting RBG (colour) images into Grayscale images using MATLAB. To improve the available dataset, RGB is converted to grayscale. Converting the images to grayscale helps in improving the accuracy of the result.

C. *Image Segmentation*

The conversion of segmented objects into representations that more accurately reflect their primary characteristics and qualities is the common objective of feature extraction and representation techniques. The goal is to simplify or change the representation into more meaningful image. It sets apart the things from the background or other objects that we wish to examine more closely.

D. *Feature Extraction*

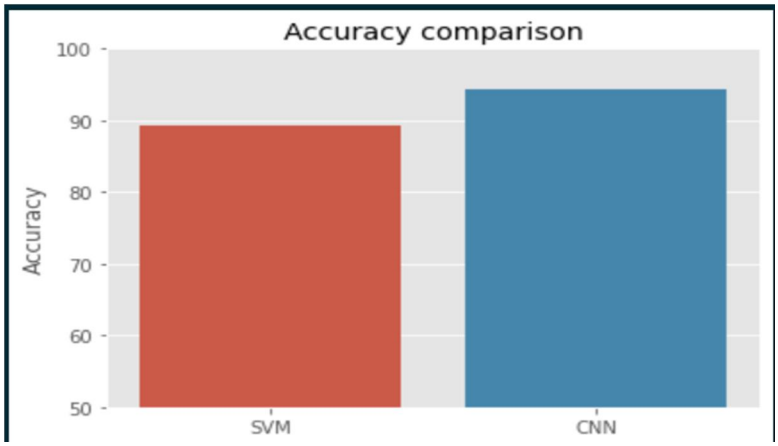
Feature extraction is extracting or showing of the portion of the tumour so that classification becomes easy. To discriminate between the photos, features are retrieved. Nearly all machine vision techniques rely on features extraction. The conversion of segmented objects into representations that more accurately reflect their primary characteristics and qualities is the common objective of feature extraction and representation techniques. Here, shape of the wound is extracted.

E. *Classification*

Based on the augmented images that are obtained so far, the machine learning algorithms like a SVM and CNN algorithms are used to train the images to classify them into normal and abnormal. The new input images are then tested.

VIII. RESULT ANALYSIS

Normal (healthy) skin Abnormal (Ulcer) skin



Accuracy comparison of SVM and CNN for best detection of diabetic foot ulcer

IX. CONCLUSION

The goal of proposed system is to provide the better wound image and healing status analysis. With these methods patients are actively involved in their own care and the wound analysis systems where by physicians can remotely access the image of wound and the result of wound healing. Also, it will reduce the patients rare tensity and stress. Through the segmentation of wound photos, a doctor can quickly diagnose the issue. Mobile applications for ulcer recognition and user-friendly software tools are to be implemented. In future an automatic ulcer detection, recognition, and segmentation with the help of these classifiers can be developed to help patients receive better treatment and care.

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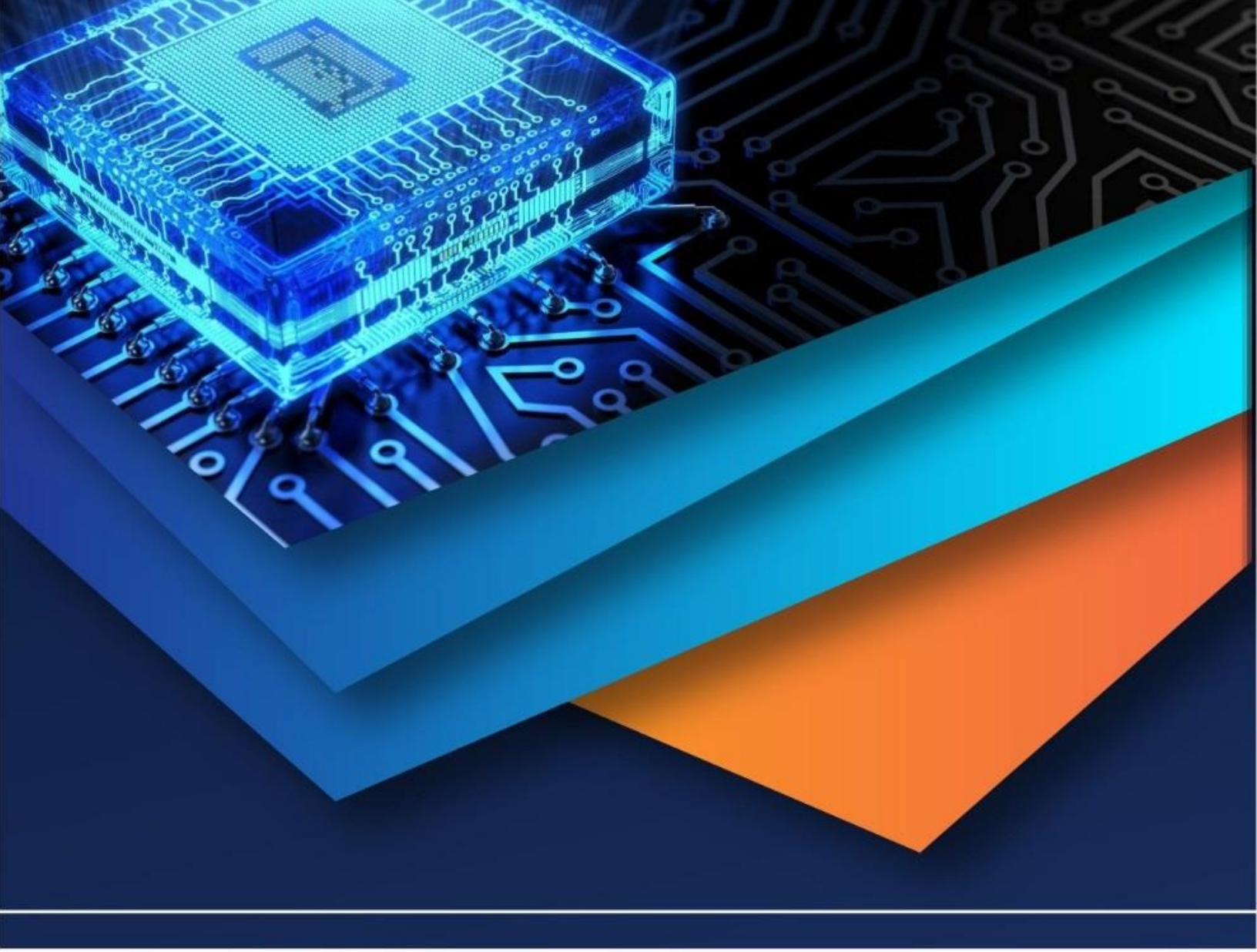

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