Evaluation and Risk Identification of Diabetic Foot Ulcers Using SVM Algorithm

Dr.A.Sumaiya Begum[1], Ishwarya.S[2], Janaki.R[3], Gowsalya.R[4]

[1]*Assistant Professor, Department of Electronics and Communication Engineering, R.M.D. Engineering College, Affiliated to Anna University, Chennai, India*

[2,3,4]*U.G. Students, Department of Electronics and Communication Engineering, R.M.D. Engineering College, Affiliated to Anna University, Chennai, India*

***Abstract*- Diabetes Mellitus (DM) often called as Diabetes, is a lifelong disease which affects the human body due to damaged pancreas producing inadequate aggregate of insulin. One of the major problems in diabetic patients is the development of diabetic foot ulcers (DFU). This leads to gangrene formation and loss of sensation in the patient's foot. If ignored, it may lead to lower leg amputation. The presently available clinical techniques to DFU treatment depend on patient and clinical surveillance which has more significant limitations such as the high cost involved in the diagnosis, treatment and lengthy care of the diabetic foot ulcer. A large dataset of foot images which contain DFU from diabetic patients has been collected. We have used SVM (Support Vector Machine) algorithm for classification. This experiment is performed to evaluate the skin conditions of medium level(low risk) and abnormal level(high risk). The present work defines evaluation and risk identification of the level of diabetic foot ulcers whether it is medium or abnormal in display through microcontroller and the message will be sent to the concerned person using GSM (Global System for Mobile communication).**

***Index terms*- Diabetic foot ulcers, machine learning, classification, gangrene**

I.INTRODUCTION

Diabetes Mellitus (DM) is a lifelong condition which results from high blood sugar (hyperglycemia). Difficulties such as cardiovascular diseases, kidney failure, blindness and lower leg amputation is often caused by Diabetic foot ulcers (DFU). According to the global report on diabetes, in 2014, there were 422 million people living with DM compared to 108 million people in 1980. Among the adults that are over 18 years of age, the global prevalence has gone up from 4.7% in 1980 to 8.5% in 2014. It is estimated that, by the end of 2035, the figure is expected to rise to 600 million people living with DM worldwide.
It is worth mentioning that about only 20% of these people will be from developed countries and the rest will be from developing countries due to poor awareness and insufficient healthcare facilities. There is about 15% - 25% chance that a diabetic patient will end up in DFU and if proper care is not taken, that may result in lower limb amputation.

In recent years, there has been a fast development in computer vision. The computer vision and machine learning algorithms are widely used for the analysis of medical imaging of various modalities such as Computed Tomography (CT) scan, MRI scan, ultrasound, X-Ray and ceroscopy. From a computer vision and medical imaging point of view, there are four common tasks which can be performed for the detection of abnormalities on medical images which are:

1 Preprocessing
2 Feature Extraction
3 Segmentation
4 Classification

The studies have performed the segmentation task by extracting colour descriptors on small patches of wound/DFU images, followed by traditional machine learning algorithms to classify them into medium and abnormal skin patches.

Fig 1.1 Medium DFU

Fig 1.2 Abnormal DFU

II. LITERATURE SURVEY

1. Diabetic foot ulcers and their Recurrence
Author: David G. Armstrong, D.P.M., M.D., Ph.D., Andrew J.M. Boulton, M.D. and Sicco A. Bus, Ph.D.
Year: 2017
Adversities of diabetes that affect the lower extremities are common, complicated and costly. Foot ulceration is the most frequently recognized complication. In a community-based study in the north western United Kingdom, the prevalence of active foot ulcers identified at screening among persons with diabetes was 1.7% and the annual incidence was 2.2%. Higher annual incidence rates have been reported in specific populations: 6.0% among Medicare beneficiaries with diabetes, 5.0% among U.S. veterans with diabetes and 6.3% in the global population of persons with diabetes. On the basis of 2015 prevalence data from the International Diabetes Federation, it is estimated that, annually, foot ulcers develop in 9.1 million to 26.1 million people with diabetes worldwide. The proportion of persons with diabetes and a history of foot ulceration is understandably higher than the proportion with an active ulcer; 3.1 to 11.8% of persons with diabetes, or 12.9 million to 49.0 million persons worldwide and 1.0 million to 3.5 million in the United States alone, have a history of foot ulceration.

2. DFUNet: Convolutional Neural Networks for Diabetic Foot Ulcer Classification
Author: Manu Goyal, Neil D. Reeves, Adrian K. Davison, SatyanRajbhandari, Jennifer Spragg, and MoiHoon Yap
Year: 2018
Universally, in 2016, 1 out of 11 adults are subjected to diabetes mellitus. Diabetic foot ulcers (DFU) are a major complication of this disease, which if not maintained properly can lead to amputation. The current clinical approaches to DFU treatment rely on patient and doctor vigilance, which has significant limitations, such as the high cost and large amount of time involved in the clinical care of the DFU. We collected an extensive dataset of foot images, which contain DFU from different patients. In this DFU classification problem, we analysed two classes as normal skin (healthy skin) and abnormal skin (DFU). In this paper, we have proposed the use of machine learning algorithms to extract the features for DFU and healthy skin patches to understand the diversities in the computer vision perspective. This experiment is performed to evaluate the skin conditions of both classes that are at high risk of misclassification by computer vision algorithms. Furthermore, we used convolutional neural networks for the first time in this binary classification. We have proposed a novel convolutional neural network architecture, DFUNet, with better feature extraction to identify the feature differences between healthy skin and the DFU. Using 10-fold cross validation, DFUNet achieved an AUC score of 0.961. This outperformed both the traditional machine learning and deep learning classifiers we have tested. Here, we present the development of a novel and highly sensitive DFUNet for intentionally detecting the presence of DFUs. This fresh approach has the capacity to deliver a typical model in diabetic foot care among diabetic patients, which represent a cost-effective, remote, and convenient healthcare solution.

III. ALGORITHM

The algorithm that we have used for classification is Support Vector Machine. Support vector machine is a supervised machine learning method that is widely

used for data analyzing and pattern recognizing. The algorithm was invented by Vladimir Vapnik and the current standard incarnation was proposed by Corinna Cortes and Vladimir Vapnik. This application note is to help in understanding the concept of support vector machine and how to build a simple support vector machine using Matlab. Classifying data has been one of the major parts in machine learning. The idea of support vector machine is to create a hyper plane in between data sets to indicate which class it belongs to. The challenge is to train the machine to understand structure from data and mapping with the right class label, for the best result, the hyper plane has the largest distance to the nearest training data points of any class.

IV. BLOCK DIAGRAM

Training Section:

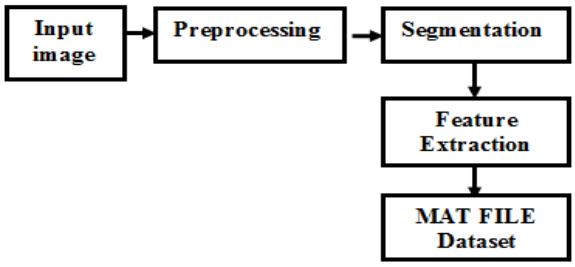

Fig 4.1 Training Section

Testing Section:

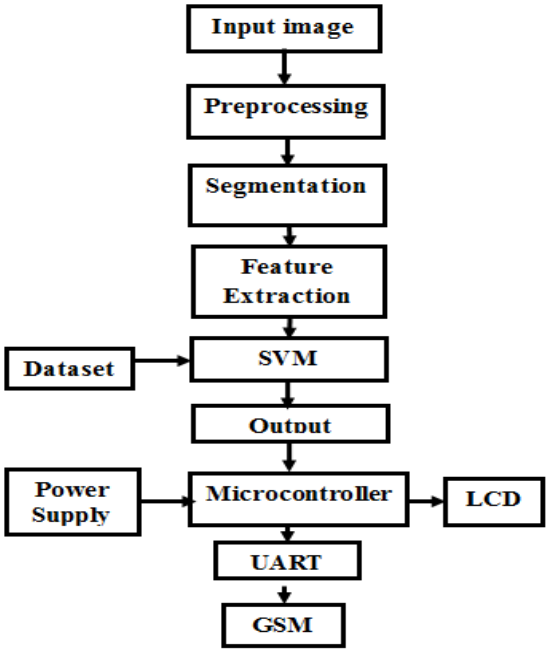

Fig 4.2 Testing Section

V. PROJECT DESCRIPTION

An image of a patient's foot ulcer is given as input. The input image is pre-processed using Median filter. The segmentation is carried out by using "K means Clustering" algorithm. Feature Extraction is carried out by using GLCM. SVM algorithm is used for classification. The level of foot ulcer, either medium or abnormal is displayed on the LCD. The corresponding message will be sent to the concerned person using GSM (Global System for Mobile communication).

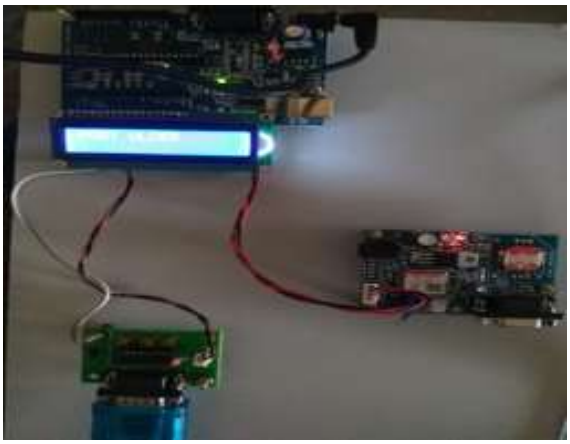

Fig 5.1 Experimental Setup

VI. RESULT

The stage of the diabetic foot ulcer whether medium or abnormal is displayed on the LCD and the message is also sent to the concerned person using GSM. This indicates the level of seriousness of the diabetic foot ulcer. The accuracy of various algorithms are compared below:

ALGORITHM	ACCURACY
SVM	98.67%
Decision Tree	84.23%
K-Nearest Neighbours	83.56%
Naïve Bayes	80.11%

Compared to other algorithms, SVM has the highest accuracy of classification.

VII. CONCLUSION AND FUTURE WORK

We achieved comparatively good performance using conventional machine learning technique. This method is capable of confining multiple Diabetic foot ulcers with high inference speed. The level of

accuracy is also high. This present work has composed the basis to achieve future targets that include: 1) developing an annotator that can automatically portray and classify the foot images without the support of doctors, 2) developing the automatic ulcer detection, recognition and segmentation with the help of this classifier.

REFERENCES

[1] M. Goyal, N. D. Reeves, A. K. Davison, S. Rajbhandari, J. Spragg, and M. H. Yap, "Dfunet: Convolutional neural networks for diabetic foot ulcer classification," IEEE Transactions on Emerging Topics in Computational Intelligence, 2018.

[2] C. Wang, X. Yan, M. Smith, K. Kochhar, M. Rubin, S. M. Warren, J. Wrobel, and H. Lee, "A unified framework for automatic wound segmentation and analysis with deep convolutional neural networks," in Engineering in Medicine and Biology Society (EMBC), 2015 37th Annual International Conference of the IEEE. IEEE, 2015, pp. 2415– 2418.

[3] A. Van Opbroek, M. A. Ikram, M. W. Vernooij, and M. De Bruijne, "Transfer learning improves supervised image segmentation across imaging protocols," IEEE transactions on medical imaging, vol. 34 , no. 5, pp. 1018–1030, 2015.

[4] M. Goyal, M. H. Yap, N. D. Reeves, S. Rajbhandari, and J. Spragg, "Fully convolutional networks for diabetic foot ulcer segmentation," in 2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Oct 2017, pp. 618–623.

[5] K. Bakker, J. Apelqvist, B. Lipsky, J. Van Netten, and N. Schaper, "The 2015 IWGDF guidance documents on prevention and management of foot problems in diabetes: Development of an evidence-based global consensus," Diabetes/Metabolism Res. Rev., vol. 32, no. S1, pp. 2–6, 2016.

[6] D. G. Armstrong, A. J. Boulton, and S. A. Bus, "Diabetic foot ulcers and their recurrence," New England Journal of Medicine, vol. 376, no. 24, pp. 2367–2375, 2017.

[7] J. J. van Netten, D. Clark, P. A. Lazzarini, M. Janda, and L. F. Reed, "The validity and reliability of remote diabetic foot ulcer assessment using mobile phone images," Scientific Reports, vol. 7, no. 1, p. 9480 , 2017. L. Wang, P. Pedersen, E. Agu, D. Strong, and B. Tulu, "Area determination of diabetic foot ulcer images using a cascaded two-stage svm based classification," IEEE Transactions on Biomedical Engineering, 2016.

[8] C. E. Hazenberg, J. J. van Netten, S. G. van Baal, and S. A. Bus, "Assessment of signs of foot infection in diabetes patients using photographic foot imaging and infrared thermography, "Diabetes Technol. Therapeutics, vol. 16, no. 6, pp. 370–377, 2014.

[9] M. Goyal and M. H. Yap, "Multiclass semantic segmentation of skin lesions via fully convolutional networks," arXiv preprint arXiv:1711.10449, 2017.

[10] M. Adam, E. Y. Ng, J. H. Tan, M. L. Heng, J. W. Tong, and U. R. Acharya, "Computer aided diagnosis of diabetic foot using infrared thermography: A review," Computers in biology and medicine, vol. 91, pp. 326–336, 2017.