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Diabetes Detection using Foot Thermography with Deep Learning

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ABSTRACT: Diabetes Mellitus (DM) is a metabolic disorder characterized by in-creased blood glucose. The pathology can manifest itself with different conditions, including neuropathy, the main consequence of diabetic disease. Statistics show worrying figures worldwide, diagnosed an estimated 1.6 million people with DM by 2025. In this sense, alternative and automated methods are necessary to detect DM, allowing it to take the pertinent measures in its treatment and avoid critical complications, such as the diabetic foot. On the other hand, foot thermography is a promising tool that allows visualization of thermal patterns, patterns that are altered as a consequence of shear and friction associated with lower limb neuropathy. Based on these considerations, we explored different strategies to detect patients with DM from foot thermography in this research.

I. INTRODUCTION

The Detection of Diabetes Mellitus with Deep Learning using thermal images represent a cutting-edge approach to diabetes diagnosis and monitoring. Diabetes Mellitus is a prevalent and chronic medical condition that affects millions worldwide, and early detection is crucial for effective management. In recent years, deep learning, a subset of artificial intelligence, has demonstrated remarkable capabilities in analysing thermal images to identify patterns and anomalies related to various health conditions. This innovative application harnesses the power of thermal imaging technology to detect subtle temperature variations and thermal signatures associated with diabetes. By utilizing deep learning algorithms, it promises a non-invasive, cost-effective, and efficient means of screening for diabetes, offering the potential to revolutionize how we approach this disease's early identification and management. This development holds great promise for improving healthcare outcomes and enhancing the quality of life for individuals living with or at risk of diabetes.

II. LITERATURE REVIEW

This paper investigates the use of deep learning with data augmentation techniques for diabetes mellitus detection solely based on foot thermography [1]. It highlights the potential of this approach for non-invasive diabetes diagnosis. In this investigation we use deep convolutional neural networks, using 12 distinct data augmentation approaches, to identify DM patients based on foot thermography alone. We employ categorization indices, such as the Thermal Change Index (TCI), in order to synthesize thermal images of the foot.

Significant morbidity might result from amputation and diabetic foot ulcers (DFU) [2]. DFU can be avoided by identifying patients who are at risk and putting preventative measures like education and unloading into practice. According to studies, thermogram pictures may be useful in by identifying patients who are at risk and using preventative strategies like education and unloading, DFU can be averted. Thermogram images have been shown to be helpful in recognizing plantar temperature rises that take place before to DFU.

The studies reports that thermogram images may help to detect an increase in plantar temperature prior to DFU [3]. It can be challenging to measure and use plantar temperature as a predictor of results, nevertheless, because of its potentially diverse distribution. Using foot thermogram images, we have tested the performance of numerous state-of-the-art Convolutional Neural Networks (CNNs) with a machine learning-based scoring system that includes feature selection, optimization techniques, and learning classifiers. The result is a reliable method for identifying the diabetic foot.

The study proposes a new method based on deep learning for the early detection of diabetes [4]. The PIMA dataset used in the study is entirely composed of numerical values, just like many other medical data sets. This makes it difficult to

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apply widely used convolutional neural network (CNN) models to these kinds of data. In order to employ the robust representation of CNN models in the early detection of diabetes, this work transforms numerical data into visuals based on feature importance.

The classification outcome from a parallel classifier is combined in the study [5]. Shuffle Net and MobileNetV2 convolutional neural network (CNN) models were used as the baseline classifier. Plantar thermogram datasets were used to train MobileNetV2 and Shuffle Net, which were then used to create the classifier model. One hundred binary classes of positive and negative situations were achieved by the framework.

This work introduces a plantar thermogram database comprising 334 thermograms obtained from 122 diabetic and 45 non-diabetic individuals [6]. Each thermogram is accompanied by four additional images representing plantar agnosies, along with their respective temperature files. This database facilitates the analysis of temperature variations in specific foot regions, aiding in the identification of potential changes in blood supply that may indicate ulceration risk. Researchers can utilize this database to assess the potential of infrared thermography (IRT) for early detection of diabetic foot complications.

The study compares infrared energy emitted by feet, revealing average temperature differences of 4.27ΣC (right foot) and 3.39ΣC (left foot) between diabetic and non-diabetic individuals [7]. They developed a thermographic camera prototype for clinical use to detect temperature asymmetry, potentially indicative of diabetes mellitus. The research aims to analyse treatment effects on diabetic feet through thermal analysis. Additionally, they corrected the prototype's characteristic equation using data from industrial thermographic cameras and infrared thermometers for accuracy.
The study [8] proposes early diabetic foot detection through radiometric data analysis and IR thermography image processing. Samples from 12 diabetes mellitus patients revealed non-homogeneous temperature patterns. Resulting binary images highlighted elevated temperature areas, potentially indicative of lesion-prone spots. This pioneering approach, utilizing radiometric data processing, offers a promising avenue for early detection, supporting subsequent numerical analysis and pattern recognition. It sets a precedent for augmenting diagnostic support systems like medical thermography, facilitating more proactive diabetic foot management and care.

This study explores using IR thermography to identify subtle temperature variations in the foot [9]. Researchers tested their method on 12 diabetic patients, finding temperature differences in concerning areas were less than 1°C. Despite this, the algorithm successfully pinpointed regions with abnormal temperature patterns. This research highlights the potential of IR thermography and image processing for early detection of diabetic foot complications.
This study explores using thermography to detect diabetic foot ulcers (DFUs). It compares machine learning and deep learning approaches on publicly available images. Their custom CNN model outperformed others in accuracy. Notably, analyzing entire thermographic images (image-level) proved more effective than focusing on smaller areas (patch-level) or combining both [10].

This study explores using infrared thermography of the entire foot sole to detect early signs of diabetic foot ulcers. It acknowledges limitations of past research due to small, unbalanced datasets [11]. The authors introduce a larger, more general dataset and compare feature extraction methods to identify diabetic patients. They find success in both identifying relevant features and generalizing their approach to a wider range of data, highlighting the potential of thermography for early diabetic foot ulcer detection.

This study explores using infrared foot thermograms to detect diabetic foot complications early. While temperature distribution in diabetic feet varies, the abnormal patterns hold promise for early detection. The authors propose a novel approach using k-means clustering on existing diabetic foot thermogram data [12]. This unsupervised method groups images based on severity risk, as verified by medical professionals. The system's potential for remote diabetic foot monitoring via mobile application and infrared camera is highlighted.

This study tackles diabetic foot ulcer (DFU) classification using Convolutional Neural Networks (CNNs). While existing CNN methods rely solely on RGB images, this research introduces a two-stage approach [13]. The first stage extracts texture information from the RGB image. This texture data, combined with the original RGB image, is then fed into the CNN. This method outperforms prior CNN-based approaches using only RGB data, achieving an improved Area Under the Curve (AUC) and F-Measure.

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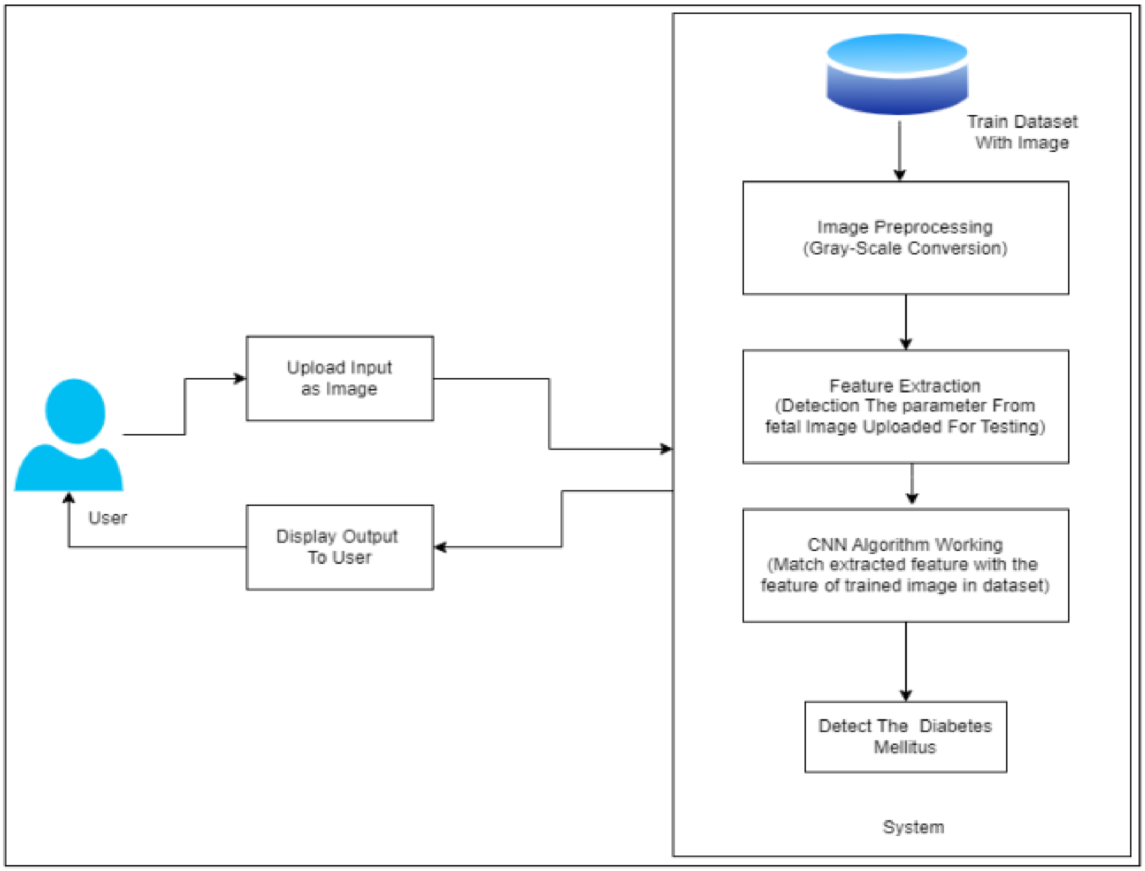
III. OBJECTIVES

- To identify diabetes at its earliest stages, allowing for prompt intervention and treatment.
- To provide a non-invasive and convenient method for diabetes screening, reducing the need for traditional blood tests.
- To continuously monitor diabetic patients' health by analyzing thermal images for variations that indicate changes in their condition.
- Identify early signs of diabetic neuropathy and vascular abnormalities in the feet.
- To make diabetes screening more accessible to a wider population, especially in regions with limited healthcare resources.
- To contribute to more effective and personalized diabetes management, leading to better health outcomes for patient.

IV. SYSTEM ARCHITECTURE AND DATA MODEL



Features of the Diabetes Detection using Foot Thermography Deep Learning:

• Early Detection: Enables the identification of diabetes at its early stages, al lowing for timely intervention and treatment.

• Non-Invasive: Offers a non-invasive and painless method for diabetes screening, reducing the need for blood tests.

• Cost-Effective: Potentially reduces healthcare costs associated with traditional diagnostic procedures.

• Accessible: Makes diabetes screening more accessible, particularly in underserved or remote areas.

• Continuous Monitoring: Allows for continuous monitoring of diabetic patients, enabling proactive management.

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V. TESTING OF MODELS

Testing Flowchart for Diabetes Detection using Foot Thermography Deep Learning Features:
Testing is an investigation conducted to provide stakeholders with information about the quality of the product or service under test. Software testing also provides an objective, independent view of the software to allow the business to appreciate and understand the risks of software implementation. Test techniques include, but are not limited to, the process of executing a program or application with the intent of finding software bugs. Software testing can also be stated as the process of validatingand verifying that a software program or application or product:

- Meets the business and technical requirements that guided
- Works as expected
- Can be implemented with the same characteristics

TYPE OF TESTING

- **Unit Testing**

It focuses on smallest unit of software design. In this we test an individual unit or group of inter related units.

- **Regression Testing**

The objective is to take unit tested components and build a program structure that has been dictated by design. Integration testing is testing in which a group of componentsare combined to produce output.

- **Smoke Testing**

Very time new module is added leads to changes in program. This type of testing makes sure that whole component works properly even after adding components to the complete program.

- **System Testing**

In this software is tested such that it works fine for different operating system. It is covered under the black box testing technique.

VI. RESULT AND CONCLUSION

In conclusion, the application of Deep Learning with thermal images for the detection of Diabetes Mellitus represents a significant step forward in healthcare. This innovative approach offers early diagnosis, non-invasive screening, and continuous monitoring, enhancing the overall management of diabetes. While it has immense potential, it is essential to address limitations and regulatory concerns, ensuring its ethical and accurate use. With ongoing research and development, this technology holds promise in revolutionizing diabetes care by making it more accessible, cost-effective, and efficient, ultimately improving the quality of life for individuals affected by this chronic condition.

REFERENCES

1. Bhoi, S.K. Prediction of diabetes in females of Pima Indian heritage: A complete supervised learning approach. Turk. J. Compute. Math. Educ. (TUR COMAT) 2021, 12, 3074–3084.
2. Mellitus, D. Diagnosis and classification of diabetes mellitus. Diabetes Care 2005, 28, S5–S10.
3. Madan, P.; Singh, V.; Chaudhari, V.; Alba gory, Y.; Dumka, A.; Singh, R.; Gehlot, A.; Rashid, M.; Alshamrani, S.S.; AlGhamdi, A.S. An Optimization Based Diabetes Prediction Model Using CNN and Bi-Directional LSTM in Real-Time Environment. Appl. Sci. 2022, 12, 3989. [CrossRef]
4. Pippitt, K.; Li, M.; Gurgle, H.E. Diabetes mellitus: Screening and diagnosis. Am. Fam. Physician 2016, 93, 103–109. [PubMed]
5. Xu, G.; Liu, B.; Sun, Y.; Du, Y.; Snetselaar, L.G.; Hu, F.B.; Bao, W. Preva lancer of diagnosed type 1 and type 2 diabetes among US adults in 2016 and 2017: Population based study. BMJ 2018, 362, k1497. [CrossRef] [PubMed]

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6. Chiefari, E.; Arcidiacono, B.; Foti, D.; Brunetti, A. Gestational diabetes mellitus: An updated overview. J. Endocrinol. Investig. 2017, 40, 899–909. [CrossRef] [PubMed]

7. Mirghani Dirar, A.; Doupis, J. Gestational diabetes from A to Z. World J. Diabetes 2017, 8, 489–511. [CrossRef] [PubMed]

8. Sarwar, A.; Ali, M.; Manhas, J.; Sharma, V. Diagnosis of diabetes type-II using hybrid machine learning based ensemble model. Int. J. Inf. Technol. 2020, 12, 419–428. [CrossRef]

9. Zhou, H.; Myrzashova, R.; Zheng, R. Diabetes prediction model based on an enhanced deep neural network. EURASIP J. Wirel. Commun. Netw. 2020, 2020, 148. [CrossRef]

10. Cho, N.; Shaw, J.; Karuranga, S.; Huang, Y.; da Rocha Fernandes, J.; Ohlrogge, A.; Malanda, B. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Res. Clin. Pract. 2018, 138, 271–281. [CrossRef]

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