International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 26 Issue 4 – JUNE 2019.

A Quantitative Index for Classification of Plantar Thermal Changes in the Diabetic Foot

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***ABSTRACT*: One of the main complications caused by diabetes mellitus is the development of diabetic foot, which in turn, can lead to ulcerations. Because ulceration risks are linked to an increase in plantar temperatures, recent approaches analyze thermal changes. These approaches try to identify spatial patterns of temperature that could be characteristic of a diabetic group. However, this is a difficult task since thermal patterns have wide variations resulting on complex classification. Moreover, the measurement of contralateral plantar temperatures is important to determine whether there is an abnormal difference but, this only provides information when thermal changes are asymmetric and in absence of ulceration or amputation. Therefore, in this work is proposed a quantitative index for measuring the thermal change in the plantar region of participants diagnosed diabetes mellitus regards to a reliable reference (control) or regards to the contralateral foot (as usual). Also, a classification of the thermal changes based on a quantitative index is proposed. Such classification demonstrate the wide diversity of spatial distributions in the diabetic foot but also demonstrate that it is possible to identify common characteristics. An automatic process, based on the analysis of plantar angiosomes and image processing, is presented to quantify these thermal changes and to provide valuable information to the medical expert.**

KEYWORDS – Contralateral Foot, Thermal Patterns, Image Processing, Thermal Reduction, Quantitative Index.

1. INTRODUCTION

The term digital image refers to processing of a two dimensional picture by a digital computer. In a broader context, it implies digital processing of any two dimensional data. A digital image is an array of real or complex numbers represented by a finite number of bits. An image given in the form of a transparency, slide, photograph or an X-ray is first digitized and stored as a matrix of binary digits in computer memory. This digitized image can then be processed and/or displayed on a high-resolution television monitor. For display, the image is stored in a rapid-access buffer memory, which refreshes the monitor at a rate of 25 frames per second to produce a visually continuous display.

2.LITERATURE SURVEY

"The Application of Thermal Image Analysis to Diabetic Foot Diagnosis",by Kuo-Sheng Cheng and Jin-Shen Yang.

Due to the deficiency of peripheral sensory and autonomic nerves and the complication of peripheral vascular disease, the patients with diabetes are prone to induce the ulcers on their limbs. If the ulcer formation or poor circulation area can be detected as early as possible, the occurrence of amputation morbidity may be reduced. In this study, the thermal image analysis is applied to characterize the superficial circulation of foot. Nine subjects with or without diabetes needing skin graft are recruited and divided into control group and experimental group. Both static and dynamic thermal images are acquired for analysis. The temperature difference percentage, Karhunen-Loéve transform, and thermal recovery tendency analysis are employed for thermal image analysis. From the results, it is shown that the area of poor circulation around the wound in the patients with diabetes may be significantly revealed using Karhunen-Loéve transform and thermal recovery tendency analysis

" Correlation between Plantar Foot Temperature and Diabetic Neuropathy: A Case Study by Using an Infrared Thermal Imaging Technique", by Subramnaiam Bagavathiappan.

Diabetic neuropathy consists of multiple clinical manifestations of which loss of sensation is most prominent. High temperatures under the foot coupled with reduced or complete loss of sensation can predispose the patient to foot ulceration. The aim of this study was to look at the correlation between plantar foot temperature and diabetic neuropathy using a noninvasive infrared thermal imaging techniqueInfrared thermal imaging, a remote and noncontact experimental tool, was used to study the plantar foot temperatures of 112 subjects with type 2 diabetes selected from a tertiary diabetes centre in South India.

"The Prediction Of Diabetic Neuropathic Plantar Foot Ulceration By Liquid-Crystal Contact Thermography", By Susan J. Benbow.

To assess whether the development of plantar foot ulceration could be predicted from the mean plantar foot temperature (MFT), as assessed by liquidcrystal contact thermography (LCT), in patients with peripheral neuropathy.

"Can Plantar Pressure Predict Foot Motion",by Friso Hagman.

The use of two legs to move about is a quality of humans. After an extensive period of evolution, walking and running are the most natural forms of human locomotion. Other forms of human locomotion do exist: some are developmental in nature such as crawling in case of very young children, others are situational such as stair climbing and hurdling. In this thesis, we focus primarily on gait, that is walking, with an occasional side step to running. Though natural, these two forms of locomotion are by no means infallible. Deciencies to the locomotion system make up an important part of the injuries sustained in our present day society. Besides injuries, the locomotion system is susceptive to diseases. Both injuries and deceases change our gait pattern from its natural, "normal state", to a sometimes painful.Since the problems accompanying gait disorders have a great impact on both the individual (for example restraint mobility) and society (for example loss of working hours), the professional community involved in gait analysis is numerous. This area of study draws the attention of both the medical and the scientifc world. These communities are constantly trying to better understand the underlying processes of gait. The knowledge acquired is used to medically treat gait disorders, and to scienti¯cally indicate intrinsic factors that may lead to the development of future individual gait problems.

5 . "Does Alignment in the Hindfoot Radiograph Influence Dynamic Foot-floor Pressures in Ankle and Tibiotalocalcaneal Fusion", by Arno Frigg MD, Benno Nigg.

Background The Saltzman-el-Khoury hindfoot alignment view (HAV) is considered the gold standard for assessing the axis from hindfoot to tibia. However, it is unclear whether radiographic alignment influences dynamic load distribution during gait. Questions/purposes We evaluated varus-valgus alignment by the HAV and its influence on dynamic load distribution in ankle and tibiotalocalcaneal (TTC) arthrodesis. Patients and Methods We clinically assessed 98 patients (ankle, 56; TTC, 42) with SF-36 and American Orthopaedic Foot and Ankle Society (AOFAS) scores, visual hindfoot alignment, HAV angle, and dynamic pedobarography using a five-step method. For comparison, 70 normal feet were evaluated.

3.EXISTING SYSTEM

It has been recognized that the main causes of ulceration are diabetic neuropathy and vascular disease of both the macro- and microcirculation.1 Uncontrolled diabetes leads to various complications affecting the eyes, kidneys, heart, nerves, and feet. Indeed, foot complications are one of the most frequent problems of diabetes mellitus and key contributors to medical costs, as 50% of all inpatient admissions due to diabetes are due to foot complications. The two main causes of diabetic complications are decreased blood supply and loss of sensation in the feet (neuropathy).

3.1 LIMITATIONS OF EXISTING SYSTEM

- If the image is too condensed, in the sense that it does not contain 'lessimportant' areas, then any type of content-aware resizing strategywill not succeed.
- Images can be retargeted only to rectangular target shape.

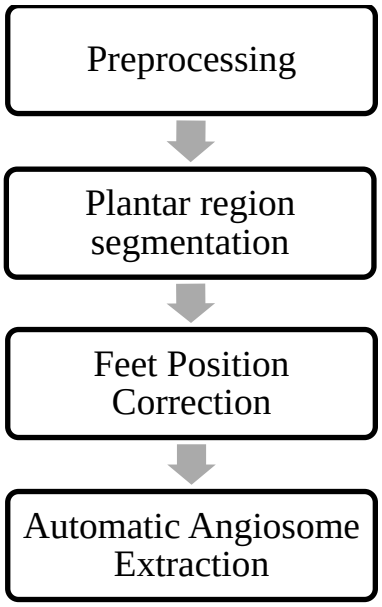
2. PROPOSED SYSTEM

The goal is to develop a methodology for identifying and characterizing the diversity of thermal changes in the plantar region of control and DM groups. This is important since it is known that temperature increment is related to high risk ulceration. To do so, a quantitative indicator will be provided to medical specialists, which will enable them to classify and analyze the progress of the temperature variations. We have found that by using the angiosome concept and by measuring their temperature, it is possible to detect thermal changes even in the early stages. This is a difficult task to achieve by using qualitative methods. Furthermore, an automatic methodology is proposed to offer a fast and reliable procedure, providing an indicator index which can be used by the medical expert to monitor DM subjects.

4.1 ADVANTAGES IN PROPOSED SYSTEM

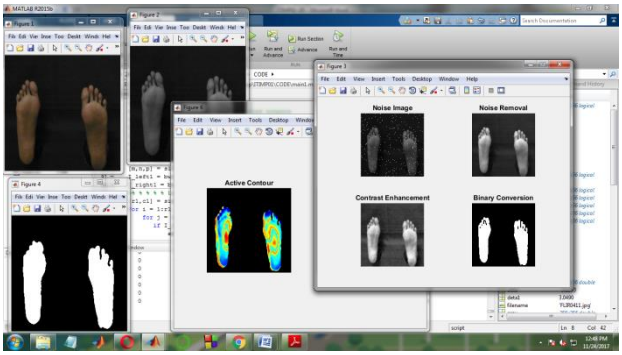
This approach takes advantage of the fact that there is a well established pattern for the control group.

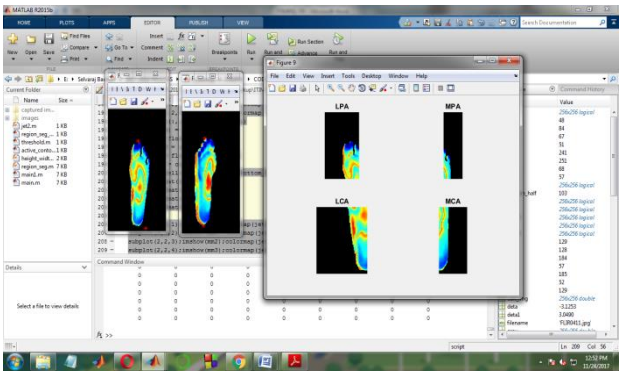
3. BLOCK DIAGRAM



4. RELATED RESULTS AND OUTPUTS

The launching of Anaconda navigator and after the launching jupyter is used to run the python code.





5. CONCLUSION

In this work a methodology to classify the thermal changes in the temperature plantar distribution based on a quantitative indicator is presented. Our research confirmed that the wellknown butterfly pattern is observed on non-diabetic plantar temperatures and, an unpredictable spatial pattern in diabetic subjects also was confirmed by observing wide variability of thermal distributions. The main contribution of the present work is to provide an automatic and simple assessment to identify the thermal change of a diabetic foot through a single index (*TCI*). The *TCI* was also used to identify significant changes that corresponds to certain values of thermal change. Thus, it was possible to find characteristic classes in the DM group. Five classes were proposed according to the *TCI* value and it was found that a difference of 1◦C is enough to notice a significative difference between classes. Moreover, with this index, early but not visually obvious affectations can be detected. Thus, a classification based on *TCI* provides information regarding whether a thermal change is happening, and if so, to measure it. To the best of our knowledge, this is the first study that quantitatively evaluates the thermal change of the plantar region in the diabetic foot. The asymmetry and wide variety of thermal distribution of patients with DM demonstrates the importance to keep studying the way of these changes occur and evolve in order to take preventive actions against ulceration risks. This valuable information could potentially provide medical experts not only with an accurate reference, but also with an indicator parameter for simple interpretations and comparisons of thermal changes in the diabetic foot.

6. REFERENCES

[1] R. A. Welikala, J. Dehmeshki, A. Hoppe, V. Tah, S. Mann, T. H. Wiliamson, and S. A. Barman, ”Automated detection of proliferative diabetic retinopathy using a modified line operator and dual classification,” Computer Methods and Programs in Biomedicine 114, 247–261 (2014).

[2] International Diabetes Federation. IDF Diabetes Atlas, 6th edn.Brussels, Belgium: International Diabetes Federation, 2013. http://www.idf.org/diabetesatlas

[3] P. Zhang, X. Zhang, J. Brown, D. Vistisen, R. Sicree, J. Shawn, and G. Nichols, ”Global healthcare expenditure on diabetes for 2010 and 2030,” Diabetes Research and Clinical Practice 87, 393–301 (2010).

[4] D. S. Sims, P. R. Cavanagh, and J. S. Ulbrecht, ”Risk factors in the diabetic foot recognition and management,” Physical Therapy 68, 1887–1902 (1988).

[5] M. M. Iversen, G. S. Tell, T. Riise, B. R. Hanestad, T. stbye, M. Graue, and K. Midthjell, ”History of Foot Ulcer Increases Mortality Among Individuals With Diabetes Ten-year follow-up of the Nord-Trndelag Health Study,” Norway, Diabetes Care 32, 2193–2199 (2009).

[6] F. J. Service, R. A. Rizza, J. R. Daube, P. C. O’Brien, P. J. Dyck, ”Near normoglycaemia improved nerve conduction and vibration sensation in diabetic neuropathy”, Diabetologia 28, 722–727 (1985).

[7] G. Wigington, B. Ngo, M. Rendell, ”Skin blood flow in diabetic dermopathy”, Archives of Dermatology 140, 1248–1250 (2004).

[8] S. W. Kim, S. C. Kim, K. C. Nam, E. S. Kang, J J. Im, D. W. Kim, ”A new method of screening for diabetic neuropathy using laser Doppler and photoplethysmography”, Med. Bio. Eng. Comput. 46, 61–67 (2008).

[9] F. Ring, ”Thermal imaging today and its relevance to diabetes”, J. Diabetes Science and Technology 4, 857–862 (2010).

[10] D. G. Armstrong, K. Holtz-Neiderer, C. Wendel, J. Mohler, H. R. Kimbriel, L. A. Lavery, ”Skin temperature monitoring reduces the risk for diabetic foot ulceration in high-risk patients”, American Journal ofMedicine 120, 1042–1046 (2007).

[11] L. A. Lavery, K. R. Higgins, D. R. Lanctot, G. P. Constantinides, R. G. Zamorano, K. A. Athanasiou, D. G. Armstrong, C. M. Agrawal, ”Preventing diabetic foot ulcer recurrence in high-risk patients: use of temperature monitoring as a self-assessment tool”, Diabetes Care 30, 14–20 (2007).

[12] L. A. Lavery, K. R. Higgins, D. R. Lanctot, G. P. Constantinides, R. G. Zamorano, D. G. Armstrong, K. A. Athanasiou, C. M. Agrawal, ”Home monitoring of foot skin temperatures to prevent ulceration”, Diabetes Care 27, 2642–2647 (2004).

[13] T. Nagase, H. Sanada, K. Takehara, M. Oe, S. Iizaka, Y. Ohashi, M. Oba, T. Kadowaki, G. Nakagami, ”Variations of plantar thermographics patterns in normal controls and non-ulcer diabetic patients: novel classification using angiosome concept”, J. Plastic, Reconstructive and Aesthetic Surgery 64, 860–866 (2011).

[14] T. Mori, T. Nagase, K. Takehara, M. Oe, Y. Ohashi, A. Amemiya, H.Noguchi, K. Ueki, T. Kadowaki, H. Sanada, ”Morphological patterns classification system for plantar thermography of patients with diabetes”, J. Diabetes Science and Technology 7, 1102–1112 (2013).

[15] H. Peregrina-Barreto, L. A. Morales-Hernandez, J. J. Rangel-Magdaleno, J. G. Avina-Cervantes, J. M. Ramirez-Cortes, R. Morales-Caporal, ”Quantitative Estimation of Temperature Variations in Plantar Angiosomes: A Study Case for Diabetic Foot”, Computational and Mathematical Methods in Medicine 2014, 585306 (2014).

[16] C. Liu, J. van Netten, J. van Baal, S. Bus, F. van der Heijden, ”Automatic detection of diabetic foot complications with infrared thermography by asymmetric analysis”, J. of Biomedical Optics 20, 026003–026003 (2015).

[17] J. J. van Netten, M. Prijs, J. G. van Baal, C. Liu, F. van der Heijden, and A. Sicco, ”Diagnostic values for skin temperature assessment to detect

diabetes-related foot complications", Diabetes technology & therapeutics 16, 714–721 (2014).
[18] "Thermography guidelines, Standards and Protocols in Clinical Thermographic Imaging IACT (International Academy of Clinical Thermology),"
http://www.iact-org.org/professionals/thermogguidelines.html (2002).
[19] S. Bagavathiappan, J. Philip, T. Jayakumar, B. Raj, P. N. S. Rao, M. Varalakshmi, V. Mohan, "Correlation between plantar foot temperature and diabetic neuropathy: a case study by using an infrared thermal imaging technique," J. Diabetes Science and Technology 4, 1386–1392 (2010).
[20] S. Sivanandam, M. Anburajan, B. Venkatraman, M. Menaka, and D. Sharath, "Medical thermography: a diagnostic approach for type 2 diabetes based on non-contact infrared thermal imaging," Endocrine 42,, 434-351 (2012).
[21] M. Sezgin, B. Sankur, "Survey over image thresholding techniques and quantitative performance evaluation", J. Electronic Imaging 13, 146–168 (2014).
[22] S. J. Benbow, A. W. Chan, D. R. Bowsher, G. Williams, I. A. MacFarlane, "The prediction of diabetic neuropathic plantar foot ulceration by liquid-crystal contact thermography," Diabetes Care 17, 835–839 (1994).
[23] K. Cheng, J. Yang, M. Wang, S. Pan, "The application of thermal image analysis to diabetic foot diagnosis," J. Medical and Biological Engineering 22, 75–82 (2002).
[24] A. W. Chan, I. A. MacFarlane, D. R. Bowsher, "Contact thermography of painful diabetic neuropathic foot," Diabetes Care 14, 918–922 (1991).
[25] P. C. Sun, H. D. Lin, S. H. Jao, Y. C. Ku, R. C. Chan, C. K. Cheng, "Relationship of skin temperature to sympathetic dysfunction in diabetic at-risk feet," Diabetes Research and Clinical Pactice 73, 41–46 (2006).