A Novel Approach to Classify Nailfold Capillary Images in Indian Population Using USB Digital Microscope

Suma K. V., Department of Electronics and Communication, Ramaiah Institute of Technology, Bangalore, India

Vishwajit Sasi, Department of Electronics and Communication, Ramaiah Institute of Technology, Bangalore, India

Bheemsain Rao, Crucible of Research and Innovation, PES University, Bangalore, India

ABSTRACT

Nailfold capillaroscopy is a simple, non-invasive clinical aid used for the diagnosis of vascular dysfunction. The method proposed emphasizes on the USB Digital Microscope which is a cheaper and useful alternative to commercially available expensive videocapillaroscopes which produces high quality images. As the process of identifying anomalies in nailfold capillaries is a tedious and time-consuming process this article proposes a completely automated system to diagnose anomalies. The nailfold capillary images are pre-processed to highlight the important features and remove noise in the images. The processed images are then used to train machine learning models. This article then assays and compares the performance of Logistic Regression classifier, fully connected neural network, Convolutional Neural Network (CNN) and Random Forest classifiers by evaluating their classification accuracy, sensitivity and specificity. The results prove Logistic Regression to be most accurate with a low classification error rate of 10.64%. while, a substantial classification accuracy of 72% was obtained with a small dataset by using bottleneck features of a deep CNN.

KEYWORDS

Convolutional Neural Networks, Logistic Regression, Nailfold Capillary Image, Neural Networks, Random Forest Classifier, USB Digital Microscope

INTRODUCTION

Capillaries are the sites in the circulatory system where the actual exchange of nutrients and wastes along with gases O_2 & CO_2 take place. They are ultra-thin blood vessels and can be imaged conveniently at the nail bed region of fingers since they appear parallel to the skin at the nailfold. They appear as a bunch of inverted-U shaped and uniformly spaced blood vessels in healthy individuals. In diseased subjects, the capillaroscopic pattern could consist of loss of capillaries and other physical anomalies. Specific capillaroscopic patterns are identified in various diseases. Hypertensive subjects seem to have low capillary density and presence of elongated capillaries while in Diabetes there is rampant occurrence of capillary disorganizations such as giant capillaries, bushy capillaries and avascular

regions. In Scleroderma, three stages of severity namely 'Early', 'Active', and 'Late' are identified by Cutolo et al (Cutolo, 2013).

Nailfold capillaroscopy is a simple, non-invasive, inexpensive and repeatable clinical test. It has immense potential as a clinical tool for diagnosis, prognosis, research and therapeutic use in varied spectrum of diseases (Eduardo, 2015). The nailfold capillary (NFC) images are acquired using the microscope with a magnification of 20x onwards, but the capillaries are visible better when the magnification is 200x. Multiple types of equipment are used for this purpose. Reuven Bergman et al (2003) have used the unmodified hand-held dermatoscope as a capillaroscopic instrument to detect a scleroderma - dermatomyositis pattern. They found that the capillaroscopic results obtained with the dermatoscope can help the dermatologist in the clinical diagnosis of connective tissue disorders. Stereomicroscope has been used as a method of nailfold capillaroscopy (NFC) which is applicable to a wide age range of paediatric patients. H J Anders et al (2001) have conducted a prospective study comparing nailfold capillaroscopy using an ophthalmoscope and stereomicroscope for differentiating between primary and secondary Raynaud's phenomenon. Nailfold videocapillaroscopy (NVC), is the current gold standard for detection of capillary abnormalities which produce superior quality images. NVC is expensive and hence in developing countries like India an inexpensive, yet reliable equipment is in need. This is especially relevant given the inclusion of capillaroscopic abnormality within the 2013 classification criteria for SSc (Van Den, 2013). Vivek Vasdev et al (2011) have proposed the use of USB Digital Microscope for acquiring NFC images with high reliability.

The novelty of our work lies in two aspects: one, in the use of nailfold capillary images rather than the video sequence as in nailfold videocapillaroscope and two, in the automation methodology employed for classifying these images based on the health condition. We propose an efficient computer automated diagnosing system using the images obtained from the USB digital microscope as depicted in Figure 1.

Figure 1. Classification system
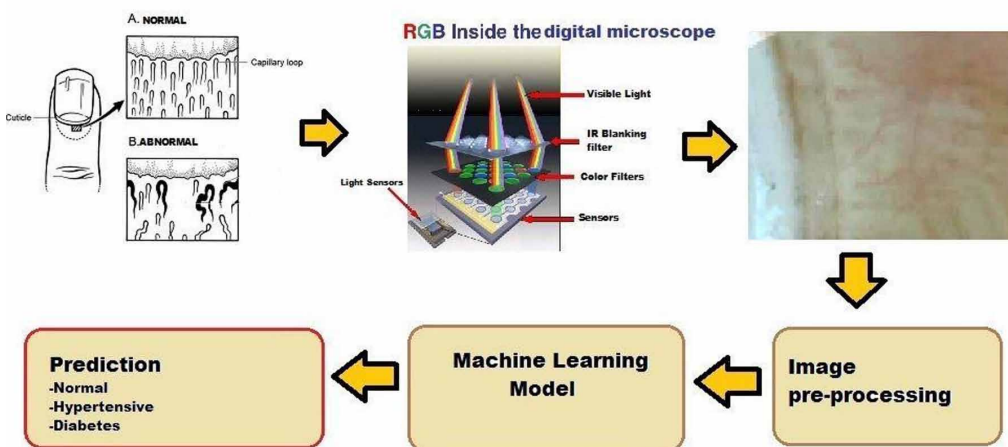
13 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/article/a-novel-approach-to-classify-nailfold-capillary-images-in-indian-population-using-usb-digital-microscope/199094

Related Content

Treatment Case Studies and Emissions Analysis of Wood in Yagya: Integrating Spirituality and Healthcare With Science
Rohit Rastogi, Sheelu Sagar, Neeti Tandon, Priyanshi Gargand Mukund Rastogi (2021). *International Journal of Biomedical and Clinical Engineering (pp. 29-43).*
www.irma-international.org/article/treatment-case-studies-and-emissions-analysis-of-wood-in-yagya/282493

Low Noise EEG Amplifier Board for Low Cost Wearable BCI Devices
Ravimand Suma K. V. (2016). *International Journal of Biomedical and Clinical Engineering (pp. 17-28).*
www.irma-international.org/article/low-noise-eeg-amplifier-board-for-low-cost-wearable-bci-devices/170459

EEG Based Thought Translator: A BCI Model for Paraplegic Patients
N. Sriraam (2013). *International Journal of Biomedical and Clinical Engineering (pp. 50-62).*
www.irma-international.org/article/eeg-based-thought-translator/96828

Elderly People, Disability, Dependence and New Technologies
José Millán-Calentiand Ana Maseda (2011). *Handbook of Research on Personal Autonomy Technologies and Disability Informatics (pp. 36-45).*
www.irma-international.org/chapter/elderly-people-disability-dependence-new/48273

Artificial Intelligence in Medicine and Biomedicine
Athanasios Zekiosand Dimitra Petroudi (2006). *Handbook of Research on Informatics in Healthcare and Biomedicine (pp. 346-351).*
www.irma-international.org/chapter/artificial-intelligence-medicine-biomedicine/20598