

Digital Circumferential Finger Measuring Device for Finger Clubbing Identification

Sharifah Masniah Wan Masra¹, Mohd Saufee Muhammad¹, Rahardjo Darmanto Djodibroto², Rohana Sapawi¹, Kuryati Kipli¹, Siti Kudnie Sahari¹, Nur Syahira Shahrom¹ and Maryam Rufaidah Mazlan¹

¹Department of Electrical and Electronic Engineering, Faculty of Engineering, UNIMAS, 94300 Kota Samarahan, Sarawak, Malaysia.

²Department of Medicine, Faculty of Medicine and Health Sciences, UNIMAS, 94300 Kota Samarahan, Sarawak, Malaysia.

wmmasnia@unimas.my

Abstract—This paper presents the development of a digital circumferential measuring device for facilitating measurements at various points along fingers, particularly at the nail-fold (NF) and distal interphalangeal joint (DIP). This project involves hardware and software development for helping clinicians to investigate and identify the early stage of finger clubbing within a short period. The value of Digital Index (DI) in this study is 9.30 ± 0.35 (Mean \pm SD) for 20 subjects. The average time taken to measure both NF and DIP circumferences using Digital Circumferential Finger Measuring Device (DCFMD) and to compute DI values using DI Calculation System for a single subject is 5 minutes 10 seconds. The developed device and its system have shown to be reliable in this study and achieve significant time savings in comparison to the existing measurement device.

Index Terms—Assistive Device; Computerized Instrumentation; Design Engineering; Electronic Medical Records; Finger Clubbing.

I. INTRODUCTION

In medicine, the term finger clubbing, also known as drumstick finger, refers to enlargement of the distal segments of the fingers, reduction in the nail-fold angle, and the sponginess of the nail beds [1]. Clubbing is associated with a number of diseases, such as pulmonary, cardiovascular, hepatic, thyroid and gastrointestinal system [2-4]. Clubbing may occur in stages, where the whole process usually takes years. The presence of drumstick finger identified a high-grade finger clubbing. However, the identification of lower grades or early stage of clubbing is challenging to the clinicians. A general appearance of the fingers' growth abnormalities may indicate the symptoms of clubbing. Obvious observation for finger clubbing includes the swelling of fingers' distal phalanges and change in the nail-fold (NF) angle. NF angles, shape, depth, and width of the terminal phalanges reveal abnormalities in those individuals with finger clubbing symptoms, as compared in Figure 1.

Profile angle measurement, hyponychial angle measurement, and Schamroth test are known as the effective techniques for measuring and accessing finger clubbing [2]. Two objective measures known as the phalangeal depth ratio and digital index (DI) have been proposed for determining the presence of clubbing [5]. This project will be focusing on the DI, where it measures two separate circumferences on each of 10 fingers at the NF and the DIP, as illustrated in Figure 2. The sum of NF:DIP ratios for all 10 fingers determines the DI [5]. DI of 10.2 or higher signifies the presence of clubbing.

Djodibroto et al. [6] proposed a simple but time-consuming device and method for identifying finger clubbing. It consists of non-elastic thread, a stand device to stabilize the finger, firm and thin paper, a clamp, cellophane tape, scissors and Vernier caliper for measuring NF and DIP. The time taken to perform the measurement and calculate the DI values manually for 23 male subjects and 21 female subjects is ranged from 21:63 to 68:80 minutes with an average of $35:97 \pm 9:16$ (Mean \pm SD). This is considered too time-consuming and impractical for a busy clinic practice. It would be clinically advantageous if a simple and automatic device for measuring finger circumference and calculating DI exists. We hope that the availability of a new device in wards will help the clinicians to speed up the investigation and identification procedure of the early stage of finger clubbing.

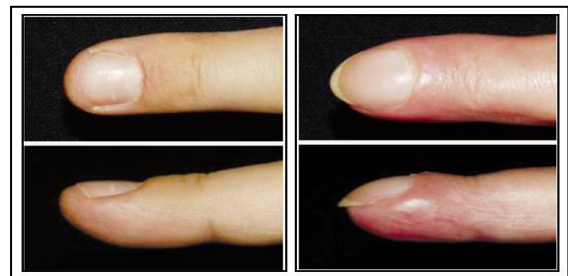


Figure 1: Comparison of normal finger (left) and clubbed finger (right) [6]

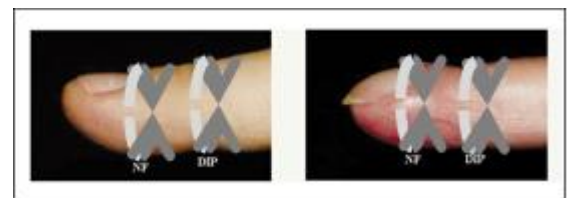


Figure 2: NF and DIP circumferences of a normal and clubbed finger (right) [7]

Masra et al. [7] have developed a first prototype of measuring finger circumference and its GUI interface for digital index calculation system. This device combined features of an analog sensor with a digital readout, and a case was made of acrylic Perspex.

It was found that the average time required to complete the measurement of both NF and DIP circumferences using the developed device, and DI calculation using the developed interface was $6:36 \pm 1:24$ minutes (Mean \pm SD) with a range