Following the diabetic feet progress for the prevention of ulcers using Optical Image Registration techniques*

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***Abstract*— The global burden of diabetes is projected to increase from 246 million people to over 380 million people by 2025 [1]. The main pathogenic mechanisms involved in diabetic foot complication include ischemia, neuropathy, and infection which combined with the presence of foot deformities and high pressure can produce tissue ulceration, necrosis, and finally leeds to amputation [2]. Foot ulcers recurrence was addressed in several studies and one of the main risk factors reported was the Motor Neuropathy complication associated to foot deformities (claw toe) [3]. The loss of foot flexor strength allows the foot extensors to contract and consequently the toes are pulled into a claw position and as a result the fat pad is pulled off the metatarsal heads, producing high pressure points under the metatarsal heads and the tips of the toes; those are the common areas for ulceration. Furthermore, it was also evidenced that the foot injuries occur while the patient is walking and are mainly caused by the forces that are generated during gait.**

I. Introduction

For the early prevention of ulcers in diabetic patients it is necessary to explore and develop new non invasive techniques by using optical images for following the changes of the foot morphology. This paper is going to present an image registration technique in order to detect changes of foot morphology in time.

II. Methods and Results

A Beurer brand balance was used, which was adapted to a Cannon scanner: 'CanonScanLiDe Model 100, the scanner was modified to place it under the balance. This adaptation brought some problems of artifacts and noise in the image which were reduced using digital image filtering. The resolution of images was 300 dpi, that means 2544 ***x*** 3496 pixels, RGB of 24 bits of depth. In order to enable image registration we developed new software in MATLAB that has five modules as shown in figure 1: a) Acquisition of the images with the scanner. b) Automatic splitting of two feet. c) Filtering to reduce noise in the image. Two methods of image registration were compared in this work: 1) *Control Point Registration* **(CPR)**. *2) Intensity– Based Automatic Image Registration.* **(AIR)**.

The first method: "CPR", we selected manually points in the image to be registered and the corresponding point in the reference image. In case of figure 2, nine control points were selected, and a correct registered of both images is observed. The drawback of this method is that the control points must be selected manually, which in some cases demands a lot of time, and there is a problem of variability of operators.

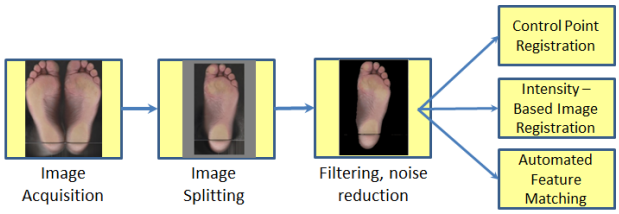

Figure 1. Schematic block diagram of registration technique.

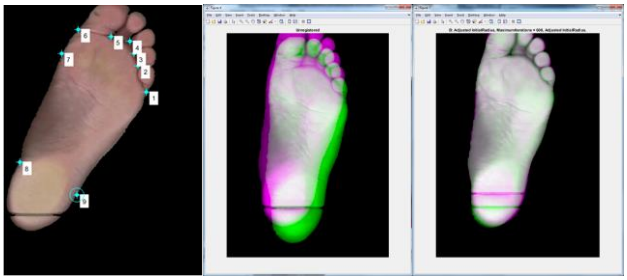

Figure 2. a) "CPR" method. b) Second registration method: "AIR" in process. c) Final best registration of two images

The second method: "**AIR**" is an iterative process. This requires the specification of a couple of images, the metric, optimizer, and a transformation type. The metric defines the similarity of the images for the evaluation of the accuracy in the registry. Thus, the similarity metric takes two images and returns a scalar value that describes how similar the images are. Four different metrics were tested; and results of the accuracy assessment allowed to determine that the 'Adjusted Initial Radius' modified with a maximum of iterations of 600 was the best register within this method, depicted on Figure 2 (b and c).

III. Conclusion

The implemented Optical Image Registration technique promises improved detection of early anatomic changes on the foot plantar and a more comprehensive study will follow for evaluating its robustness and effectiveness.

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