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AUTOMATED NEUROPATHY ASSESSMENT FROM PLANTAR IMAGES USING K-MEANS CLUSTERING

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Abstract - *People who live with type-2 diabetes suffer from plantar sensory neuropathy. Regular testing is required to avoid ulceration to patient's feet. Currently testing is done by using hand-held nylon monofilament probe and this is time consuming and prone to error. This paper automatically identify the pressure points on a given patients foot for via optical image processing incorporating plantar anthropometry. It automatically selects suitable test points on the plantar surface. The proposed system automatically identifies the specific pressure points at different locations namely toe(hallux),metatarsal heads and heel(calcaneus) areas and this approach is 100% reliability*

Key Words: ROI,k means,HSV,Foot region

1.INTRODUCTION

Diabetes mellitus is along with the most frequent chronic illnesses in the UK. Its frequency is rising and it has significant fiscal importance. As well as the direct costs of treating the illness and its associated complications, diabetes also has a number of indirect social and manufacture costs, including those related to increased mortality and morbidityand the call forrelaxed care. Diabetes UK reports that one in 10 people admitted to hospital have diabetes and in the order of15% of deaths per year are caused by diabetes.

There are two primary forms of diabetes, which are more often than not completely grouped together, but the causes and costs of which are different. Type 1 diabetes is an autoimmune syndrome that affects 10–15% of those with diabetes [1]. It is

Caused by alack of insulin produced in the body, with beginning of mostly before the age of 30 years, the exact cause being unknown. Type 2 diabetes affects 85–90% of those with diabetes and is caused by the body not efficiently using the insulin it produces because its cells are challenging to the action of the insulin [1]. It is often caused by obesity, age and inherited risk factors, with onset usually behind the age of 40 years. These two Main subtypes of diabetes mellitus are rarely distinguished in the media and even in some academic studies. A number of studies have put the broad cost burden of diabetes mellitus to the National Health Service (NHS) at between 5 and 10%, but with no breakdown between Types 1and 2 [2,3].

The primary method of mapping the profitable impact of a disease is burden-of-illness analysis. The aims of this paper are:

(1) to quantify the current direct costs to the NHS and indirect costs to society of diabetes mellitus in the UK;

(2) to project the future direct and indirect costs of diabetes to the UK;

(3) to provide a distinction between Type 1 and Type 2 diabetes in each of these analyses in order that they can be considered separately.

2. METHODS

Colour Representation

The appearance of an object is basically resulted from: the nature of the light reflected from the object, its optical characteristics, and the human perception. The colours are actually electromagnetic waves described by their wavelength. The visible spectrum, i.e., the portion of the electromagnetic spectrum that can be detected by the human eye, ranges from 390nm (violet) to 750nm (red). There are four main attributes that characterize the light: *intensity*, *radiance*, *luminance*, and *brightness*. In the case of achromatic light, the intensity is the only attribute involved. This is the case where the called *gray-scale* is used: intensity varies from black to white (gray levels in between). On the other hand, in the case of chromatic light, the other three attributes are used to measure the quality of the light source. The radiance refers to the amount of emitted energy by the light source, and it is measured in watts (W). The luminance measures the amount of radiation perceived by an observer, and it is measured in lumens (lm). The brightness is associated to the light intensity. Although the brightness has an accurate interpretation in monochromatic images, it is a very subjective property in the case of chromatic images. Because of the absorption characteristics of the human eye, the colours are considered to be formed from different combinations of the *primary colours* red, green, and blue. These three colours can be added to create the *secondary colours* magenta (red + blue), cyan (green + blue), and yellow (green + red). The white colour can be formed if the three primary colours are mixed or if a secondary colour is mixed with its opposite primary colour (all in the right intensities). In colour image analysis three attributes are used to differentiate one colour from another: *brightness*, *hue* and *saturation*. The hue attribute brings the information

concerning the main wavelength in the colour, i.e., it is responsible for verifying the colour, in the complete spectrum, from red to violet, and magenta. The saturation describes the level of mixture between the hue and the white light, i.e., it defines the "purity" of the colour. High values of saturation result in more gray-scale pixels and small values result in pixels with high "purity". For instance, the red colour is highly saturated and the pink color is unsaturated. A fully saturated color does not Contain white light. Finally, the *chromaticity* is a description that combines hue andSaturation. Hence, it is possible to describe an image according to brightness andchromaticity. The *colour depth* measures the amount of colour information available to display or print each pixel of a digital image. A high colour depth leads to more available colours, and consequently to a more accurate colour representation. For example, a pixel with one bit depth has only two possible colours: black and white. A pixel with 8 bits depth has 256 possible values and a pixel with 24 bits depth has more than 16 million of possible values. Usually, the colour depths vary between 1 and 64 bits per pixel in digital images. The *colour models* are used to specify colours as points in a coordinate system, creating a specific standard. In the following, the most common colour spaces are briefly presented.

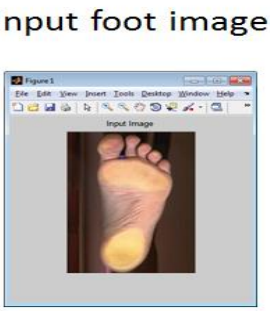

Fig 1 Input foot image

RGB Colour Model

The RGB (Red, Green, and Blue) colour space is one of the most used colour spaces, specially for 8 bit digital images. This model is usually used for representing colours in electronic devices as TV and computer monitors, scanners, and digital cameras. The theory of the trichromatic colour vision of Young–Helmholtz and the Maxwell's triangle is the basis of the RGB model. The RGB is an additive model where the red, green, and blue colours are combined on different quantities or portions to reproduce other colours. The pixels of an image represented in the RGB model have usually 8 bits depth, resulting in 256 possible intensities, i.e., the range of [0, 255] for each colour. A colour in the RGB model can be described indicating the amount of red, green, and blue. Each colour can vary between the minimum value (totally dark) and the maximum value (totally intense). When all the colours have the minimum value, the resulting colour is black. On the contrary, when all the colours have the maximum value, the resulting colour is white. This model is known as the RGB colour cube, because the model is based on the Cartesian coordinate system and its colour subspace of interest is a cube. The primary and secondary colours are at the corners of the cube. The black colour is at the origin and the white color is at its opposite corner. The diagonal between the black and the white colors is the gray scale.

HSV Colour Model

The HSV colour system, created by Alvy Ray Smith, is composed by three components: hue, saturation, and value. This model is also known as HSB (hue, saturation and brightness).These three parameters are used to define the colour space as explained before. The possible values for the hue attribute range from 0 to 360 and the values for the other two attributes range from 0 to 100. The HSV model is based on cylindrical coordinates and it is actually a nonlinear transformation of the RGB system. Hence, it is possible to transform directly a colour from the HSV system to the RGB system, and contrariwise (Smith 1978). There are two other colour systems related to HSV: the HSL (Luminosity) system and the HSI (intensity) system. This colour system is very interesting, because it allows the separation of the three components of a specific colour (hue, saturation, and intensity). It is broadly used in artificial vision systems, as it is a powerful tool for the development of digital image processing algorithms based on the human colour perception model. Indeed, the HSV model is well suited to characterize colours in practical terms for human interpretation, differently from the RGB and CMYK models

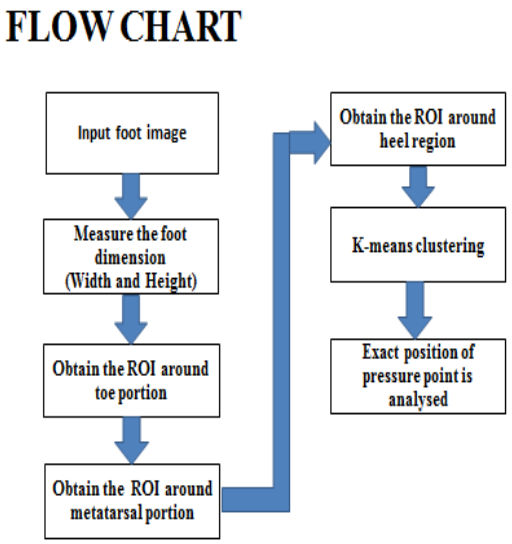

Fig 2 Flow chart

- In RGB , color components are difficult to execute some image processing techniques.
- An improved alternative to RGB is Hue, Saturation and Voluminous (HSV) that is closer to the human color perception system.

In HSV

1.One layer for brightness information i.e. V.

2.Two layers for color information i.e. H and S.

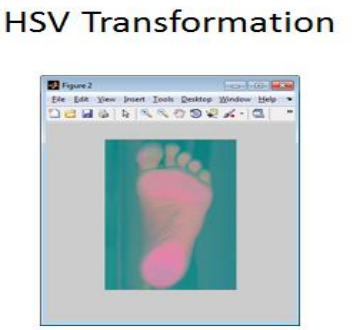

Fig 3 HSV Transformation

- F - set that contains all points belonging to plantar surface and F contains all white color pixels.
- Let S is the set that contains foot stopper color values in HSV space.

STEPS:

- A contour is drawn around the plantar surface called the foot rectangle.
- The bounded rectangle representing the foot dimension in terms of width and length .
- The region of interest (ROI) for the toe pressure area is bounded by a sub-rectangle.

METATARSAL REGION

The required pressure points at metatarsal are given as

$$M1(Mx1,My1) \mid Mx1 = \min(x) \wedge M1 \in M$$
$$M2(Mx2,My2) \mid Mx2 = \max(x) \wedge M2 \in M$$
$$M3(Mx3,My3) \mid (M1(Mx1,My1)+M2(Mx2,My2))/2 \wedge M3 \in M$$

where M1, M2 and M3 are left, right, and middle metatarsal pressure points.

Fig 4 Cluster index

K-means clustering

- k-means clustering is an algorithm to classify or to group the objects based on attributes/features into K number of group.
- K is positive integer number.
- The grouping is done by minimizing the sum of squares of distances between data and the corresponding cluster centroid.

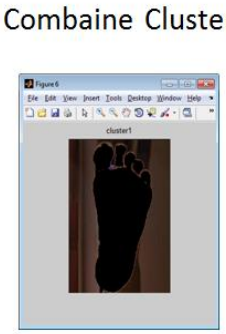

Fig 5 Combined Cluster

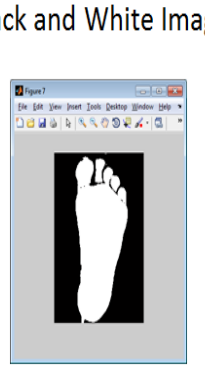

Fig 6 Black and White Image

3. CONCLUSIONS

Most of the cost estimates in this study were derived by taking estimates of incidence and prevalence and aggregating the musing unit costs. In some cases, costs have been extracted from other studies. The two key variables for sensitivity analysis are incidence / prevalence and cost. A full sensitivity simulation was not carried out, but the variables were adjusted to reflect the underlying uncertainty that exists in the data. For diagnosis and treatment, sensitivity analysis of _ 20% was applied to incidence and prevalence. This is on the basis that there is variation in estimates of diabetes prevalence and incidence and approximately 20% of people with diabetes may be undiagnosed. Based on the premise that incidence and prevalence may vary _ 20%, sensitivity analysis of _ 10% was

applied to the incidence of complications. This is because an increase in incidence and prevalence of the disease would not necessarily equate to a similar increase in complications, which tend to occur in people who have had diabetes for a number of years. The costs variable was adjusted by _ 20% to examine how sensitive the estimates are to fluctuations in cost.

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