

Early Detection of Ulcer using the Non Invasive Thermography Technique on the Foot Images

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ABSTRACT

Day by day the numbers of diabetic patients are increasing rapidly. In diabetes ulcer is a major complication and once the ulcer is occurring then it does not cure easily. Ulcer can be prevented if it is detected in early stage. For detection of diabetes there are many pathological techniques are available, but all they are invasive techniques and many people have panic of that so they avoid for regular diabetes checkup. Thermography is used for detection of ulcer area and this technique is totally non-invasive technique. Thermography is working on heat which is naturally emitted from the human body. High temperature under the foot is a symptom of diabetic neuropathy, and if this symptom is detected using a thermal technique then detection of ulcer in early stage is possible.

Keywords

Diabetes, neuropathy, temperature, wound area, masking

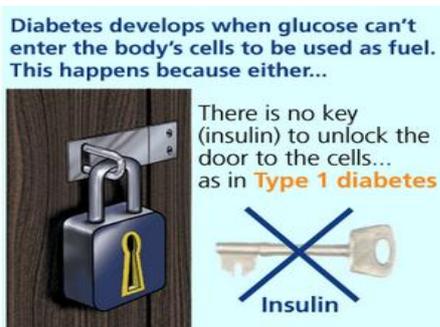
1. INTRODUCTION

Diabetes is also known as diabetes mellitus. It describes a group of metabolic diseases. Diabetes occurs due to the high blood sugar, either because an insufficiency of insulin production, or because the body's cells do not respond properly to insulin, or both [1]

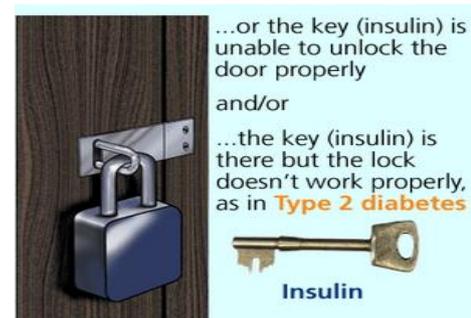
There are mainly two types of diabetes:

Type 1 diabetes-In this case body does not produce insulin.

Type 2 diabetes – In this case body does not produce enough insulin for proper function, or the cells in the body do not react to insulin that time type 2 diabetes accrued.



(A) Type I Diabetes



(B) Type II Diabetes

Fig 1. (A) Type 1 diabetes and (B) type 2 diabetes

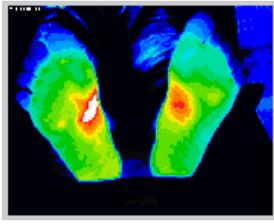
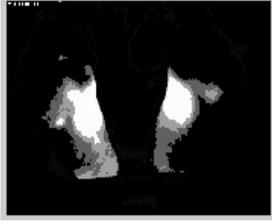
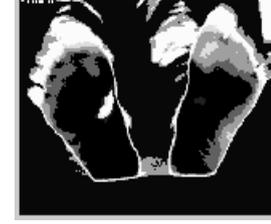
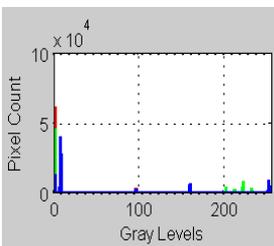
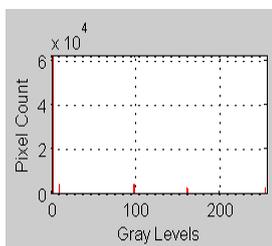
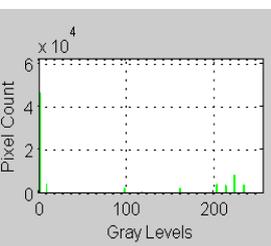
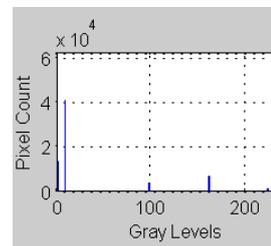
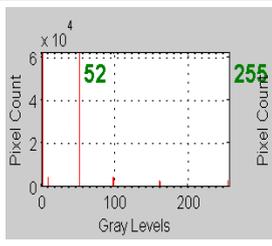
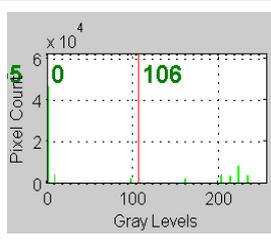
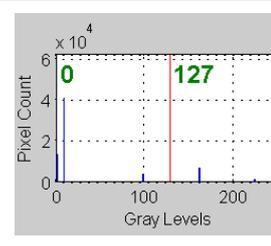
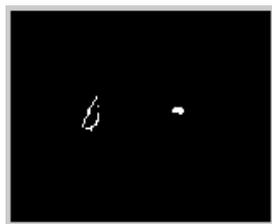
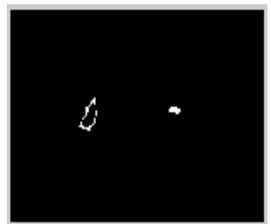
Figure 1 referred from the reference number [2] Day by day the patient with type 2 diabetes is rising rapidly worldwide. If diabetes is not recognized in early stage then it can be converted into the ulcer. Uncontrolled diabetes can affect the eyes, kidneys, heart, nerves, and feet. In that foot complications are one of the most common problems. Due to the foot complications near about 50% diabetic patients are admitted in the hospitals. There are main two causes of diabetic complications that are decreased blood supply and loss of sensation in the feet and these are the symptoms of diabetic neuropathy [3, 4]. Nerves are damaged due to the diabetic is called a diabetic neuropathy and diabetic neuropathy is a major problem in diabetes [5]. The term neuropathy is short for peripheral neuropathy, meaning nerve damage in the peripheral nervous system. In peripheral neuropathy only nerves outside of the brain and spinal cord are involved, it does not affect the central nervous system [6]. In peripheral neuropathy feet and legs are often affected first and followed hands and arms [7]. The early natural warning system of ulceration is, it increases the temperature of any particular area continuously 6-7 days and if these high temperature areas detect during those 6-7 days then detection of ulcer in early stage is possible. Using the thermography we can detect this high temperature area because thermography works in the heat. This technique is totally non invasive technique. In medical procedure non-invasive means without cutting a skin or without touching the internal body of a human. Thermography works on infrared radiation [8]. It captures the natural thermal radiation which is generated by an object at a temperature above absolute zero [9]. Thermography gives valuable information of human body surface on the temperature differences of different parts [10].

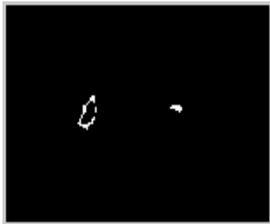
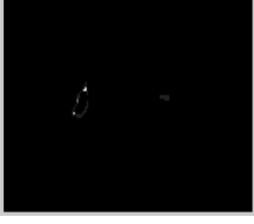
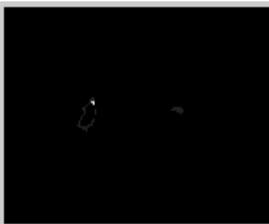
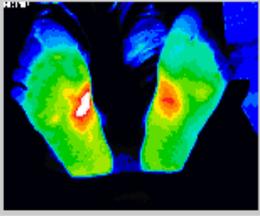
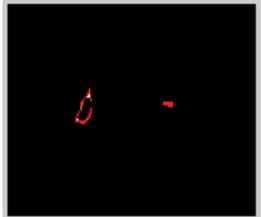
8) Statistical analysis
After extracting the wounded area, next step is, to calculate the size of that wounded area for knowing the

type of the wound area and also calculate the values of RGB pixels in that area. Table 3 shows the output of this experiment.

4. OUTPUTS

Table 3: Some output images

Individual Color Band			
Original Color Image	Red Band	Green Band	Blue Band
			
Histogram			
Histogram of all Bands	Histogram of Red Band	Histogram of Green Band	Histogram of Blue Band
			
Apply color threshold range and dispaly them over the Histogram			
	Histogram of Red Band	Histogram of Green Band	Histogram of Blue Band
			
Apply each color band threshold range to the color band			
	Is Red Mask	Is Not Blue Mask	Is Not Green Mask
			
Eliminate smaller region			
	Remove Smaller Objects	Border smoothed	Regions filled
			
Apply This mask to the Original Image			

	Mask Red Image	Mask Green Image	Mask Blue Image
			
Original Image	Mask original Image showing only the red object		
			

Once the wounded areas are detected, then the second step will be to detect in which stage this ulceration are. By calculating the size of wound area and calculating the numbers of wound areas the stage of ulcer can be detected. Some samples of images are explained below,

Example 1: Image of Non diabetic subject

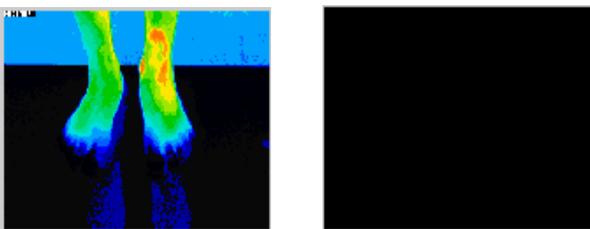


Figure 2: (A) Original Image (B) After processing

The above figure 2 shows the thermal image of normal (non diabetic) subject. Fig 2 (A) shows the some red portion after processing there is no any red area is found in fig 2 (B). It means that this red portion is not because of diabetic ulcer, this area shows red color due to the some other reasons like any external injury. When calculate the mean value of that red pixel area which is shown in fig 2(A) it is very less as compared to the mean value of diabetic infected areas. According to these mean value it is clear that this areas are not infected due to the diabetes.

Example 2: Proliferative phase

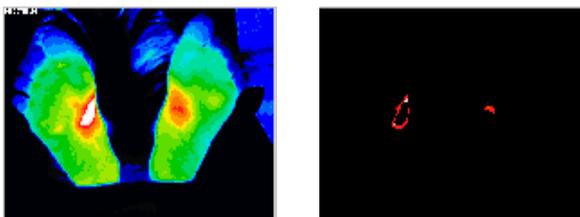


Figure 3: (A) Original Image (B) After processing

Figure 3 (a) show the thermal image of plantar foot. Above image is off 69 years old person. Figure 3 (b) shows the

extracted red object and this extracted red objects are nothing but an ulcer areas. The following table shows the mean value of RGB channels of Example 2.

Table 4: Outputs of example 2

Sr. no	Area in pixel	Mean R	Mean G	Mean B
1	191	251.02	50.71	49.5
2	80	251	35.15	30.8

Table 4 shows the number of extracted wound areas, pixels count of that extracted wound area and show the pixel values of Red green blue of that extracted wound area. According to table and fig(3) there are two wound areas are extracted, one from left foot and one from the right foot. Pixel count of first extracted wound area is 191 pixels and pixel count of second extracted wound area is 80 pixel. According to the pixel count of that wound areas, it is clear that this is a Proliferative phase means it is an initial stage.

Example 3: Maturation stage

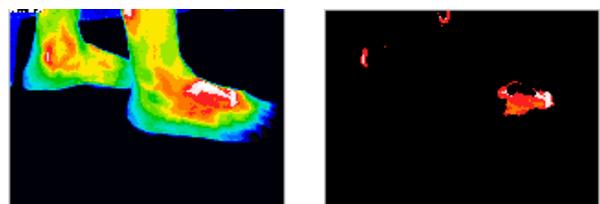


Figure 4: (A) Original Image (B) After processing

Table 5: Outputs of example 3

Sr. no	Area in pixel	Mean R	Mean G	Mean B
1	1388	251.08	79.22	58.41
2	145	251	79.03	76.63
3	102	251	51.42	43.46

According to table 5 and fig 4 there are three wound areas are extracted one from the left foot and two from the right foot. Pixel count of first extracted wound area is 1388 pixels and

pixel count of second extracted wound area is 145 pixels and pixel counts of third wound area is 102 pixels. According to the pixel count of that wound area, it is clear that this is a Maturation stage.

Outputs of all 7 images

Table 6: Outputs of all 7 images

Area in pixel	Mean R	Mean G	Mean B
170	251	125.37	0.19
119	251	140.93	0
187	251	132.33	0
1653	251	84.95	12.4
146	251	71.91	18.68
145	251	79.03	76.63
102	251	51.42	43.46
1388	251.08	79.22	58.41
614	251.09	64.43	51.96
63	251.19	110.11	104.59
87	251	66.31	66.31
191	251.02	50.71	49.5
80	251	35.15	30.8
222	101.83	0	152.17
83	253.98	3.04	3.04
642	253.84	17.25	17.25
2213	252.67	65.69	31.66
3663	252.22	115.55	99.21
514	252.2	74.14	12.35

The above table shows the output of all wound areas which are extracted from the thermal images of diabetic subjects

5. CONCLUSION

Diabetic patients have the highest risk of ulcer. Many times ulceration cannot be detected in early stage, so it may be converted in higher risk. Early symptoms of ulcer are temperature of the foot is increase before 7-8 days. If this inflammation detect within 7-8 days then it can easily prevent the ulcer. Using the thermography it can easily detect because thermography is mainly working on the heat. In diabetic ulceration temperature of some areas are increases or decrease as compared to surrounding areas, using thermography it is easy to detect the infected areas. But some time when any person had any internal injury at that time there is chances of thermal camera detect it as an infected area because, when people have any injury that time this area shows the different temperature as compared to the surrounding. To avoid this problem this work is useful.

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