Peer Learning Session (PLS)

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What Is Diabeties ?

It is an Medical Condition In Which Pancreas Not Secreting Enough Insulin Or Cells Become Unresponsive to Hormones, It is characterised By High Level Of Glucose In Blood, If Left Untreated It Leads to More Compilications, One Such Complication Is DFU (Diabetic Foot Ulcer).

Diabetic Foot Ulcer

Diabetic foot ulcer (DFU) is a common complication of diabetes and is characterized by the development of open sores or wounds on the feet of diabetic patients. These ulcers typically occur due to a combination of factors

- nerve damage
- poor circulation
- trauma
- impaired immune function.

DFUs can lead to serious complications, including infection, tissue necrosis(decay), and even lower limb amputation if not promptly diagnosed and managed.

Diabetic Foot Ulcer

So to facilitate early diagnosis a self care system needs to be implemented

Symptops

- Skin Color Changes (Redness)
- Temperature Change
- Damaged Skin (Due to Abnormal Foot Plantar Presure)
- Change In Sensation and Pain Level
- Swelling and Odor.

Diabetic Foot Ulcer

Indicative Features

- Wound Appearance: Affected Area Will Get Visibly Deformed and Redness which can be observable in Visible Spectrum (RGB)

- Temperature: Affected Area and Surrounding is observed to have some abnormaity in temerature of the feet which can be observable by Photography in Infrared.

- Pressure: ?

Figure 1: Diabetic Foot Ulcer

How It Looks Like

Figure 2: Diabetic Foot Ulcer Thermogram

Detection Methodology

- Non Invasive

1. RGB Imaging
2. Hyperspectral Imaging
3. Thermal Imaging
4. NIR

- Invasive

1. Tissue Biopsy
2. Foot Measurement
3. Doppler Ultrasound etc
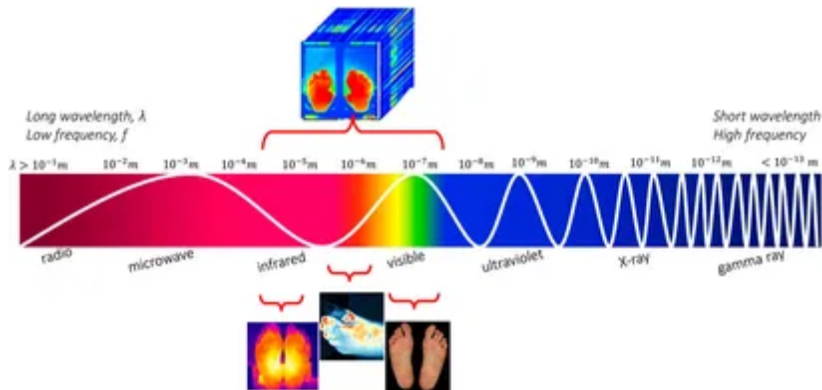
Electromagnetic Spectrum

Figure 3: Electromagnetic Spectrum

Non Invasing Sensor Based Techniques

- RGB Imaging : It Involves Capturing Image In Visible Spectrum Which Allows Us to Observe Apperance Of Affected Area, It Is Easily Accesible as it can be captured through a smart phones camera.

- NIR (Near IR) Imaging: Capture Image In Near IR to Monitor Oxygen and Hemoglobin Saturation Under Skin.

- Thermal Imaging: It Also Requires IR Camera That Allows us to measure Temerature Variation

- Hyperspectral Imaging : Captures a Continous Portion Of Light (NIR, MIR, FIR) Produces a Hypercube Consiting Of Mulitple Images Observed In Different Portion Of Light Spectrum, although it contains a lot of information but it is not easy to acquire and requires specialised equipement
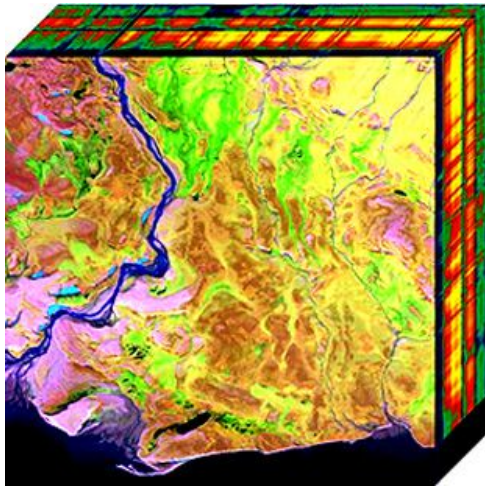
HyperSpectral Cube

Figure 4: HyperSpectral Cube

Comparison

Category	RGB Imaging	NIR Imaging
Cost	Low	Low
Accesibilty	Yes	Yes
Captured Information	Appearance	Oxygen and Hemoglobin Saturation Levels
Sensors	Smart Phone Common Cameras	Specialized Cameras

Comparison

Category	HSI Imaging	MID-IR Imaging
Cost	Low	Low
Accesibilty	No	Yes (Relativly More)
Captured Information	Multidimensional Information (In Different IR Regions)	Glucose Concentration
		Saturation Levels
Sensors	Specilized Equipement	Specialized Cameras

Research Gaps

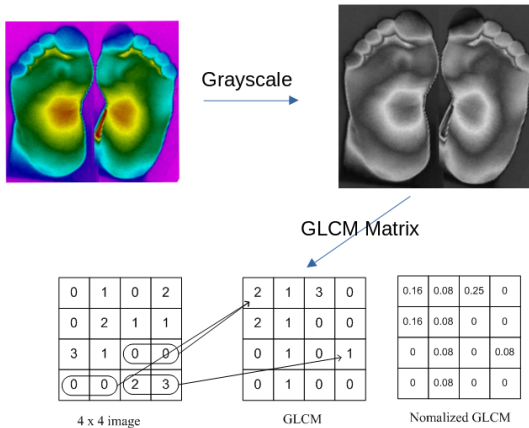1. HSI on Smart Phone Devices or Low Cost Devices
2. Optimizatized Algorithm for Low Cost and Embedded Devices with have Limited Computation Resources
3. Safety and Privacy Of Patient's Data

Pilot Study (Thermography)

How Features are Extracted From Thermogram Images

1. Thermogram Images
2. Preprocessing {Convert To Grayscale Image)
3. Create A GLCM Matrix
4. Compute Features
   1. Textural Features
   2. Histogram Features
5. Feature Fusion
6. Clustering/Classification

Grayscale

GLCM Matrix

0	1	0	2
0	2	1	1
3	1	0	0
0	0	2	3

4 x 4 image

2	1	3	0
2	1	0	0
0	1	0	1
0	1	0	0

GLCM

0.16	0.08	0.25	0
0.16	0.08	0	0
0	0.08	0	0.08
0	0.08	0	0

Nomalized GLCM

Pilot Study (Thermography)

GLCM Matrix

- It Indicates Probability Of A Pair of Grayscale value occuring in the images, it allows it to extract textural data from Image By Computing Following Quantities

1. Contrast: It quantifies the amount of local variations present in an image.
2. Energy: it is a measure of the uniformity of the image texture.
3. Inverse Difference Moment: It is a texture feature that measures the local homogeneity of an image., emphasizing the contribution of the diagonally oriented texture patterns.
4. Entropy: Quantify Amount of uncertainty or randomness
5. Correlation: measure that indicates the linear dependency between the gray-level co-occurrence matrix elements.

References

- Eid, Marwa M., Reem N. Yousef, and Mohamed A. Mohamed. "A proposed automated system to classify diabetic foot from thermography." Int. J. Sci. Eng. Res 9 (2018): 371-381.

- Kaselimi, Maria, Eftychios Protopapadakis, Anastasios Doulamis, and Nikolaos Doulamis. "A review of non-invasive sensors and artificial intelligence models for diabetic foot monitoring." Frontiers in Physiology 13 (2022): 924546.

End

Thank You