



PRESSURE MONITORING BY CAPTURING IR IMAGE

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Abstract – In this paper a method to monitor the pressure of the foot or hand by capturing an IR image is introduced. The test device consists of acrylic sheet, which is attached to IR led's, and an IR camera. It captures an IR image & creates a blob which is inturn useful for measuring the intensity and the pressure. The complete process is analysed and results are observed in Matlab & strain gauge

Keywords— Acrylic sheet, IR led strip, IR camera, matlab, strain gauge

observed by the scattered light rays and are recorded as a RGB image from an IR camera. The pressure at the Corresponding pressure points are analysed by using strain gauge.

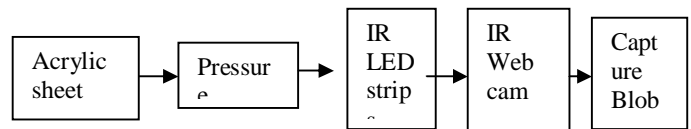


Figure 1. System model.

1. INTRODUCTION

Diabetic & polio patients mostly suffer from lack of nerve sensation, normally in hands and feet, therefore their ability in doing any activity may differ from that of a normal person and their points of high pressure are developed may vary from others

In this paper a simple apparatus is introduced to access and measure the pressure points. This typically uses a clear glass slab horizontally with IR led's placed at edges of the slab through which light travels within it, through a total internal reflection^[1]. An IR Camera is placed suitably below, to the acrylic sheet underside of the applied pressure onto the glass. The captured image is analysed by matlab and the pressure is calculated using strain gauge

2. METHODOLOGY

A. System Architecture:

The device consists of a transparent acrylic sheet of 5 mm thickness and 30 cm in height and width, which is cheaper than any other transparent materials like glass & plastic. IR led's attached to it, surrounds by producing certain radiation of wavelength 700nm. Light from the IR led's enters into the acrylic sheet from a side and traverse the thickness into total internal reflection. The pressure points of the hand will be

B. Sensor Design

In this paper we are using an 5mm thick transparent acrylic sheet, it can be scratched easily which inturn changes in the rays of scattered light^[1], so it is has to be fixed correctly by using a wooden board or notches to avoid further changes caused by scratching in the image. In this paper the main part of the sensor is the acrylic transparent plate with all its edges smoothly polished so that light does not get scattered back from any part of the edges. Initially no light ray enters into the acrylic surface either upwards or downwards. The device includes the IR led's through which the light enters into sides and passes through the acrylic surface causing a total internal reflection.

An IR camera is placed within the setup below or underneath the acrylic surface facing upwards. The Distance between the IR camera and the acrylic surface should be appropriate in order to focus the clear surface and its point of view.

Initially, without applying any pressure on to the acrylic surface gives an IR image which is of dark background^[2]

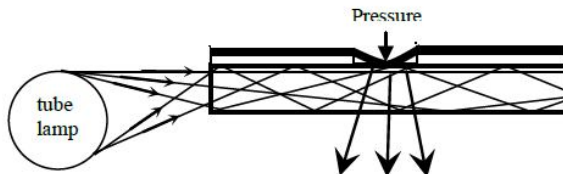


Figure 2: pressure at the sensor breaks down total internal reflection & scatters its beams downwards

The points where the pressures acts onto the sensing surface, the blood moves away from the high pressure points and this inturn changes the brightness, contrast and colour of the image between pressurized & less pressurized areas. At points of pressure, the microscopic spots which have air molecules are displaced in the transparent acrylic sheet, which causes breakdown of total internal reflection and light rays go out of the acrylic plate upwards^[2].

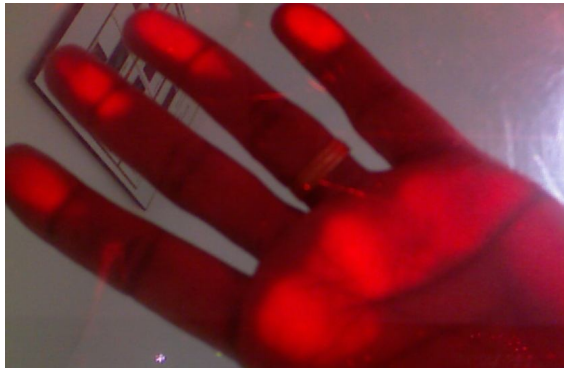


Figure 3. RGB image

From the above Figure, in this paper we can observe that the points which are appeared as bright spots were identified as the pressure points and their brightness increases by the increase of the amount of the pressure applied on the acrylic surface as it increases the microscopic area of the contact. The IR camera placed below the apparatus captures the patterns of light and stores the data in the computer. As the scattered ray would ideally range from total darkness, the camera should be sensitive enough to work even at low light levels. IR camera can easily be controlled from a PC and the data of the image can be stored in it, most of them slow down at low light levels giving more time for every exposure.

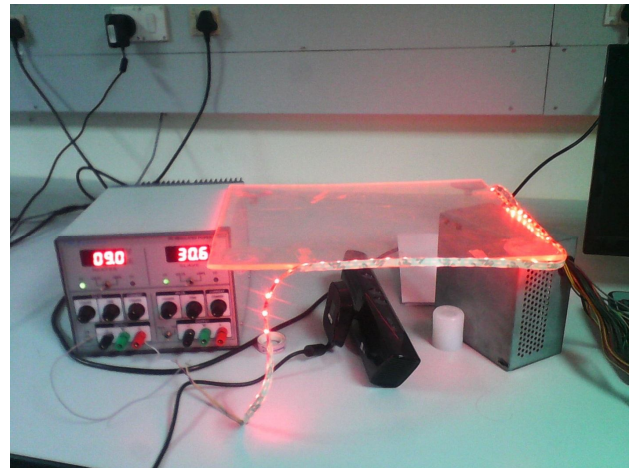


Figure 4: Complete apparatus

3.PROGRAMMING AND ANALYSIS

In the displayed mat lab program, the captured image is conFigureured through converting it into gray scale from an obtained RGB image, it is so converted because by this, the blob at the pressure points can be easily identified

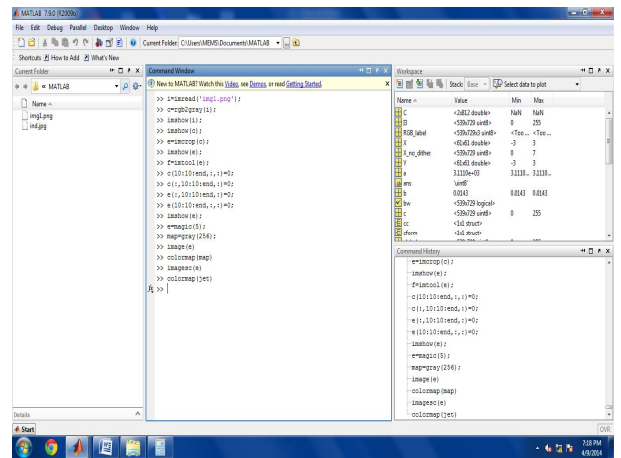


Figure 5: Matlab code

A particular blob is selected and is made into grid format which of dimensions 5x5 in which each grid is having a different intensity and different pixel values present. These pixel values and intensities, grid, and complete programming at each and every block is calculated with the help of the following matlab code

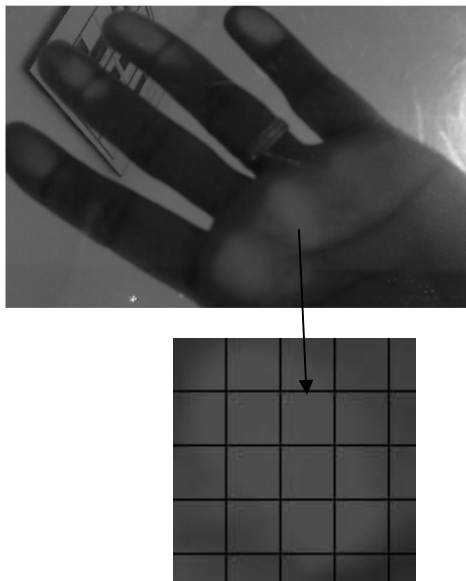


Figure 6: Selecting a particular pressure point

On the execution of the above code, the following window appears showing the pixel values at each of the points and its corresponding intensities at its respective targets are also appeared

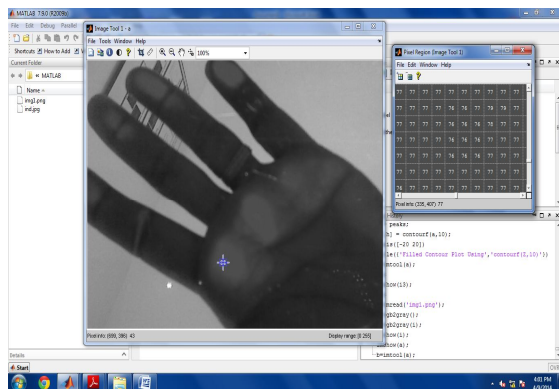


Figure.7: intensities at a point

The intensities and pixel values varies for each and every point, where the minimum intensity appears to be 0 and the maximum intensity is at 255, the intensity for each and every point is studied as different at different points.

These intensities which are differed by point to point can also be showed as different shaded patterns which are intended to be appeared as black as indicating '1' which has highest intensity among all the others in the blob and white being '0' gives the lowest intensity among all the others present in the blob.

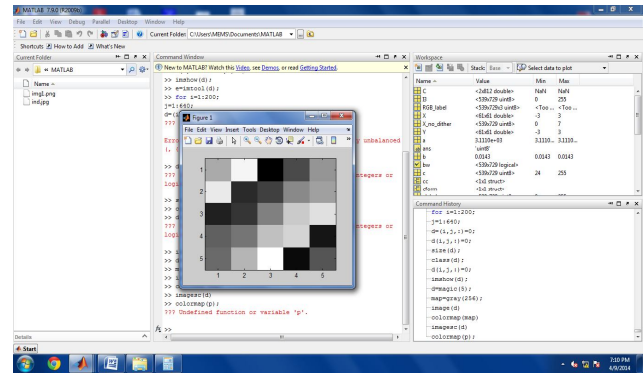


Figure 8: Different Intensities with shades

The shaded region which is nearer to the black and white depends upon the intensity values which are nearer to them This can also be performed by indicating the lowest and the highest intensities by separate colours which can be analysed by the same codes which gives the output pattern as the shades which are nearer to the intensity.

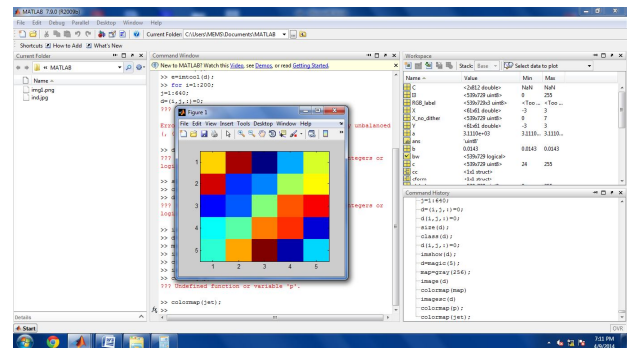


Figure 9: Different intensities indicated in colour format

4.RESULTS AND DISCUSSIONS

The pressure is obtained from the calculated intensity by using strain gauge which has beam length of 22cm, width of 2.6cm, thickness =0.25cm, and no. of arms=4 and its maximum load capacity as 1kg. The pressure is measured in Pascal's using different intensities and strains at different points and calculating the pressure by taking the relation in between them.

$$V_{out} = V_s S (P_m/P_r)$$

Here, V_{out} is the output voltage/strain occurred and S is the sensitivity which is calculated from the graph shown below and P_m is the measured pressure of the each pressure point by converting the weight of the pressure

point to the corresponding pressure from the following relation as:

$$1\text{gram/cm}^2=98.05\text{ Pascal's}$$

The rated pressure is the obtained pressure from the pressure points at their corresponding intensity. These pressure points were also be compared by taking different inputs of two persons by two different hand or foot. The pressure is almost accurate when comparing the two persons

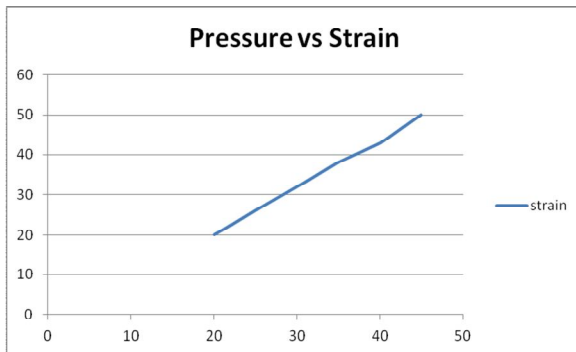


Figure 10: Graphical representation of Pressure Vs Strain

Observations

Three different types of input pressures is measured and checked for accuracy. It gives 97% accuracy. The apparatus used is well optimized and compatible. The pressure at the particular points is obtained and is represented in the following tabular form:

Pressure Points	Pressure
Point1 (Thumb)	2.3kpa
Point2 (index finger)	0.210 kpa
Point3 (middle finger)	0.25 kpa
Point 4 (ring finger)	0.185 kpa
Point 5 (little finger)	0.221 kpa
Point 6(considered pt.)	0.1705kpa

Discussion

The IR image of the hand obtained is given to the matlab. The intensity and pixel values are measured and the corresponding calculations are made for the pressure using strain gauge and the equivalent relations are taken

to the analysis. The pressure obtained is proportional to the intensity.

5. CONCLUSION

The pressure monitoring procedure using matlab has got many applications. This device can be used in analysing the suffer from lack of nerve sensation measurements in diabetic and polio patients. The advantages of this monitoring apparatus is

- Monitor degenerative foot disorders
- Identify areas of potential ulceration
- Regulate weight bearing after surgery
- Evaluate athletic footwear

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