Smart-shoes for Physiotherapy Diagnostics

Electronic Design Lab, 2018

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Group: DD08

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Motivation

Several foot and palm disorders affecting people with intellectual disabilities and have an impact on their ability to mobilise.

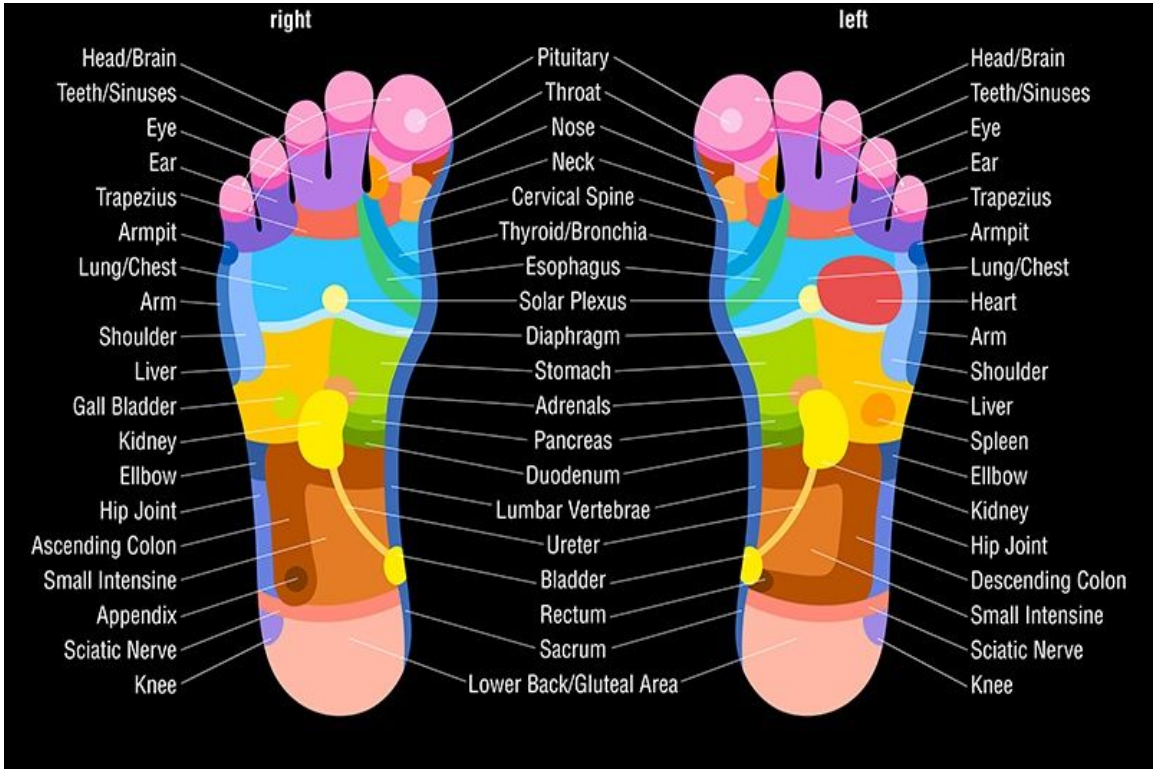
Initial diagnosis of such disabilities involves the foot-palm pressure-map analysis

Available Technology: Tekscan's pressure mapping Mat

Cost: $1700 to $2000, approximately ₹1,15,000 to ₹1,36, 000
User experience: Constrained mobility

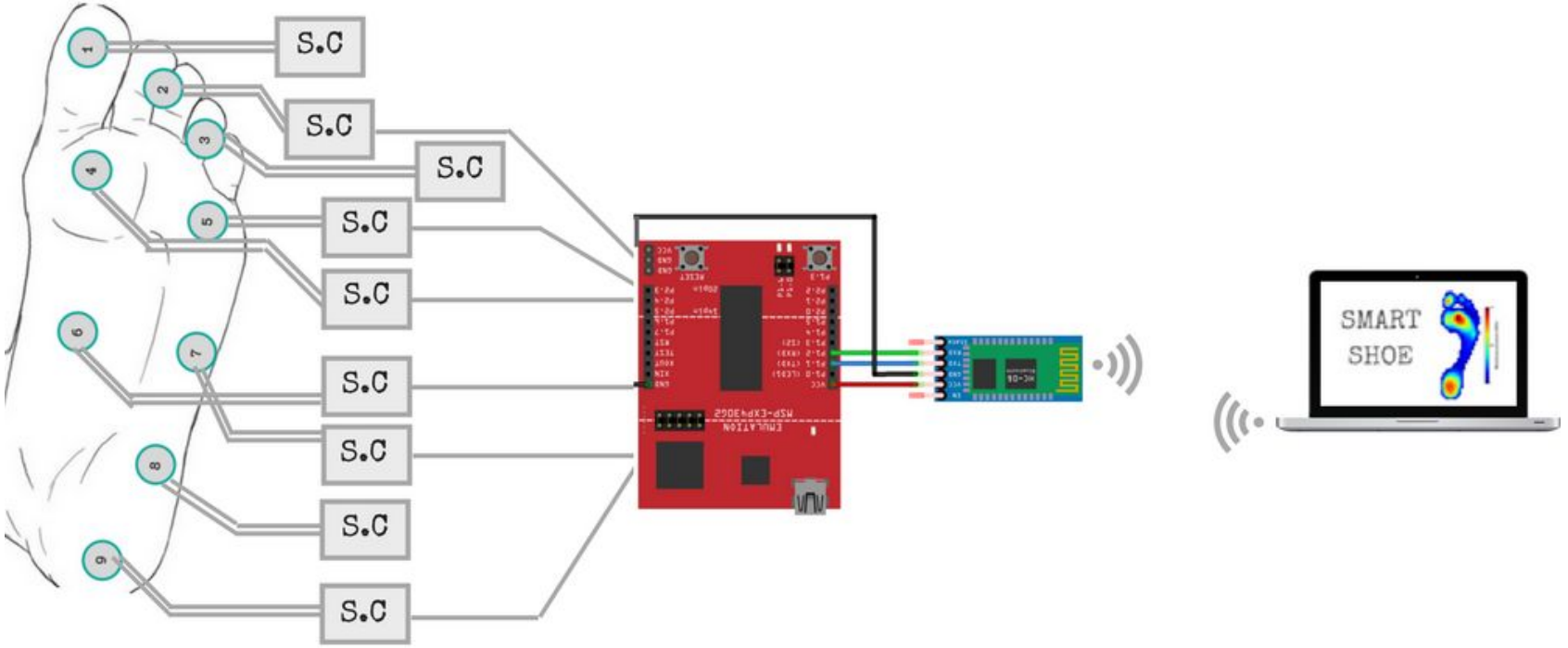
The need of a real-time, portable and wireless, low-cost, low-power and easy-to-use device to map plantar pressure for convenient diagnosis by doctors inspired us to take up this project.

Foot Reflexology Chart



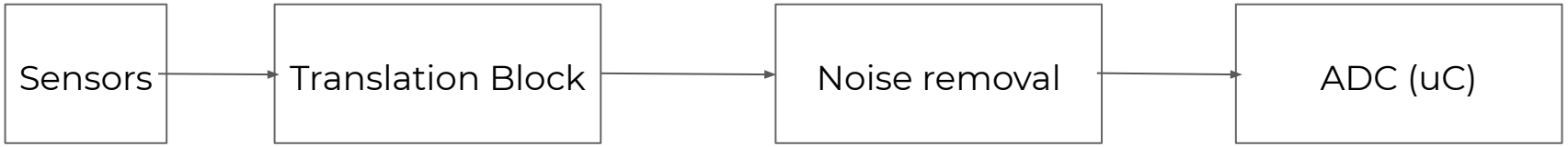
Reference: "Revisiting reflexology: Concept, evidence, current practice, and practitioner training"
Authors: Nurul Haswani, Embong, Yee Chang Soh, Long Chiau Ming and Tin Wui Wongc
Journal of Traditional and Complementary Medicine

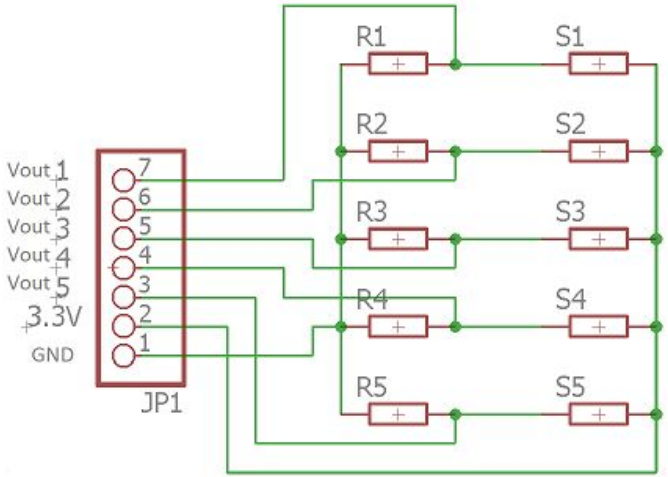
Block Diagram



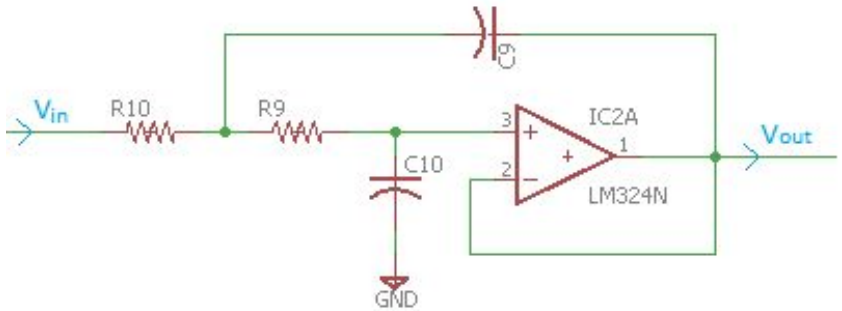
Sensors Signal Conditioning Transmission Block Receiver host Computer

Schematic Diagram of Signal Conditioning





- S1,S2,S3,S4,S5 are Force resistive sensors.
- R1,R2,R3,R4,R5 are appropriate similar resistors.

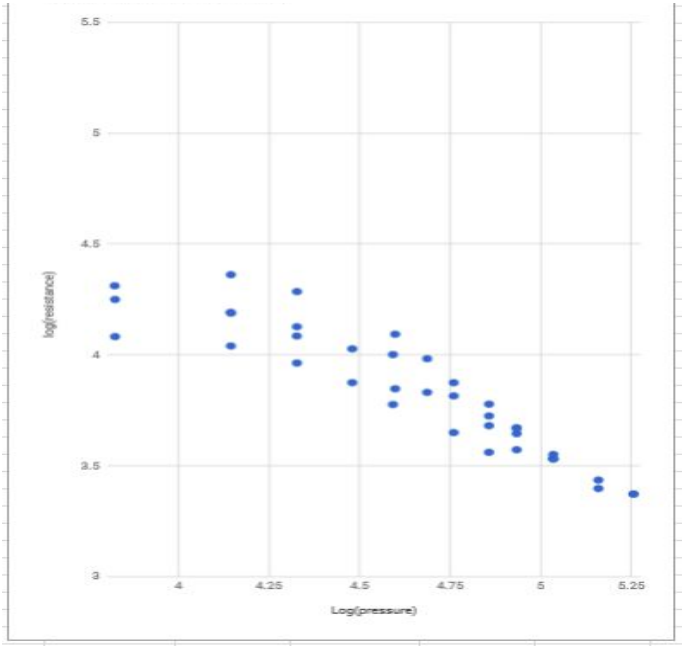


Subsytem: Noise removal circuit
Special Sallen key filter (here it act as a low pass filter)

Calibration of Sensors

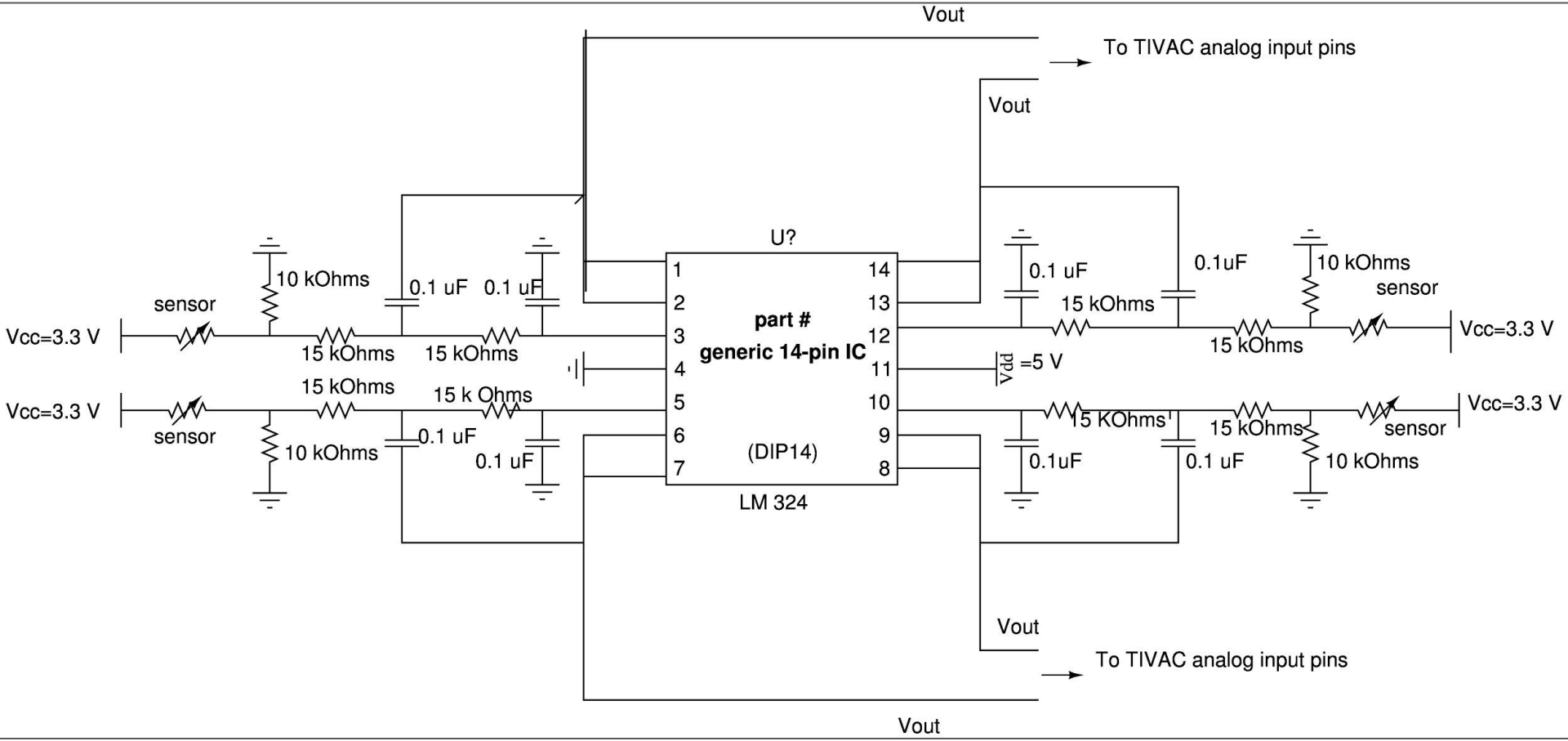
- *We used dead weights for calibrating the sensor in steps of 450 grams, from 0 to 8 kgs, followed by unloading.*

Calibration Setup

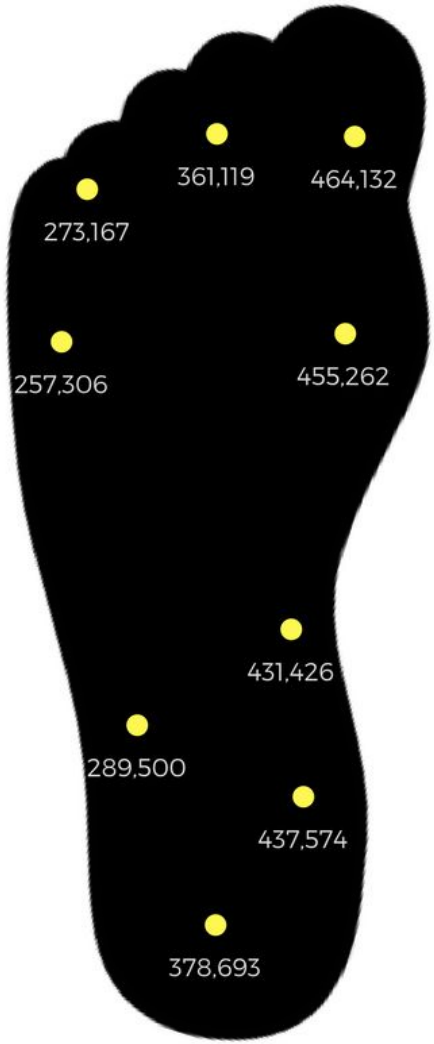


Plot of the log(Resistance) VS log(pressure) values

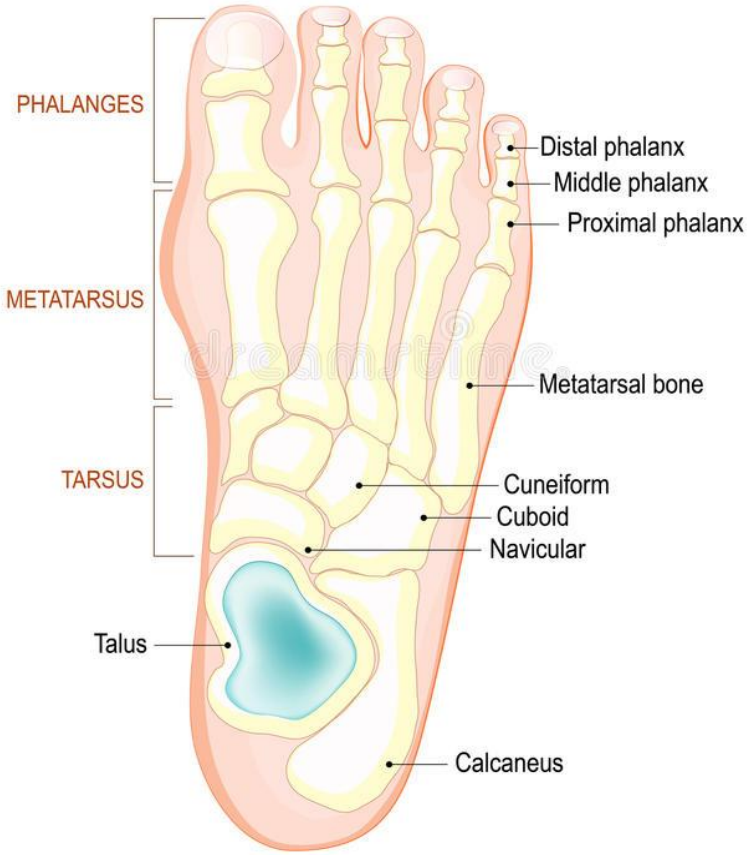
Hardware involved



2,2

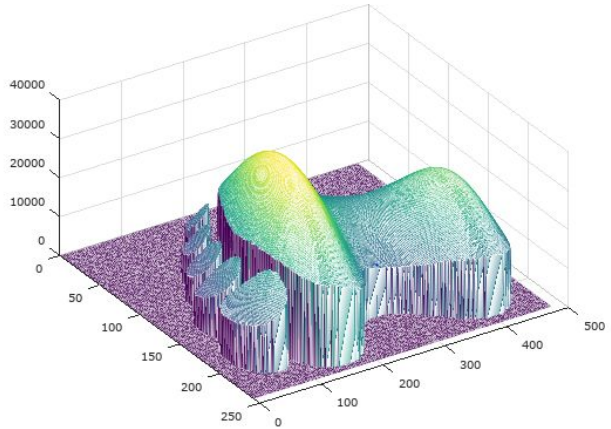


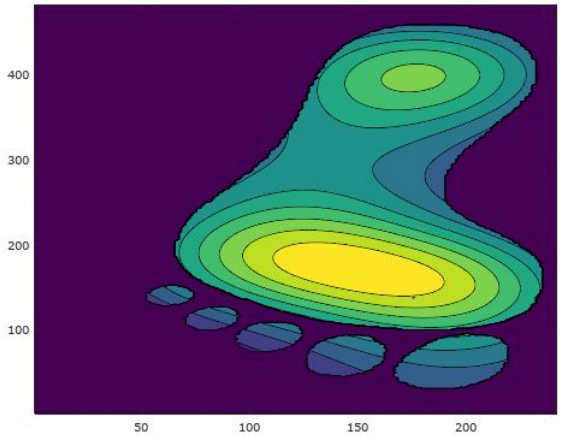
BONES OF FOOT



Initial Approach -
Using Matlab for generating Pressure Map

- Successfully generated a 2D contour as well as a 3D plot from given data





Drawbacks

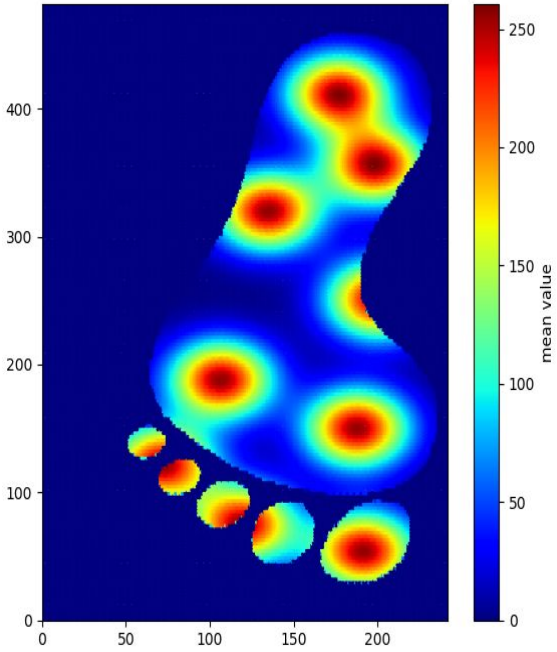
- It requires around 30 sec to generate the shown two plots
- We cannot therefore implement a real time system
- To read the values from bluetooth we would need to save the data in a file and then read it from the matlab. Hence, inconvenient.

Alternative Solution-
Using Python for generating Pressure Map

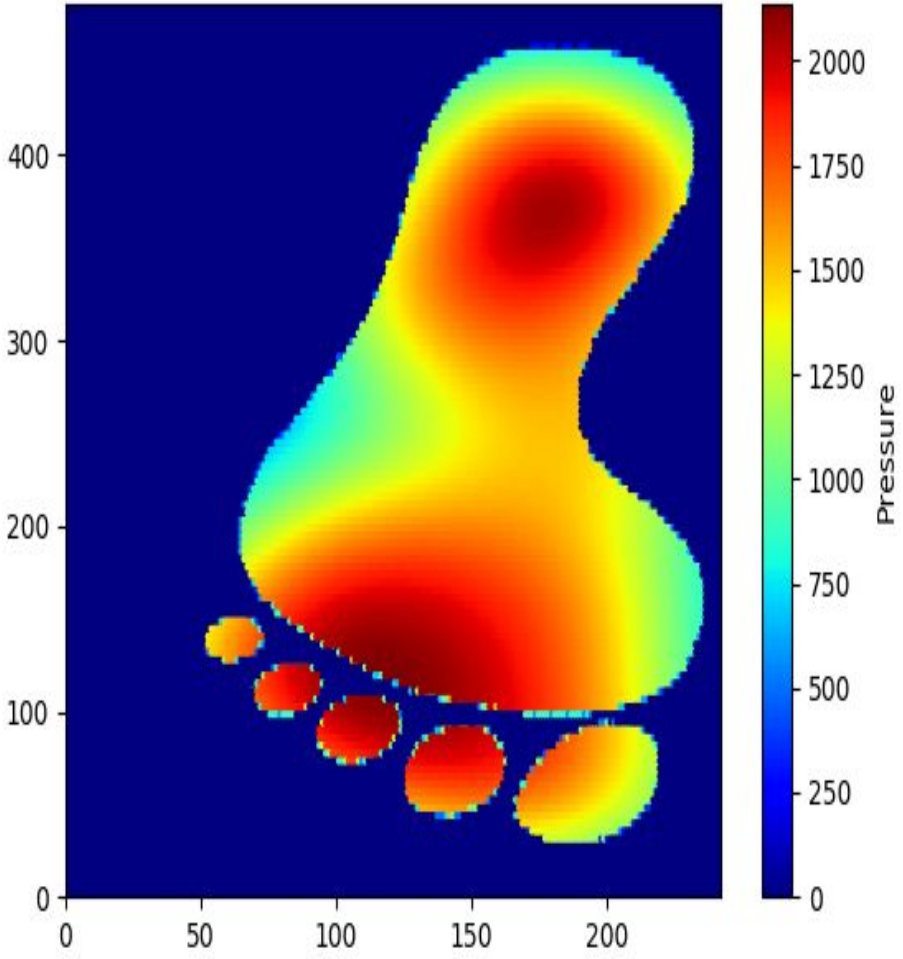
- *We implemented the same in Python which takes around 2 to 3 sec to generate the Pressure Map*
- *Since the map is calculated so rapidly, we can implement a real time system which updates itself after approximately every 3 sec*

Further Advantages-

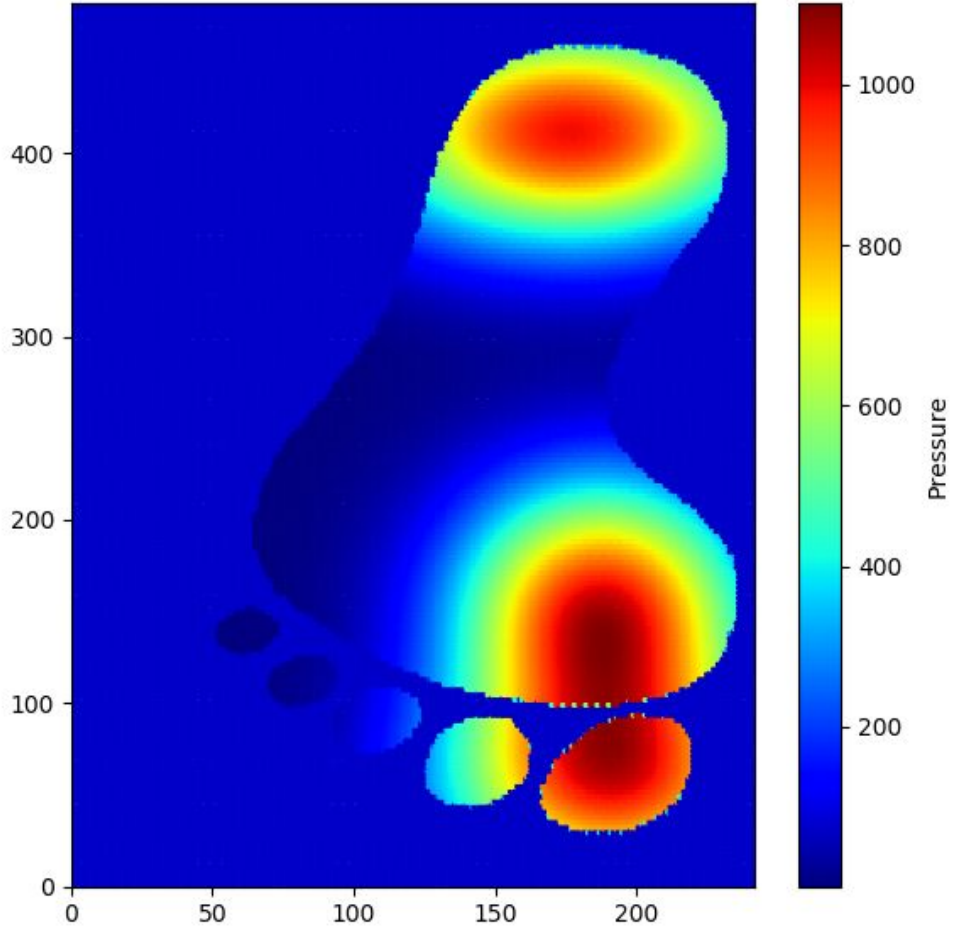
- *The values from the microprocessor are sent serially to the host PC using Bluetooth module HC05.*
- *The data is directly read in Python using Pyserial Module*
- *So in the same file we can read the data and directly plot the pressure map*



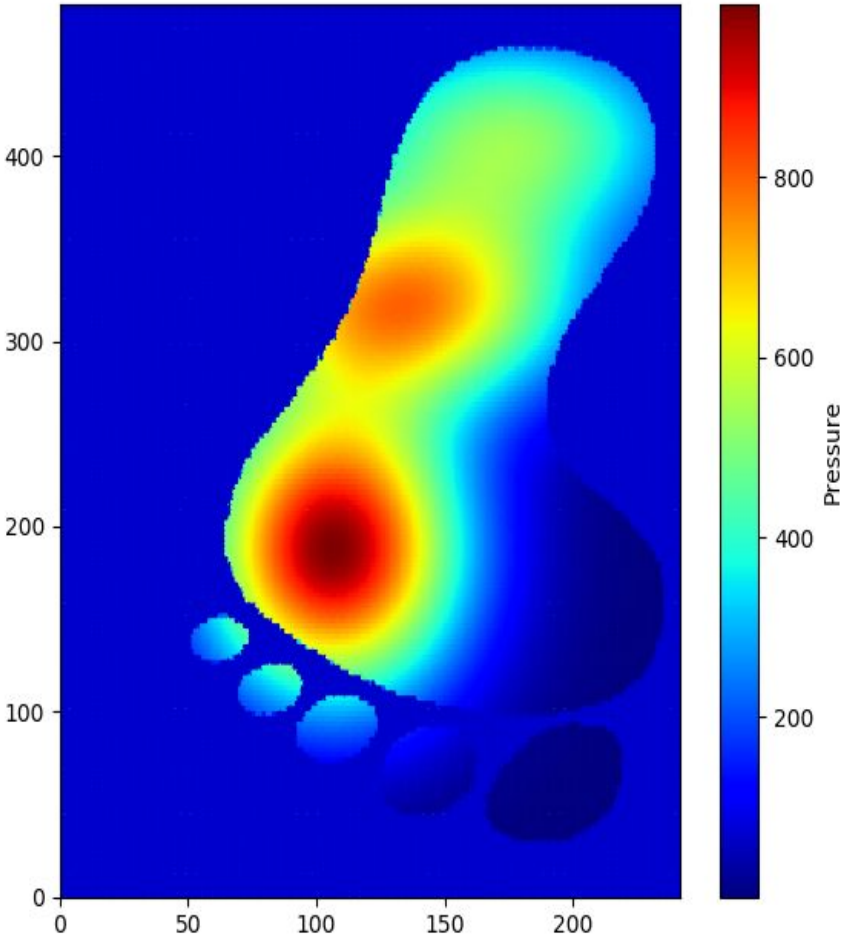
Pressure heat map of a normal heel



Pressure applied on right metatarsal side

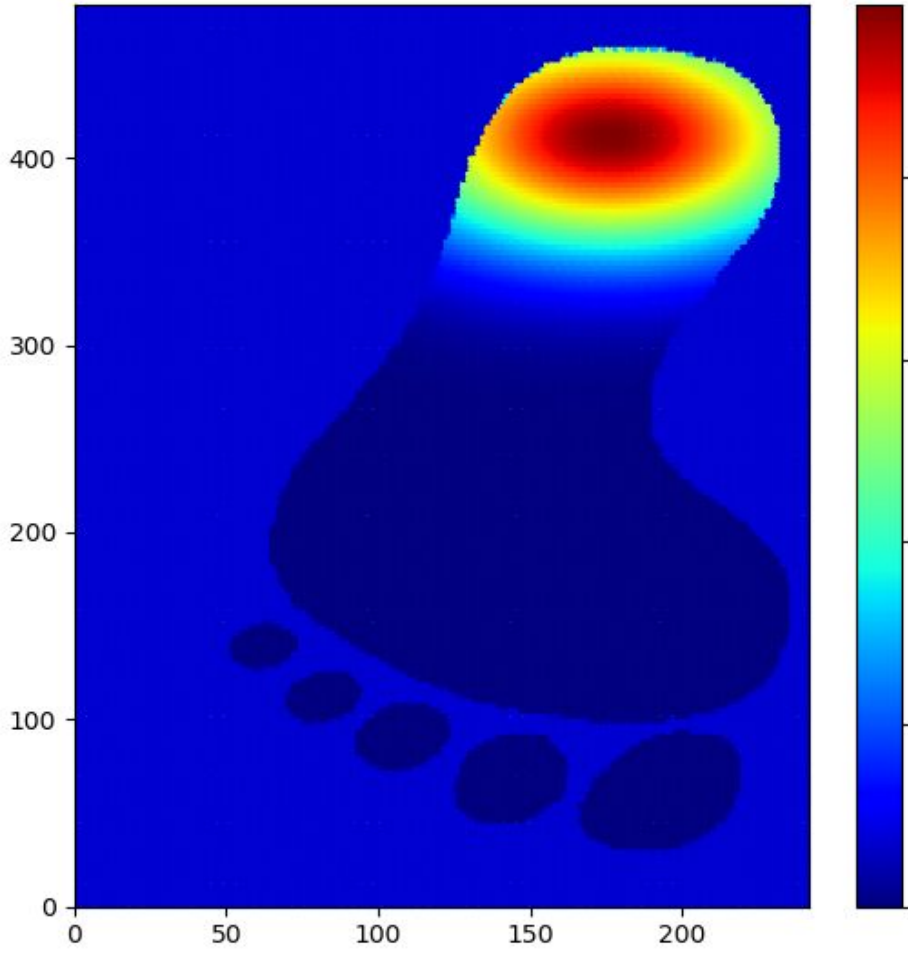


Pressure applied on left metatarsal side



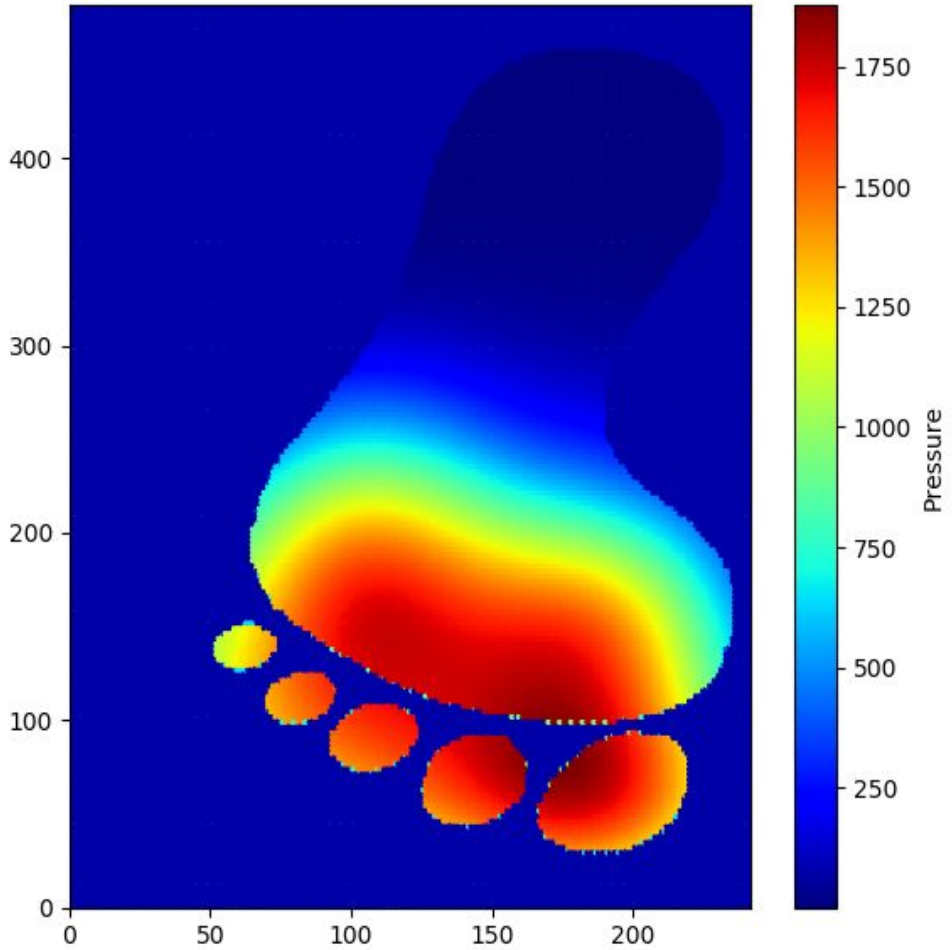
Callus bone dislocation-clubfoot

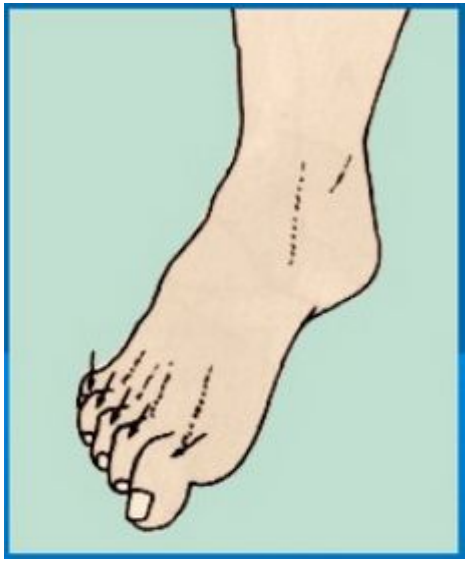
Pressure applied on heel



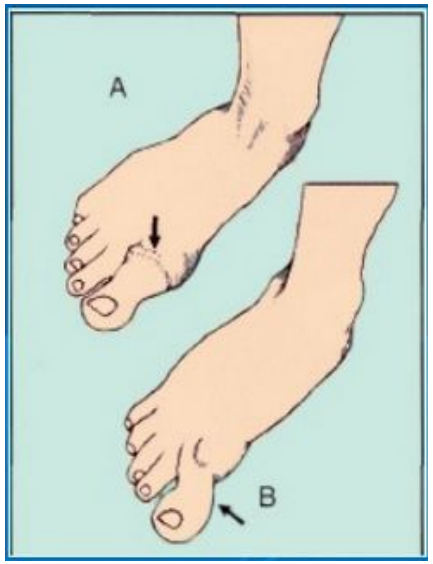
Clubfoot

Pressure applied on proximal phalanx bone



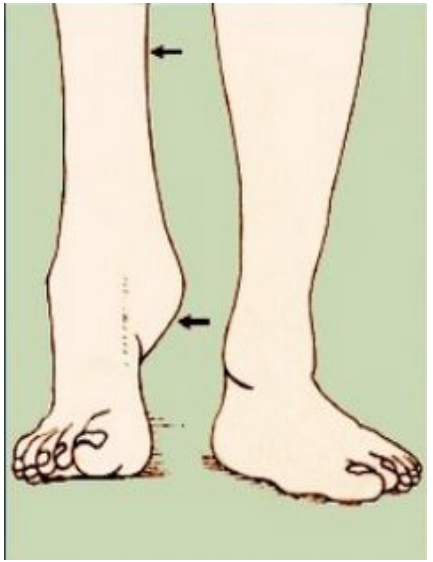


Claw toe



Thickening of big toe

Hammer toe



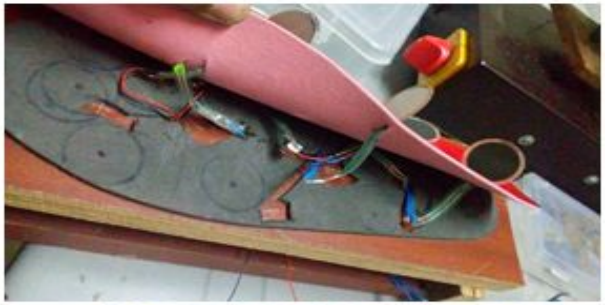
Flat foot

Clubfoot

Fabrication Process

1.

2.



3.

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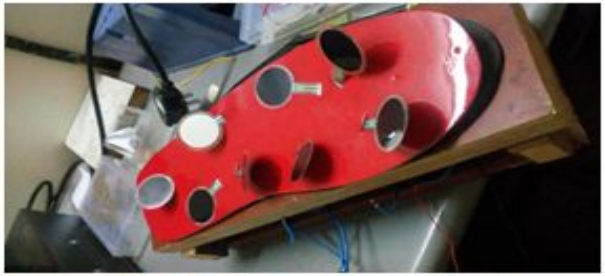

5.

6.

Goals for the Demo

Assured Claims:

- *Make a person of weight less than 50 kg stand on the sensor*
- *Then the pressure sensor values will be processed and sent through the ADC to the host PC via Bluetooth*
- *Plot the steady state pressure map of the foot*

Additional objectives which we will try to attain:

- *Implement a real time system which will update the pressure map approximately every 3 seconds via the bluetooth module*

The Team

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Thank You !