CuraMat – Pressure Detection For A Medical Environment

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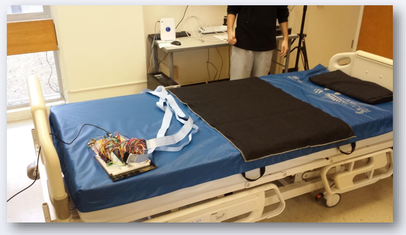
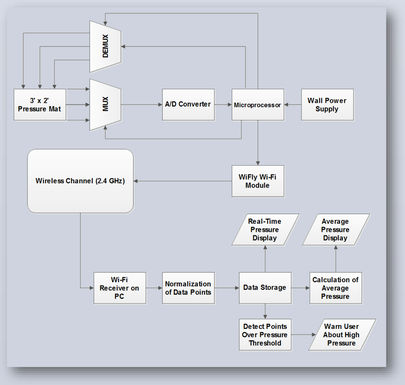
Product Overview



Pressure ulcers, also known as bedsores, are a common problem for many hospital patients. They are primarily caused by the constant application of pressure to patients' bodies during extended stays at the hospital. While general causes of pressure ulcers are known, specific treatment is another case. Modern hospitals still have no official procedure for treating pressure ulcers beyond flipping patients over every few hours. Our product looks to change this by providing hospitals with a way to accurately track the applied pressure on a patient. This will be done by placing a pressure mat--a mat consisting of an array of pressure sensors--over a hospital patient's bed.

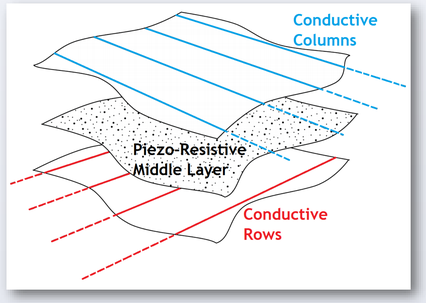
As the patient lies down, the mat will detect pressure at the individual points through its resistance that varies as a function of pressure. The microprocessor will collect the resistance data by sending out and measuring the analog voltage across the mat. This analog data will be converted into a matrix of digital values that will be transmitted wirelessly through Wi-Fi, converted to pressure using mapping formulas, signal processed to remove noise, and displayed as a gray-scale grid on Java application running on a PC.

Block Diagram

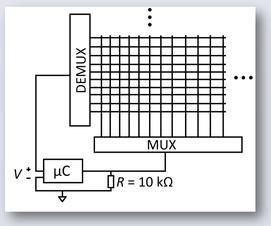


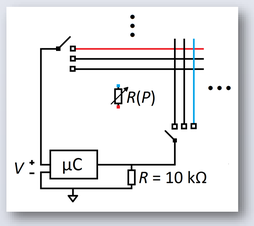
How The CuraMat Detects Pressure

The pressure mat consists of columns and rows of a conductive material (copper) that sandwich a piezo-resistive middle layer. When pressure is applied to the middle layer, its resistance lowers--allowing more current to flow through the overlapping columns and rows.

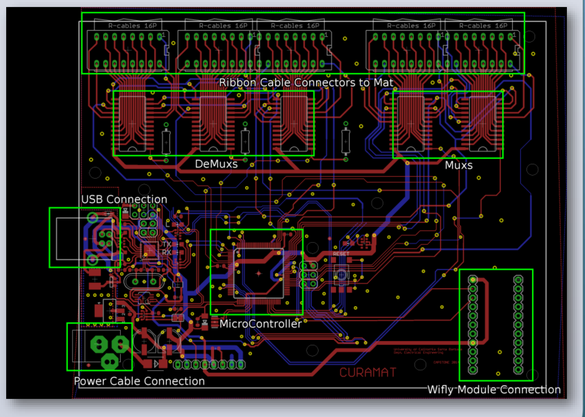


The implemented pressure mat is composed of 50x33 voltage divider circuits. The micro-controllers chooses the circuit via MUXs and DEMUXs and measures the voltage at the pull-down resistor. This voltage is then mapped to pressure.



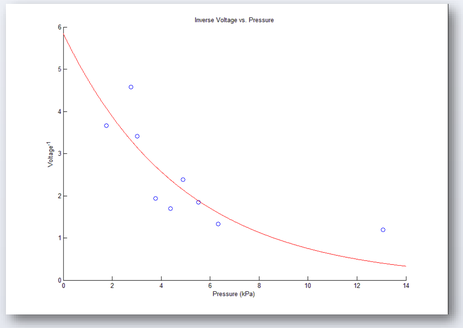


The final hardware components are implemented on a PCB, whose layout is shown above. The top half of the PCB layout contains the hardware required to collect analog voltages coming from the CuraMat's many serial connections. The microprocessor and Wi-Fi module, located in the bottom half of the PCB layout, are responsible for converting the analog voltages to digital values and sending these values to the PC over a wireless connection.



Mat Response & Calibration

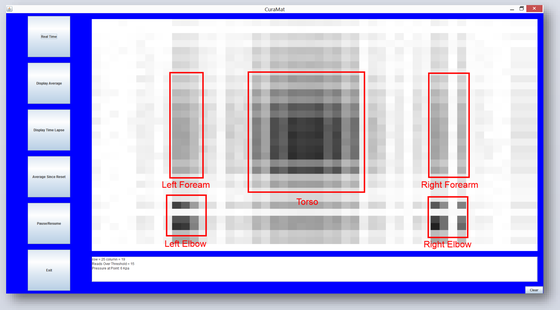
The digital values corresponding to pressure can be converted to actual pressure. This is done by first obtaining the voltage at each point. The A/D converter maps the analog voltage to digital values. We then get an estimated pressure value with the voltage-to-pressure curve determined by the calibration data.

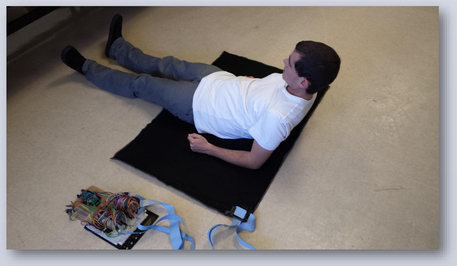


Java Application

Once the mat data has been transmitted to the PC, it can be displayed using a Java application. This application will allow the user to look at the data in real time or look at pressure averages since the app has last been reset. Additionally, if an individual pressure point is clicked, the app will display both the estimated pressure value at the chosen point along with the amount of time the selected point has been over a predetermined pressure threshold.

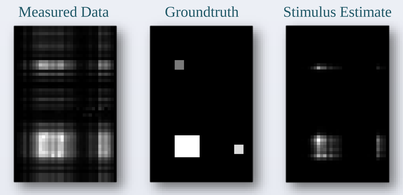
Shown below is a typical image that will be obtained when a person is laying on the mat with their arms at their sides. The darkness of a square corresponds to the amount of pressure detected at that point; darker squares results from higher pressure. It is easy to differentiate between the different parts of the body.





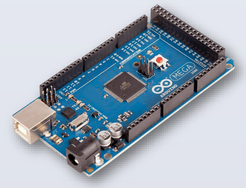
Noise Reduction & Signal Processing

The pressure mat can be approximated as a linear, shift-invariant system. In other words, the output scales linearly with the input and a shift in the input is reflected in the output. This approximated property allows the system to be characterized by an impulse response or Point Spread Function (PSF). In order to estimate the stimulus given the system response and the PSF, the iterative Richardson-Lucy (RL) de-convolution algorithm is used.



Hardware Components

The CuraMat was developed using an Arduino ATMega2560 Development Kit. The critical components of the Arduino, such as the microprocessor, were moved to the final PCB.



The CuraMat communicates with the PC using a Wi-Fly RN-XV Wi-Fi module. The module creates its own hotspot that the user can connect to with their own PC.

Product Specifications

-Time for full mat read: 5 seconds
-Powered by wall outlet
-Uses 2.4 GHz frequency band for Wi-Fi connection
-Maximum power consumption: 5 Watts
-Intended for use on a hospital bed

Future Goals

Futures goals for this product include more effective noise removal, as well as moisture detection. More effective noise removal would make it possible to track what position a hospital patient is in, and moisture detection would allow doctors to study another factor in the development of bedsores.

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