Mobility Mat

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***Abstract*— Within the Engineering department of Northern Illinois University students are put to the task of creating a Smart Mat for a client. Dr Emerson Sebastiao is our client for this project. He wanted our team to create a Smart Mat that would aide patients who need to go through various physical therapy sessions. Some of the main goals of this projects were to show and track users' steps through the various stepping patterns provided.**

Keywords-component; Smart Mat, Pressure Sensor Matrix, LED matrix

I. INTRODUCTION

Physical Therapy is a key component in the rehabilitation process for people who have gone through a traumatic event/Ailments. Millions of people around the world struggle with basic movement functions and our goal was to create a tool that would assist this process. The Mobility mat is a mat that is designed to help people who struggle with movement limitations. What this mat will do is show a pattern that the user must recreate by stepping in the correct squares. This mat will also take in data and show it visually such as the amount of force by the foot, number of steps taken and if they have stepped correctly.

II. MAT MATERIALS

As shown in Figure 1 the mat consists of 3 main layers and 5 components within those layers. LED's, clear car vinyl, velostat, rubber mat and copper strips.

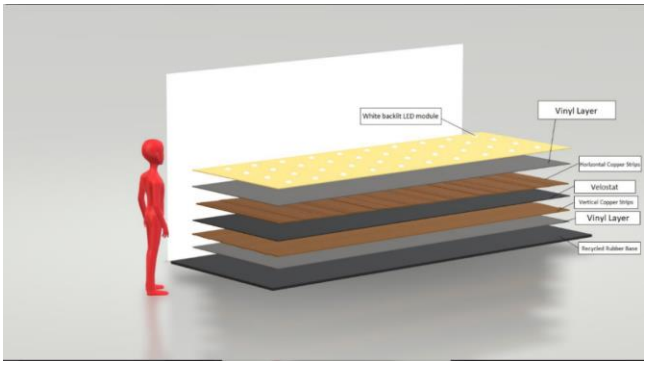

***Figure 1**: Layered Architecture*

A. *Base Layer*

Starting from the bottom, the base will be a 100 % recycled rubber mat. It will be approximately 3 mm thick, and it will act as the non-slip material, so the mat does not slip or slide while in use.

B. *Velostat Sandwich Layer*

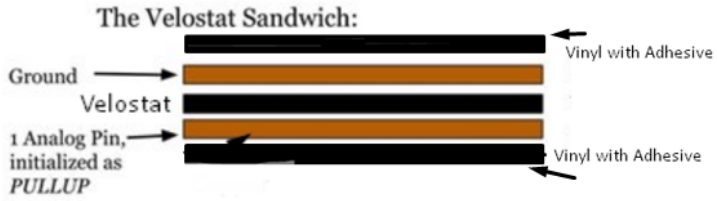

***Figure 2:** Velostat sandwich*

As shown in Figure 2 the Velostat Sandwich is comprised several different components. The main component is the Velostat which is a very thin polymeric foil that is electrically conductive. Adding copper strips to the bottom and top of the Velostat allows this layer to act as a big pressure sensor. It is then sandwiched again with car vinyl to seal the layers inside. By sealing it we can avoid electrical safety concerns and hardware safety.

C. *Faux Lether Top Layer*

This is the top layer which the patients will be stepping on and it's comprised of the 100% Polyester Faux Leather with 40 cutouts for each of the LED modules.

***Figure 3:** Faux Leather Top with LEDs*

III. LED MATRIX

For the LED matrix we used a decade counter (CD4017). This device allows us to manipulate certain LEDs at any given time. With this configuration we are able to display patterns throughout the mat using Binary Coded Decimal (BCD). We decided to use buttons to work as a switch in which we could cycle through various patterns. When the user wants to play a certain pattern, they simply press the button corresponding to that pattern. The mat then lights up according to the pattern that was selected and loops as many times as the user wants automatically. In order to stop the loop, the user in control of the mat can simply press the external reset button to stop it. From there the user can select a different button and the mat will display the pattern associated with that button.

IV. PRESSURE SENSOR MATRIX

This Matrix is how we determine where the user is stepping and with how much force they are stepping with.
By using the Velostat sandwich accompanied by Shift register and Multiplexors were able to send and receive signals. With these signals we can use a Microcontroller to run the scripts. Then have a Python Script to visualize it. By using this Matrix configuration, we are able to manipulate the matrix data, and write conditions for it.

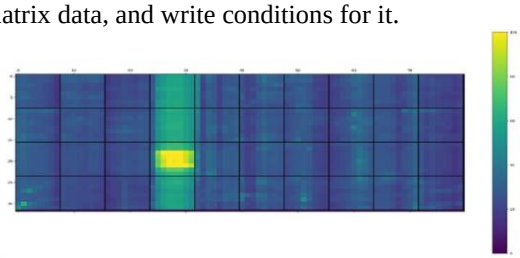

Figure 4 Visual Software

A. *Multiplexors*

Multiplexors are one major component used in this layer of the mat. What these Integrated Circuits (IC's) do are check voltage changes throughout the mat. By having these always checking certain areas of the mat were able to locate areas where pressure is being applied.

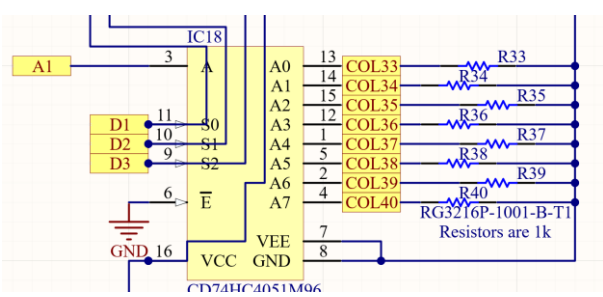

Figure 5 *Schematic of Multiplexor*

B. *Shift Registers*

Shift registers are the 2nd main component of this layer, what these IC's do is send the initial signal that the Multiplexor will intake. These signals are what change when the velostat sandwich is pressed on.

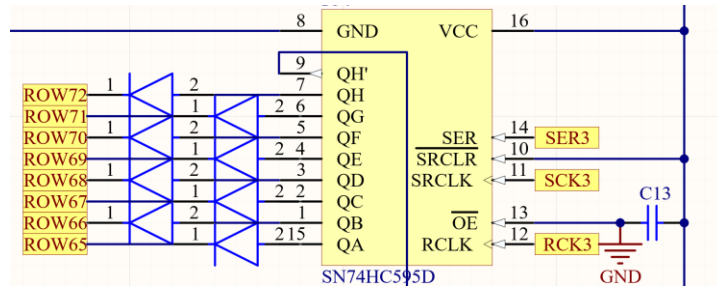

Figure 6 *Schematic of Shift Register*

V. CONCLUSION

The end goal of this project is to successfully create an exercise mat capable of assisting trainers in their rehabilitation sessions and determining the progress of their patients. With the help of mobility mat, trainers will be able to more accurately pinpoint specific issues in posture, walking struggles that need improvement, and ultimately be more effective in their methods of getting people healthy and walking properly again. As engineers, we want to improve upon the ideas and scientific methods of those who have come before us and perhaps, if possible, create innovative technology altogether. Despite the similar ideas currently floating around the market, we are confident that our design is unique, and we feel that the ideas that we have developed for this project's implementation set us apart.

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