Tanjim Ul Haque s8tahaqu@stud.uni-saarland.de

Pressure Power! : Analyzing pressure sensor structure & detecting impact from accidental injury or impaired emergency.

Abstract

Bikers ride their bikes from small distance to a very long distance. In that period of time, they need to pass some places where there is no people, not urban or maybe in between deserted areas and mountain trails. From the emergency button idea, we can construct a refined idea where some pressure sensors are connected to a bikers' helmet. The pressure sensor can be connected with a microcontroller and with that a GSM module can be connected. When a biker faces an accident and faces a high impact the sensor will trigger the mechanism. As a biker might fall an trigger the mechanism we can set a system that if a certain pressure is copiously applied on any sensor (resembles a biker is laying or not moving) then the machine can trigger. The mechanism can be such that a GSM module sends an emergency message and the geo-location to any emergency number. This method can also be implemented for any disabled person facing an emergency. The mechanism can be modified accordingly for a persons specific need of emergency. For the prototype we have tested several approaches to build a pressure sensor and for the project the pressure sensor (FSR) with velostat provided satisfactory result when we use multiple layers. This small sensor build up project prototype was designed in a time span of 2 month as a part of Interactive System course project in Saarland University.

Keywords- pressure sensor,FSR, velostat, ESD material, conductive wool, arduino, emergency trigger.

Tanjim Ul Haque s8tahaqu@stud.uni-saarland.de

Background

Using the pressure sensor one can control the voltage input to an electrical device. The more pressure it is the circuit provides more voltage. On [1] they used a simple fabric sensor to control a LED. Also in [2] research was done using a pressure sensing matrix on a gym mat to recognize the activities and count. This sensor can be used to act as a threshold switch. A pressure sensor is also used in sole sensing. Where a shoe soles consist of several pressure sensors provides analog data of where the pressure is given more for a specific person, [3]. In [2] research was done using a pressure sensing matrix on a gym mat to recognize the activities and count. Though here the research is quite complex, they used the pressure sensor in the mat as an input system after they took the value from it and mapped it in a visualization tool using an image processing mechanism. But the concept of using the mat as an input seems to have a similar pattern where I am proposing to use the mat to take the input and not mapping anywhere rather just directly connect it to a monitor where it gives the value or an alarm. In the project [4] we can see it is using fingertip connection as a switch. Meaning when the tip of the two specified fingers touches it will act as a switch. Although my design seems to match their idea the use of sensors is different. They are triggering the switch whenever the fingertips touch. Which for a patient can be inaccurate, they might touch while in sleep. Here my idea the trigger needs to have a certain amount of pressure to be activated. which reduces the error rate. In [5] we can see the basic concepts of making a pressure sensor, where we can follow the process of building a pressure sensor. In their project, they used low-density polyethylene with a carbon sheet where I am planning to use a Velostat which is quite similar but coated with carbon instead of the carbon sheet.

In [X] the researchers created a speed sensing helmet where LED will blink when a user exceeds a specific speed. They used FSR to detect whether the user has worn the helmet or not. And a fan detects the speed of the bike. This project proposal is similar in a sense but here we want to use the resistive pressure sensor to detect the impact if a user faces an accident.

Project Concept

The project concept came from several ideas. We are working with pressure sensor which can be structured in different ways with different materials. As pressure sensor works as a threshold switch we visualized it as a emergency button. The first concept we build around the idea was to create a emergency button for patients who will be wearing them in their hand. While many patient are not able to move or might not be able to call someone while having some trouble they can trigger an emergency using the pressure

sensor as it can detect lightest touch. As we are using resistive touch sensor it can react to the force according the build mechanism. So we had to find the sweet spot for our concept while building the sensor. As the accidents while biking in mountain trails can be dangerous also there might be no locality near the place. Hence we thought of a project concept that will send emergency message with location when a user faces an accident. This can also be applied to disabled person facing any kind of trouble that requires emergency action. The project concept is a FSR based pressure sensor with an microcontroller. In this prototype we will be building the suitable pressure sensor and detecting the impact. We can work with associating GPS, GSM with the microcontroller to send the emergency signal to the trusted person or nearby medical centers in the future work. The project concept is visualized in the following image-

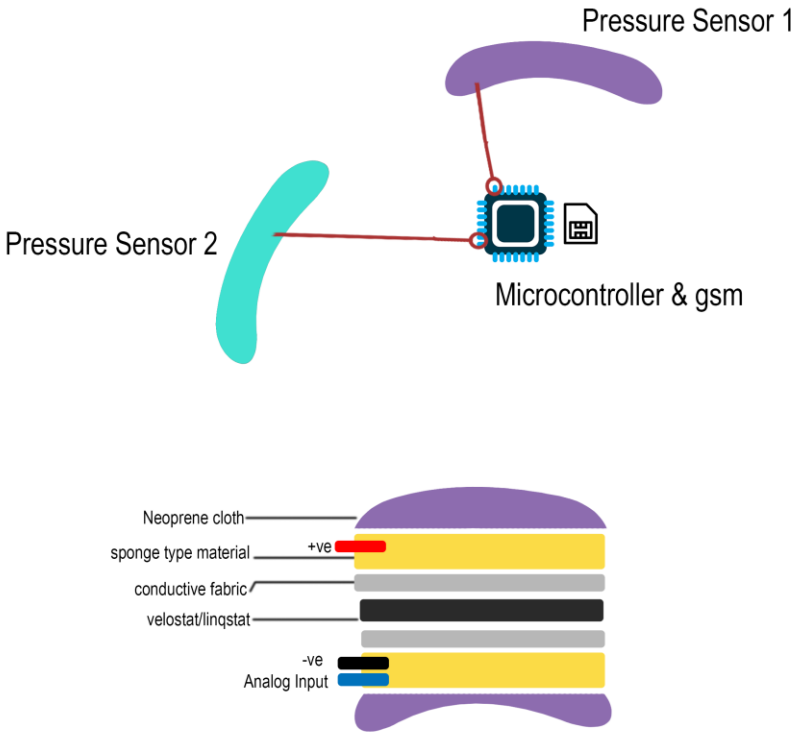

Figure 1: Project & Sensor concept

The sensor with the microcontroller can be applied to any surface accordingly. The shape can be modified according to the design necessity. While this is a concept design of the sensor we will apply several methods and design structure to ensure the best accuracy for detecting the impact. After applying it on a helmet the concept can be visualized as follow-

Figure 2: Sensors applied over a helmet

Project Implementation

Sensor Prototype Build

In this part, we are going to make the sensor prototype using a few structures and finalizing the most accurate method. For the first prototype, we are going to use Veloster as our main component. We also will compare how it changes after using multiple layer of velostat for the FSR sensor. We will also look in to the sensor building with different materials like ESD, conductive wool

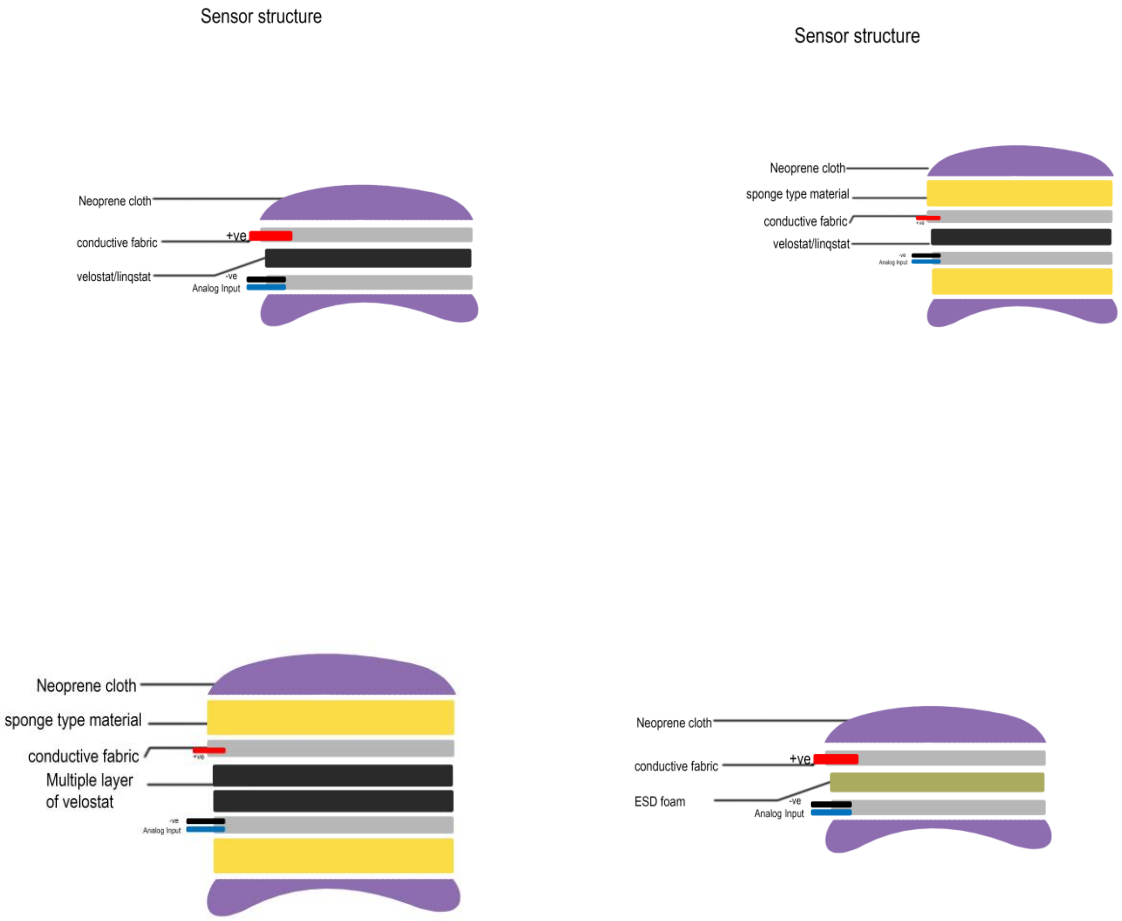

Figure 3: Different structures of building a pressure sensor

Making the prototype sensor 1

We start making the sensor by cutting 2 conductive fabric into a similar size. we cut a velostat into a little bigger size than that conductive fabric. As the velostat is the divider between two fabric it should be larger. If it was smaller than the conductive fabric might touch each other and making the connection. We then take the conductive fabric and connect 1 positive wire on to the top fabric, 1 ground wire, and one analog input wire onto the bottom fabric with a copper adhesive. Next, we take a sponge/foam material

and cut it to the size of the conductive fabric for each piece. We will then attach the fabric to the foam material with textile glue. We then keep the velostat sandwiched between two fabric. Now we can test it with a LED. For this, we connect the sensors (+ve) and (-ve) to a 9v battery. we can use a breadboard and connect the LED with a resistor to (=ve) from the pressure sensor and another to ground. Now if we press on the pressure sensor the led's glow will act according to the pressure given. After the initial test is successful we can use a neoprene fabric to cover the sensor. We can either stick it or use fabric glue to cover the sensor. The basic image can look like as follow-

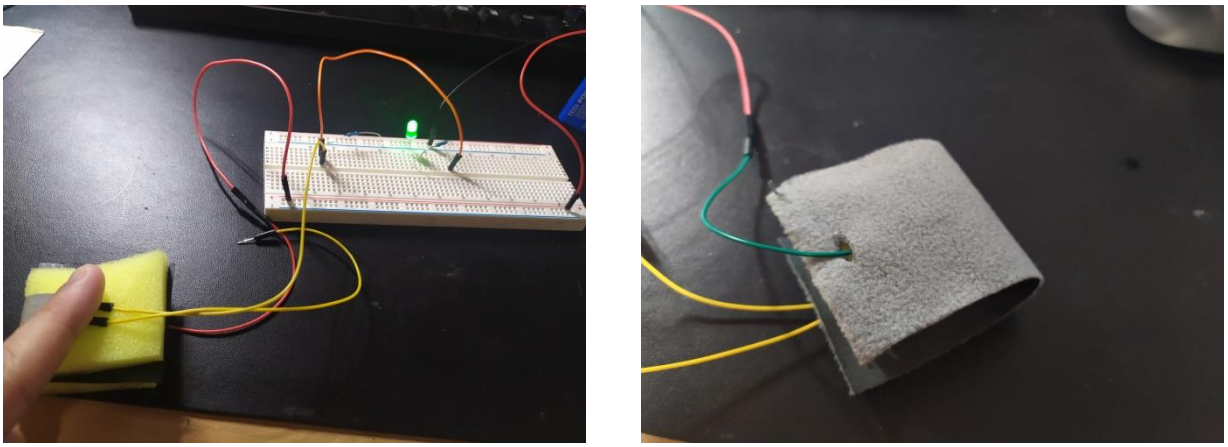

Figure 4: Pressure sensor testing and after wrapping with neoprene fabric

Data:

Now if we want to check the data of the sensor we can connect it to an Arduino. We connect the analog input pin to A0 and rest to +3.3v and ground. Then we can read the analog value and plot it to see the data while pressing and releasing. We can see a graph of a data read from our sensor above=

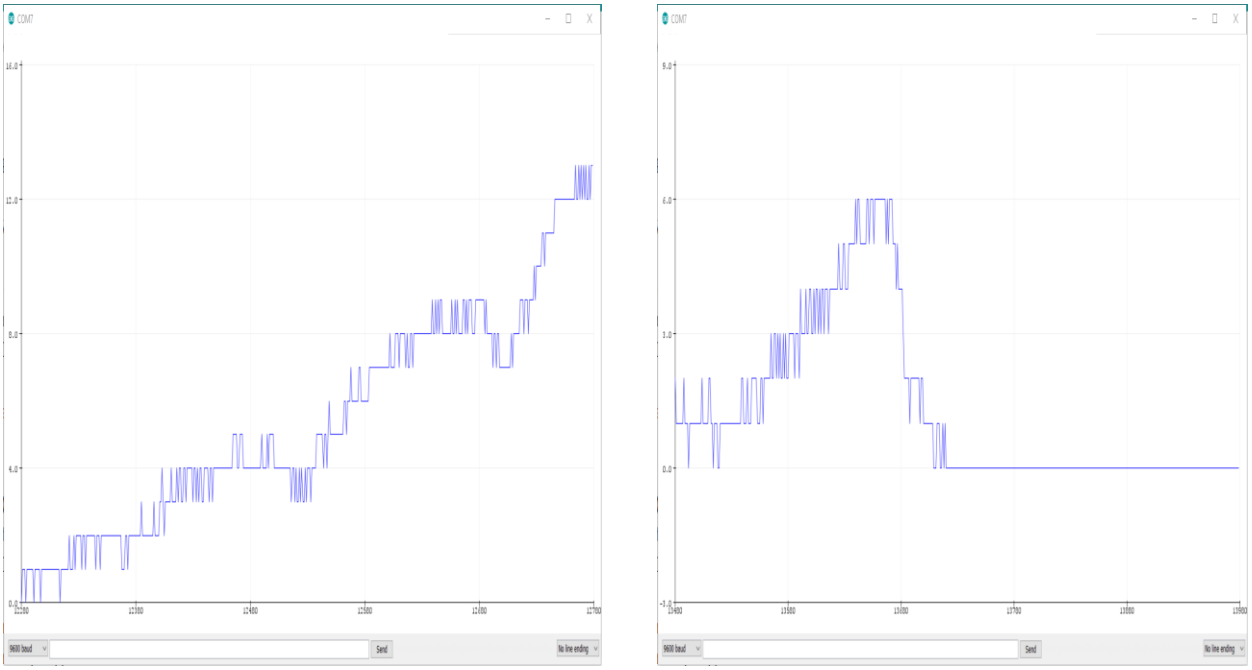

Figure 5: Graph of the sensor value while increasing and decreasing pressure

Making the prototype sensor 2

As described in the structure section we start by taking two conductive fabric of the same size. We then add one positive wire to one fabric and one ground and one analog input wire to the bottom fabric. We then take one ESD foam slightly larger than the conductive fabric and put it in between two. we can see the outcome of the sensor as follows-

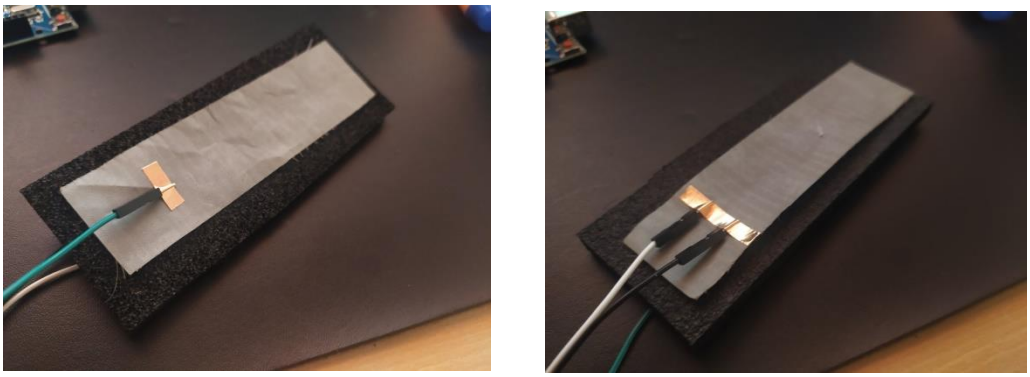

Figure 6: Making of pressure sensor using ESD foam.

Tanjim Ul Haque s8tahaqu@stud.uni-saarland.de

The outcome of sensor prototype 2:

Though from researching about using the ESD foam gave us information that the output will smoother, the current output we got is still providing worse sensitivity than the output provided by the sensor 1. Hence we will continue to tweak this method if it gives better results then we can continue further using this method or we will try other methods to get better accuracy. For this sensor, we are using a multimeter to observe the voltage value before testing with an Arduino. Therefore there can be seen no graph data for this method. From our test with this prototype method although it was controlling the current flow according to the pressure it was not as static as the 1st prototype method. This method tends to suddenly jump up and down in its result. Which might cause a short circuit in the whole sensor resulting in an error. Therefore we are ignoring this method.

We also have tried to work with conductive yarn for the pressure sensor. But yarn doesn't provide higher accuracy for this project environment as it is not conductive wool. Also crochet sensor is not also suitable for the conceptualized project. As the pressure sensor with velostat is providing more accurate results. Although it was very sensitive to touch, adding the foams decreased the sensitivity. Now we want to try using multiple layer of velostat in the middle to calibrate the sensor to its maximum accuracy. We will consider this structure as prototype 3 and compare the data with prototype1.

Making the prototype sensor 3

We have tried using single layer of velostat. Using velostat decreases the resistance between the conductive fabrics hence acts as a force resistive touch sensor. In this prototype we have tried adding multiple layers of velostat to increase the sensitiveness and the control of the sensor. We tried adding 3, 5 layers and lastly 5 layers with the sponge material. The image of the sensor can be seen as follow-

Tanjim Ul Haque s8tahaqu@stud.uni-saarland.de

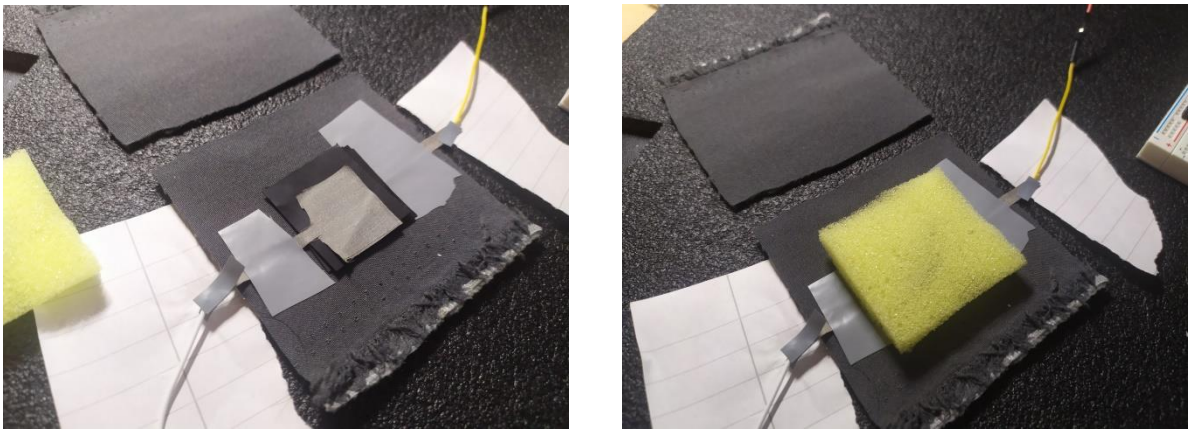

Figure 7: Pressure sensor using multi layered velostat.

Data:

We have used Arduino serial monitor and plotter to visualize the value. While reading the data we mapped the lower and highest analog input to a 0-100 % scale. The graph is a single variable Vs. time plotting. We took multiple data for different layers of velostat. The outcome can be seen below-

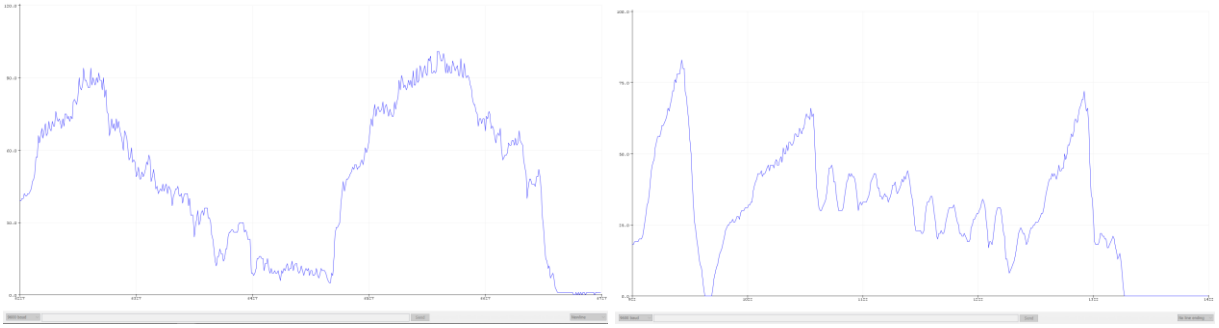

Figure 8: Plotted data for single layer velostat and 3 layer velostat pressure sensor

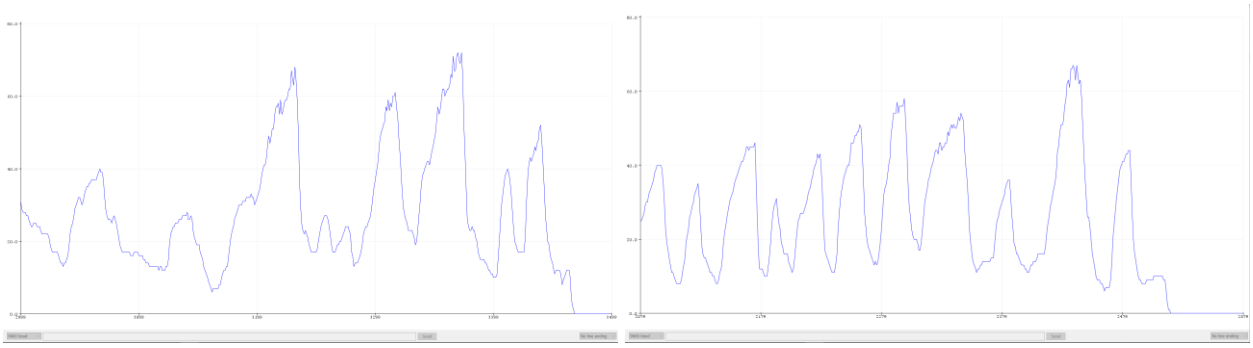

Figure 9 Plotted data for 5layer velostat and 5 layered+sponge material velostat pressure sensor

From the graphs we can see that more layer we add more stable it gets. And finally adding sponge type material also stables the control significantly.

Project Prototype

The main theme of the project prototype is to detect the impact of a user when he faces any accidental issues or when he wants immediate help and put pressure by themselves. For the initial prototype we are going to add a buzzer to our microcontroller. We map the raw input as 0-100 percentile. Here the buzzer will act as the emergency trigger. When a user faces any accident wearing it in the helmet or any other places and it feels pressure it will count the input pressure. When the pressure is higher then 60% (can vary by user preference) it will start a time delay to check whether it is a real emergency or a false request. After a certain delay if the pressure remains greater than the cut off value than it will trigger the buzzer. The final prototype can be seen below as both the raw and inside a cap –

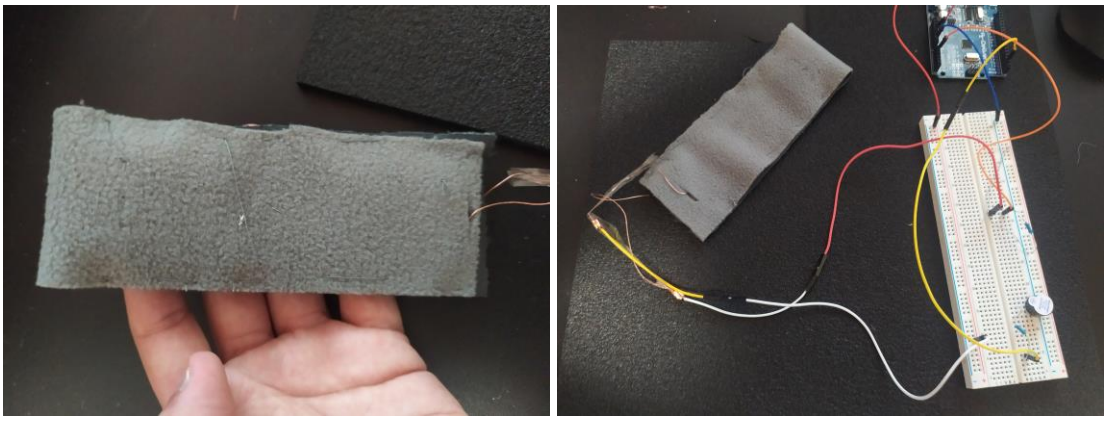

Figure 10: Final textile sensor prototype and project circuit

Tanjim Ul Haque s8tahaqu@stud.uni-saarland.de

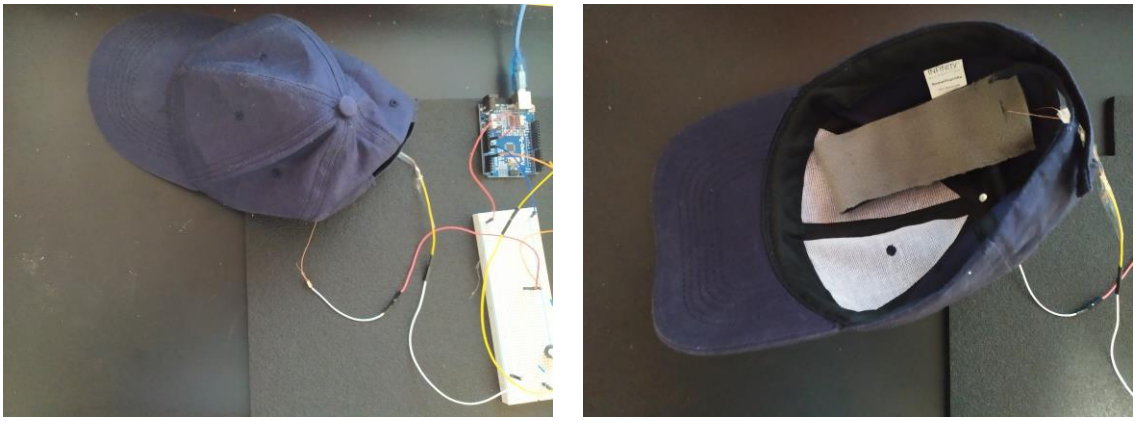

Figure 11: Final project prototype inside of a cap representing a helmet.

The Project schematic can be seen as follow –

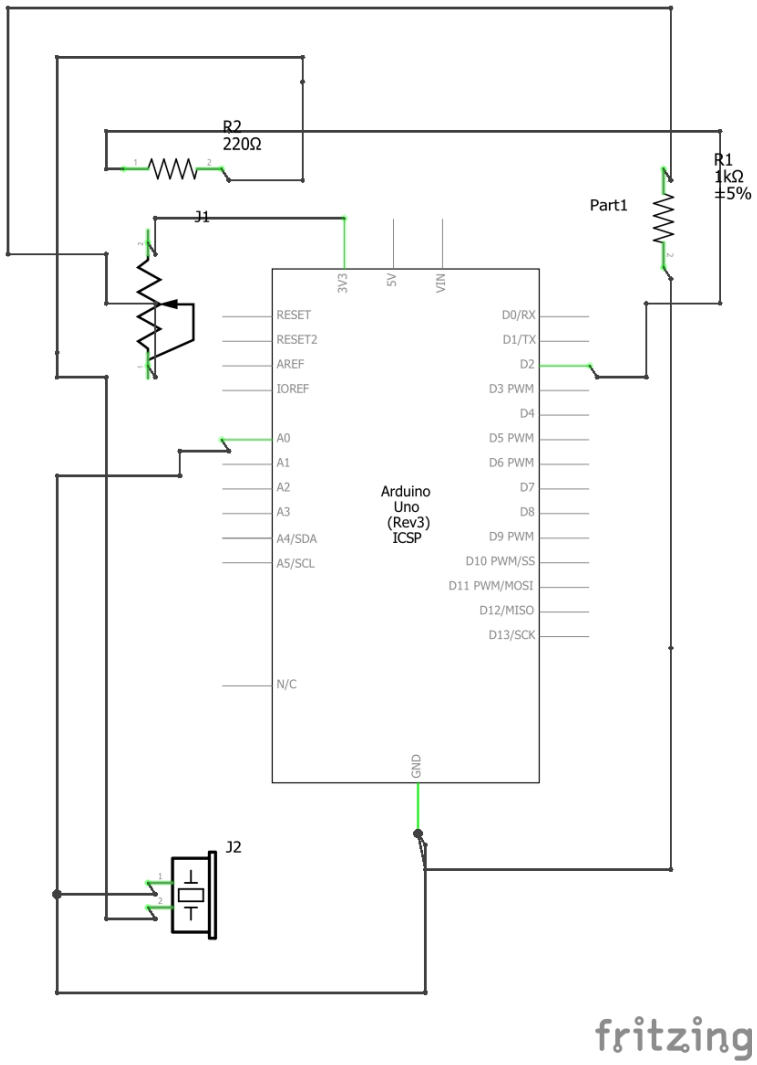

Figure 12: Final project schematic

Tanjim Ul Haque s8tahaqu@stud.uni-saarland.de

Lessons Learned

- While working with a pressure sensor we should be aware of the wires connected to the sensor. While working with the pressure sensor some wires were connected to an external source of power, due to the high amount of voltage passing through the microcontroller it burnt the microcontroller.
- While working with conductive fabric and velostat, it is better to keep the size of the conductive fabric smaller than the velostat. As when the two conductive fabric touches with each other it establishes a direct line hence data error will be shown in the analog screen, as it converted itself to a digital signal.
- Not all foam materials can be used for making a pressure sensor if there are no conductive materials attached to it. While working with velostat we added extra layer of foam to make the sensor more defined. But if we only targeted to use those foams instead of a velostat than there would be no conductivity thus resulting in no analog read at all.

Vision and Outlook

As this is a prototype of a conceptualized project in a very short span of time we could not implement the emergency help option using GSM, GPS system. We can implement a GSM for the elderly and disabled person in help at home so that whenever they are in trouble the system can trigger a SMS to their trusted person. Using geo-location from the mobile network the system can also send which area the person is in. For more detailed location tracking we can attach a GPS module with the microcontroller to send the exact co-ordinate of the users' location, which can be added to the bikers riding in mountain trails or un-localized area.

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Resources

Git Repository link : https://github.com/Tanjim67/interactive-system

Video

Video Link-
https://drive.google.com/file/d/1PeUbWgdFgRoToi-uu81UN9xRjoiPW1HC/view?usp=sharing

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[3]https://www.kobakant.at/DIY/?p=8305

[4] href="https://www.kobakant.at/DIY/?p=6706">https://www.kobakant.at/DIY/?p=6706

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