Velostat for Home-Made Pressure sensors

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Introduction

Flexible strain sensors for human motion detection are a promising field. They promise to be an unobtrusive way of integrating smart electronics and data collection into everyday objects such as clothing. The objective of this report is to outline a selection of flexible strain sensors in the application of detecting human motion and discuss their readiness to be applied to real world devices. Three materials for strain and pressure sensing are discussed. Velostat is discussed as a practical application due to its low cost and ease of use. Strain threads are discussed, as they have been demonstrated to have high accuracy and utility and can be fabricated for relatively low cost. Finally, piezoelectric materials are broadly discussed, with a focus on PVDF as the primary available material.

Velostat

Velostat

Properties

Velostat is a cheap and widely available material for at-home construction of simple flexible pressure sensors. It is a polymer material impregnated with conductive particles. The distance between these particles informs the resistivity of the material. This forms a flexible, plastic sheet which can be easily cut or shaped for many applications. The material changes resistance with strain, so a simple resistor divider can be used to measure the strain on the material. For tracking human motion velostat has a number of benefits. It is low cost, $4.95 for 121 square inches on adafruit at time of writing, highly flexible, easy to implement, and versatile. Unfortunately most of these benefits come with drawbacks, as the material also demonstrates viscoelasticity which can restrict the accuracy of certain measurements. In addition, the materials versatility also works against it. Velostat can be used to sense flex, stretch, or pressure. As such, sensor design must ensure that of these three properties, the two that are not being measured are either isolated out in the physical design or somehow compensated for. This restriction significantly restricts the use of velostat as a pressure sensing material in a wearable device context, as it must be used in a position where it is very unlikely to flex. Finally, as described in Vehec, I., & Livovsky, L. and Giovanelli, D., & Farella, E. it is difficult to extract exact pressure values from a given velostat resistor. However, these drawbacks do not make it without use. The soles of shoes, for example, are an ideal application of velostat pressure sensing, as the shape is unlikely to change significantly, but a rigid sensor would still cause irritation. Additionally, in this application absolute pressure values are often less important than relative pressure values, such as in Suprapto, S. S., Setiawan, A. W., Zakaria, H., Adiprawita, W., & Supartono, B where velostat is used to measure arch index. [1][2][3]

Sensor Construction

All velostat based sensors require two electrodes to be in contact with the material. It is ideal if such electrodes are also flexible, to retain the flexibility of the material. Additionally, as surface resistance can significantly impact the The most simple iteration of this is a single strip of velostat, sandwiched between two pieces of copper foil. The resistance through the velostat changes with both pressure and flex. As such it can be immediately used as either. However, due to the risk of flexing, individual pressure sensors should be kept as small as possible if they are at risk of flexing while in use.

Grid Sensing

A single sheet of velostat can also be used to locate applied pressure to the material. By arranging the electrodes as parallel strips, with the strips on top running perpendicular to the strips on the bottom, a grid simple sensing structure can be created. The resistance between any top and bottom electrodes will be roughly proportional to the pressure at their point of intersection. By checking each pair very quickly with a microcontroller we can get an effectively real time picture of the applied pressure. As discussed in Giovanelli, D., & Farella, E. , this pressure data is difficult to correlate to accurate values, but the relative data can be interesting. [2]

Velostat can also be used for motion detecting as it changes in resistance when flexed. As demonstrated in E. Jeong, J. Lee and D. Kim. Once again velostat has a lack of consistency in this area, and each specific implementation will require its own calibration. [4]

Conclusion

Overall, velostat is ideal for hobbyist use or proof of concept prototyping due to the low price and ease of use as a material. Its poor consistency and accuracy make it sub-optimal for data collection, but still useful for relativistic sensors.

1. Vehec, I., & Livovsky, L. (2020, May). Flexible resistive sensor based on velostat. *2020 43rd International Spring Seminar on Electronics Technology (ISSE)*. http://dx.doi.org/10.1109/isse49702.2020.9121009
2. Giovanelli, D., & Farella, E. (2016). Force sensing resistor and evaluation of technology for wearable body pressure sensing. *Journal of Sensors, 2016*. https://doi.org/https://doi.org/10.1155/2016/9391850
3. Suprapto, S. S., Setiawan, A. W., Zakaria, H., Adiprawita, W., & Supartono, B. (2017, November). Low-Cost pressure sensor matrix using velostat. *2017 5th International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME)*. http://dx.doi.org/10.1109/icici-bme.2017.8537720
4. E. Jeong, J. Lee and D. Kim, "Finger-gesture Recognition Glove using Velostat (ICCAS 2011)," 2011 11th International Conference on Control, Automation and Systems, 2011, pp. 206-210.