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Invited Demo: Pyzoflex – Printed Piezoelectric Pressure Sensing Foil

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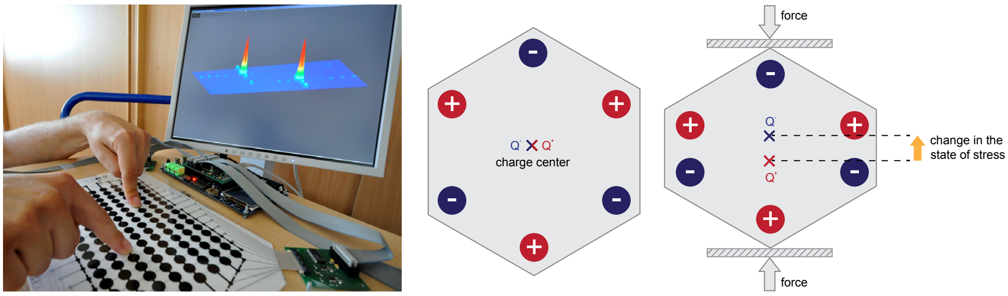
Abstract

Ferroelectric material supports both pyro- and piezoelectric effects that can be used for sensing pressures on large, bended surfaces. We present PyzoFlex, a pressure-sensing input device that is based on a ferroelectric material. It is constructed with a sandwich structure of four layers that can be printed easily on any material. We use this material in combination with a high-resolution Anoto-sensing foil to support both hand and pen input tracking. The foil is bendable, energy-efficient, and it can be produced in a printing process. Even a hovering mode is feasible due to its pyroelectric effect.

1 Introduction

Over the last decade, touch sensing devices have become more and more important. Most researchers tried to improve the multi-touch technology by introducing capacitive, resistive, or optical sensing devices. Although most of them provide already a multi-touch sensing, it is still often not possible to track *input pressure* efficiently. Tracking pen and touch separately in combination with pressure tracking provides new possibilities for user interfaces and interaction design (Brandl et al. 2008, Hinkley et. al 2010).

In this demo, we present *PyzoFlex*, a novel sensing device that is based on a pyro- and piezoelectric sensor matrix, screen-printed on a flexible film (cf., Figure 1 (a)). Moreover, the sensor area can detect changes in pressure and temperature respectively.



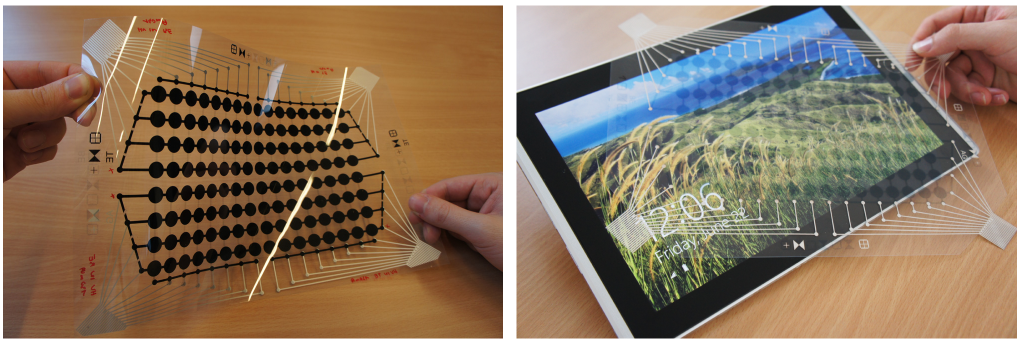
(a) *(b)*

Figure 1: (a) PyzoFlex in action - the current prototype is based on a DIN A4-sized foil that provides real-time pressure sensing feedback with a frame rate of 100 fps.(b) The Piezoelectric Pressure Sensing Effect - shifting of the charge centers in the state of stress/force generates a measureable charge.

The piezoelectric effect (Fukada 1989) can be found in any ferroelectric material. Any mechanic stress or force (e.g., touch) applied will result in a change of the electric field. This electric field variation is proportional to the mechanic deformation (cf., Figure 1 (b)). Therefore, the piezoelectric effect can be used to measure pressure changes efficiently. All ferroelectric materials also have a pyroelectric effect: a variation in temperature influences the distribution of the electrical charge, which is again measureable. As a result, ferroelectric materials can also be used to measure temperature changes.

2 PyzoFlex sensing foil

The current sensing foil is based on a 16 × 8 array of screen printed, flexible, capacitive and circular sensor spots having a diameter of 10 mm (cf., Figure 2).



(a) *(b)*

Figure 2: The current version is a 16 x 8 array of printed piezoelectric sensor spots with a size of 10 mm. The top electrodes can consist either of carbon (a) or conductive polymer (b), which results in a quasi-transparent foil.

The basis of our touch foil is the transparent plastic substrate (*PET*), which serves as carrier for the printed materials. In the next step 128 circular spots (electrodes, *Conductive Polymer*) are printed to the carrier material, which are connected horizontally. Subsequently, the whole plastic substrate gets continuously coated with the ferroelectric material (*PVDF*). After that, the second layer with vertically connected electrodes is printed. The top electrodes on the second layer consist either of non-transparent *carbon* (cf., Figure 2 (a)) or again of *conductive polymer* (cf., Figure 2 (b)).

The two layers of electrodes are forming a capacitor. Charge changes in the ferroelectric sensor layer cause measureable voltages between the electrodes. Figure 3 shows the sandwich design of our foil prototype.

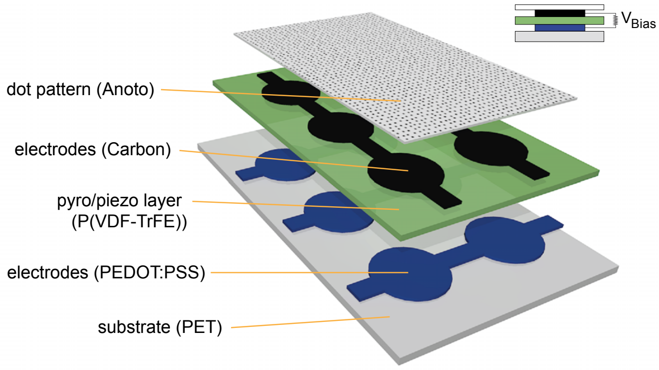


Figure 3: PyzoFlex sensor sandwich technology.

For applications with a strict pen and touch separation, a stable separation of both inputs is highly necessary. To achieve a stable pen and touch tracking we decided to combine the PyzoFlex foil with Anoto pen tracking, which facilitates ultra-high input resolutions (e.g., 677 dpi with Anoto[1]), which are hard to achieve with multi-touch sensing technology.

The current sensing electronics is able to measure and send the output voltage of each of the 128 sensor spots with 100 Hz. A software-based input driver calculates the applied pressure from the sensor output voltage. In order to achieve a high-resolution touch foil, we plan to decrease the diameter and distance of the sensor points, since there is enough capacity on the microcontroller left (up to 1024 sensor spots). This allows us to perform a linear interpolation routine to increase the resolution to modern standards.

1 http://www.anoto.com/why-anoto.aspx

3 Characteristics of PyzoFlex

The generated voltage output from the PyzoFlex foil is perfectly linear. This is important for two reasons: On the one hand it facilitates the tracking of the touch location and on the other hand it enables to utilize the absolute magnitude of the touch force for a selection of different user modi.

PyzoFlex is a bendable and flexible sensor technology, meaning that the sensor can be mounted on different curved surfaces.

Furthermore, PyzoFlex provides an energy-efficient implementation, since every touch generates a small amount of voltage. Under certain conditions the multi-touch sensing setup could serve as energy harvesting resource. Finally, another major economic advantage is the ITO-free (*indium tin oxide*) implementation, because common used indium is a very limited resource in our world.

4 Future Work

For future work, we plan to eliminate currently existing problems, including crosstalk and the cross-sensitivity of the piezo- and pyroelectric response. Furthermore, we want to increase the resolution by changing the sensor arrangement and interpolating between the sensor points. Another goal will be to improve the scalability of the sensor foil – since it can be printed on really large surfaces. In our final version, we would like to fabricate the sensor foil over several square meters in an in-line roll-to-roll process at low cost. Finally, we plan to develop a more transparent sensor foil by experimenting with new materials (e.g., for the use in mobile devices).

References

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