Sheet-based flexible technologies for mechanical sensing

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Flexible electronic technologies offer the potential for the co-integration of mechanical sensors that measure the state of the flexible surface under actuation or deformation. This format of sensor offers significant opportunities for the instrumentation of existing systems for a range of applications such as touch, measurement of acoustic field, and the detection of deformation modes of a system. Beyond the instrumentation of existing systems, flexible devices can themselves serve as actuators, allowing for sheet-based robotic devices, as well as the development of sensor formats for challenging applications.

Local amplification and use of active matrix approaches

One of the approaches that has yielded superior localization for array devices is the use of co-integrated organic field effect transistors with piezoelectric polymer sheets, allowing for local amplification. The use of these integrated devices allows for the transduction of the charge signal of a piezoelectric polymer sheet to a current, which permits the isolation of localized strain avoiding the influence of parasitic capacitance and parasitic piezoelectric coupling due to neighboring elements.[5] This approach can be used to map the mechanical profile of substrates that the sheet has been laminated to, and also allows for the creation of devices that map the mechanical modes of resonators, allowing the identification of acoustic signals using a power distribution signature and without the need for time-domain computation.[7]

Locally amplified devices, which are able to deliver a high degree of localization, are also able to overcome the downstream parasitic capacitances associated with forming an active matrix array device configuration. Such arrays have been demonstrated with acoustic frequency performance, allowing for a range of new applications including tone analysis, measurement of boundary layer flows, and use in user interface devices.[4]

Applications for mechanical sensors

In addition to the application of flexible mechanical sensors to robotic touch sensors [8, 9] and the measurement of shape [3], flexible sheet mechanical sensors can be applied to a number of new application areas that are challenging to address using traditional technologies.

One application area for such sensors is in the measurement of the pressure wave of the cochlea [2]. In this structure, the bulk hydrostatic mode of the piezoelectric element is used in a miniature device that can be threaded into the cochlea, allowing for the development of an implantable microphone as an alternative source for cochlear implant signals. Such devices can also be used in advanced user interfaces [10], for instrumenting sheet-based actuation devices such as electrostrictors [1], and the measurement of boundary layer flow over airfoil surfaces and directional acoustic pressure waves [6].

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