TFT & ULSIC: INTERFACING LARGE-AREA THIN-FILM SENSOR ARRAYS WITH CMOS CIRCUITS

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Large-area, conformable sensing surfaces could find many applications by interfacing humans or machines users with their environment. Given the success of TFT backplanes for flat-panel displays, a promising approach is the fabrication of large integrated thin-film sensor arrays on single substrates. In thin-film technology the number of sensors can be made very large, and they can be deployed on rigid or flexible, conformably shapeable or even elastically stretchable substrates. Flat-panel displays suggest that TFT integration can be less costly than arrays made by placing and interconnecting discrete sensels. Equally important is that low-temperature thin-film technology can accommodate the diversity of materials required by the various sensor technologies. However, thin-film devices and circuits are slow. TFT circuits cannot compete directly with ULSI circuits in controlling large sensor arrays, or in signal processing and extracting the germane information from the huge number of signals that such arrays can generate. To combine the advantages of large-area integrated TFT circuits with the speed of ULSI circuits, we have been making hybrid systems that combine TFT and ULSIC [1]. Our work covers the range from thin-film device materials to subsystems implemented in thin-film technology, to co-designing and interfacing the large-area thin-film domain with the ULSIC domain. We have demonstrated systems for the sensing of mechanical strain [2], image detection [3], acoustic speaker localization [4], electro-encephalography [5], gestures [6], and patterns of pressure.

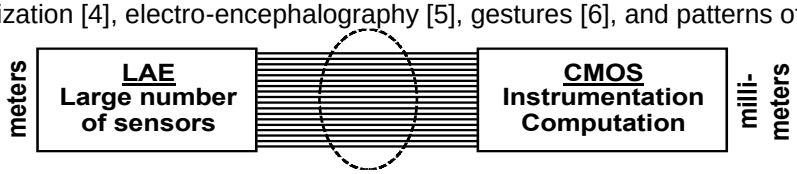

Figure 1. Illustration of the challenge of interfacing LAE / ULSI hybrid systems.

An important aspect of such hybrid systems is the number of physical interfaces between the large-area thin-film domain and the CMOS IC. This number must be kept much smaller than the number of sensels, for both controlling the sensors and extracting data from them. We have developed thin-film circuits that address this need by controlling sensor access, compressing sensor data, and even extracting, in the thin-film domain, germane signal information. These TFT-based circuits include a scan chain for sequential readout as well as several circuits that enable data compression, and even feature extraction, all in the thin-film domain. Following an overview of the physical architecture of the TFT / ULSI hybrid systems, including the underlying amorphous-silicon and zinc oxide based TFTs, we will describe these thin-film circuits and their functions.

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