Smart Active-Matrix Display Drivers For Organic Light Emitting Devices

Personnel

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In this project we are developing pixilated active matrix "smart drivers" for displays consisting of Organic Light Emitting Devices (OLEDs). Organic LEDs are perhaps the most promising novel technology for development of efficient, pixilated, and brightly emissive, flat-panel displays. They naturally emit over large areas, and offer the advantage of growth on lightweight and rugged substrates such as metal foils and plastic, with no requirement for lattice-matching.

Organic LED devices, however, exhibit non-linear light output responses that complicate their implementation in an application requiring a fine control of the output light intensity. Specifically, the I-V characteristics of OLEDs depend on the cathode/anode type, organic compound layer thickness, and operating temperature. The power efficiency of pixels in a display will drift over time due operational degradation. The individual pixels in a display can then exhibit different aging, in accordance with their use. The brightness non-uniformities due to the differential aging will reduce the useful display lifetime.

Our smart active matrix circuitry compensates for the OLED non-uniformities by monitoring light output and adjusting the driving conditions according to the OLED performance. The adjusted output provides a defect-free picture. In the final design a Si p-n detector integrated behind each pixel will give feedback to the driver circuits that will adjust the proper current level to derive a constant brightness output. Figure 27 shows a typical integrated structure in which a transparent OLED is used. In this design both OLED electrodes are capable of transmitting the emitted light, which is mostly observed on the top, but is also partially absorbed in the detector.

The initial demonstration of the concept uses discrete components assembled on a PC board according to the 5 x 5 pixel array design scheme drawn in Fig. 28. Notice that three integrated transistors control each pixel. Also, each column of 5 pixels shares one feedback circuit. The integrator compensation is used for each feedback circuit to ensure that the light output is matched to the reference input. The values of discrete components were chosen to stabilize the feedback loop. We use a digital video camera to serve the function of the integrated sensor. The digital part of the system and the image processing from the camera is done on a CPLD.

The next phase of this project will involve developing an integrated circuit that interfaces to the transparent OLEDs. We can then explore the implementation of the same circuit on flexible substrates using low-cost semiconductors (such as amorphous Si, or printed organic transistors).

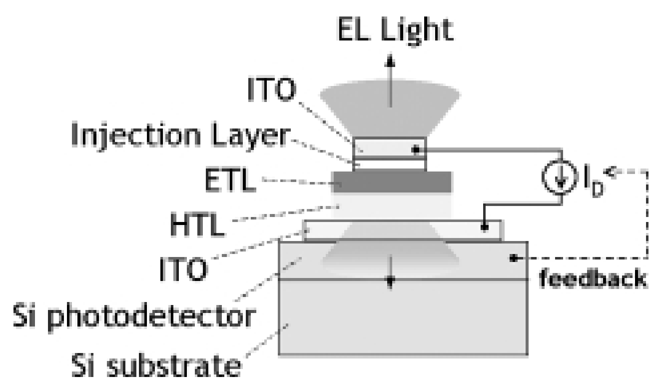

Fig. 27: An OLED pixel integrated with a "smart" Si active matrix driver. The Si photodetector monitors the intensity of the OLED pixel during the on state and provides feedback to the driving circuit to keep the light output intensity constant as the device efficiency changes with operation.

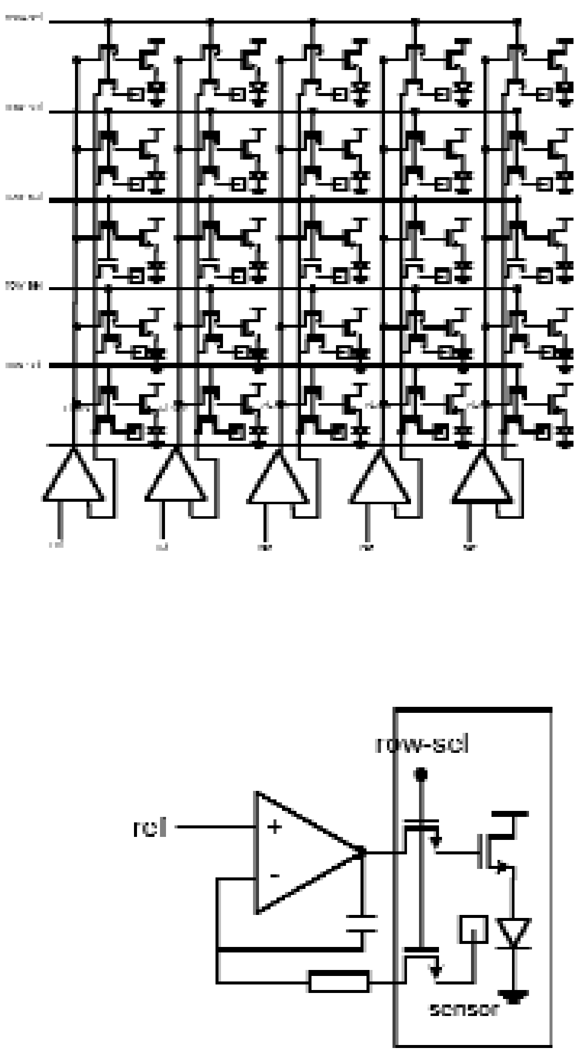

Fig. 28: (Left) A 5 x 5 pixel driver array with feedback.
(Right) A single pixel detail.