A new chip, based on the design of a human eye, will be able to monitor and execute actions.

Eye on-the-fly

Researchers at a US university have developed a chip modelled on the human eye which combines image sensing with filtering and the ability to track images. The technology could in the future lead to a new type of monitoring device which can interpret and react to movement and may eventually even be used by heart surgeons.

The work being carried out at John Hopkins University under the direction of Ralph Etienne-Cummings, assistant professor of electrical and computer engineering, has produced an integrated low-power chip which mimics the work of the high-definition central region of the retina and the lower-resolution peripheral vision area that follows movement.

The circuit is based on combination analogue-digital CMOS technology and is said to be much faster than distributed component setups which use multiple chips. Those systems typically use an image sensor, a micro-controller and non-volatile RAM.

Etienne-Cummings used the parasitic bipolar transistors that are innate to CMOS chips and created surface arrays of photo-sensitive pixels. The analogue interconnecting matrix for the transistors employs motion detection in the central area and derives speed calculations from it. The analogue inter-connection matrix in the periphery calculates the location of an object by bumping against the edge of the central area and figures a heading calculation from it.

The speed and heading calculations are combined to lock on to, and track, objects in motion. The chip itself executes all operations without the necessity of a separate computer to guide it. 'The idea of putting electronic sensing and processing in the same place is called computational sensing,' said Etienne-Cummings. 'It was coined less than ten years ago by the people who started this new line of research. Our goal is to revolutionise robotic vision, or robotics in general. It hasn't happened yet, but we're making progress.'

Etienne-Cummings points out that the significant thing is how the chip operates, not what it does. 'It's the way it functions. It's a regular CMOS [integrated circuit] chip that can execute all its operations directly without the help of a computer, which results in a very low energy requirement, small size and high speed.'

▲ON THE WAY TO THE ALL-SEEING EYE CHIP

One of the first applications mentioned for this technology is in security surveillance cameras. The chip could be embedded in cameras, which would allow them to control their own mechanised pan and tilt functions. Cameras could then track intruders.

Factory environments are another area for the technology. 'It could also be used in manufacturing to enable a robot to grab moving parts,' said Etienne-Cummings. 'The chip could be used for anything which we take for granted that uses some motor action – reaching, grabbing, following, tracking – which would require first measuring some kind of visual calculation and picking something out of the background.' Using the chip for electronic toys is another use touted for the technology within a few years.

In the longer term, Etienne-Cummings hopes the technology will be enhanced for use in computer-aided surgery. 'I hope to someday have helped create a technology that will enable doctors to track movement of a beating heart so that blocked cardiac arteries can be cleared without having to stop the heart first, as doctors must do today,' he said.

The technology still has a way to go before it meets those lofty goals. At present, its capabilities are being demonstrated by mounting two eye chips on a toy car, enabling it to follow a line around a test track. The chips force the car to follow a line detected by the sensors, unless an obstacle appears in its path. To the chips, avoiding a crash takes priority over following the line, so they steer the car away from the obstacle. The system also 'remembers' how it avoided the obstacle so it can steer the car back to the line, to resume its original course.

The chip could be embedded in cameras, which would allow them to CONTROL THEIR OWN PAN AND TILT functions. Cameras could then track intruders

It's no surprise, therefore, that Etienne-Cummings says the chips are well suited for all kinds of new mobile applications in micro-robots, autonomous flying machines and extra-terrestrial rovers.

JOHN GERALDS

Low-temperature polysilicon is leading the next generation of TFT display technology.

Dream screen

Thin film transistor displays – we all recognise their benefits of bright, sharp images with vivid contrast; but what about the drawbacks? Traditional amorphous-silicon TFT panels, as used in most modern notebook computers, cost a fortune. They break easily and consume power like it was going out of fashion. For the past few years they've been the only choice for high-quality, decent-sized notebook screens.

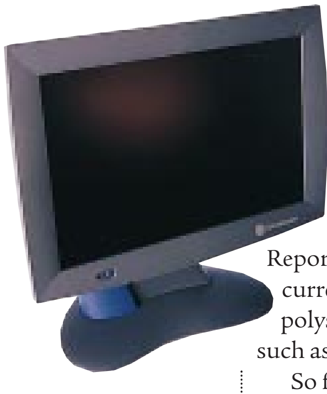
An alternative for notebook manufacturers is just around the corner, though. In fact, if you've got a recent digital camera, projector or camcorder, you're probably already holding an example of a TFT display using brand new, low-temperature, polycrystal-silicon technology.

With polysilicon screens, the silicon is randomly deposited onto the LCD glass using small unaligned crystals. This, along with a larger and more uniform crystal structure, has one vital benefit: higher electron mobility. Faster electrons are happy electrons. Since they can move more easily through the crystal structure, the overall display is brighter and consumes less power, which is great news for portable users.

With faster response and better control over the liquid crystals, the display transistors can also be used for other tasks. Believe it or not, much of the complex and expensive LCD driver chips on traditional panels could be constructed onto the polysilicon glass in the same amount of time as the TFT array. That not only makes the display smaller, thinner, lighter and cheaper but more reliable, too – reliable, since the number of potentially breakable connections to the LCD glass are reduced: a 1024 x 768 amorphous-silicon TFT panel has 4128 connections, compared with only 200 using polysilicon technology. It's more durable, too.

There's more. TFT panels employ a dedicated transistor to control each pixel element. Apart from being expensive, these transistors and their connections represent a dead area where no light can pass. With polysilicon, the TFTs can be made smaller and the connections thinner, offering greater light transmission which, with dimmer backlights, results in longer battery life.

So far so good. In fact, let's not hold back but simply admit that POLYSILICON IS ABSOLUTELY BRILLIANT – the holy grail of display technologies



▲ Current TFT screens, such as this Silicon Graphics monitor, consume more power than polysilicon displays

The smaller TFTs and thinner connections have another implication: potentially extremely high resolutions. Reports of up to ten times the resolution of current TFT displays has been claimed for polysilicon, which in turn allows possibilities such as 3D images that you could look around.

So far so good. In fact, let's not hold back but simply admit that polysilicon is absolutely brilliant – the holy grail of display technologies. So what's the catch? Well, there's the small fact that polysilicon only operates at 1000°C, which is a bit of a downer, to say the least. But hang on, what of the low-temperature stuff mentioned at the beginning of this article?

Low-temperature polysilicon offers all of the advantages mentioned above but operates at room temperature. It's already a reality in several mainstream products, albeit at a small panel size of only a couple of inches across. Most modern TFT projectors employ polysilicon panels, as do many digital cameras including the viewing panel of the Canon Powershot Pro70 [*Editor's Choice, PCW May*]. In the projector, polysilicon enables high light transmission and resolution, while all digital camera users will more than welcome brighter, lower-power displays. Camcorders and PDAs are beginning to employ low-temperature polysilicon at larger panel sizes, and you'll be pleased to learn that their dimensions are growing further still.

Toshiba in particular is leading low-temperature polysilicon development and has already produced a 10.4in panel with 1024 x 768 resolution. The company expects to produce 12in and 13in panels this summer and believes it will be the first to market with a large-screen polysilicon notebook this year.

Modern notebooks are already slim, powerful and attractive. But ask any notebook user what is their biggest bugbear and most will reply 'battery life'. Full Windows compatibility is all very well, but when the lights go off after only a couple of hours, no one's happy. With polysilicon displays, the truly portable dream looks set to become a reality.

Gordon Laing