I'm sure you all realize that size matters. This column looks at technology that will shrink computing hardware even further. Size also affects how we interact with those small devices. We do a lot with our fingers and a little with our voice. Here, I explore other input methods that could make great computing technology even more accessible.

### 3D Sensing with MEMS

Accurately sensing location in 3D currently requires large, expensive devices. Researchers in MIT’s Department of Aeronautics and Astronautics have devised an approach to microelectromechanical systems (MEMS) fabrication that lets engineers design 3D configurations for existing fabrication processes. They used the approach successfully to build a MEMS device that enables 3D sensing on a single chip. The silicon device, about the size of Abraham Lincoln’s ear on a US penny, contains microscopic elements about the width of a red blood cell that can be engineered to heights hundreds of microns above the chip’s surface.

Postdoc Fabio Fachin says that sensors can be placed atop and underneath the chip’s minuscule bridges to enable 3D sensing and actuation—for example, detecting 3D phenomena such as acceleration. Such compact accelerometers have applications—for example, space navigation—that require extremely accurate resolution of 3D acceleration fields in a small form factor.


### Ultrathin Lens

Harvard physicists have pushed the limits of light to fabricate a lens that could revolutionize photography in much the same way digital technology has. The team has created an ultrathin (60 nanometers) flat lens that’s essentially 2D and can focus light without distortion. The lens creates an instantaneous phase shift right at its surface (see Figure 1). This differs from the conventional technique, which creates phase delays as light propagates through the lens. The flat lens is fabricated from a very thin silicon wafer plated with a nanometer-thick layer of gold. Pretty cool way of getting rid of that fish-eye effect.

For more information see [www.seas.harvard.edu/capasso/2012/08/group-unveils-first-flat-lens](http://www.seas.harvard.edu/capasso/2012/08/group-unveils-first-flat-lens).

### Reconstructing Art

My career as an amateur photographer has led me to photograph objects legally around the world. On the illegal front, I was nearly kicked out of an art exhibit in Brisbane, Australia, when I was

---

**Figure 1.** Flat focus for a thin lens. The lens is essentially 2D and creates an instantaneous phase shift at the lens surface to avoid the phase delays in conventional fabrication techniques. (Source: Harvard School of Engineering and Applied Science; used with permission.)
caught surreptitiously photographing some lovely J.M.W. Turner paintings.

My photographs of famous paintings aren’t all that good. Some work from three mathematicians in Spain and France might help. They propose fusing photographs taken from different angles to reliably reproduce paintings. The photographic procedure is far simpler than the technique Google Images uses, and it eliminates sophisticated illumination and acquisition requirements.

The intensive postproduction process is statistically based and fully automated. The fusion of multiple images from well-chosen angles can eliminate glare, highlights, and motion blur. The statistical methods additionally reduce noise and compensate for optical distortion, which are typical in many digitized paintings, and the image fusion eliminates the need for a high-performance camera.

For more information, see www.eurekalert.org/pub_releases/2012-09/sfia-maf092512.php.

Radical Atoms
Hiroshi Ishii’s Tangible Media Group at the MIT Media Lab aims to turn physical objects into computer input devices and routinely pushes the state of the art in human-computer interaction. The group recently redefined its vision of “tangible bits”—a user interface that physically manifests computation to support direct interaction with it. The new vision, “radical atoms,” would physically manifest digital information for direct transformation. To follow the group’s projects, see http://tangible.media.mit.edu/projects.

Here’s a sampling of their work.

Topobo
This 3D constructive assembly system has kinetic memory that records and plays back physical motion. By snapping together a combination of static and motorized components, users can quickly assemble dynamic biomorphic forms; animate those forms by pushing, pulling, and twisting them; and observe the system play back those motions.

Topobo has implications for designing assembly and disassembly sequences and changing the kinetic motion to reflect new task sequences.

Pico
This interactive tabletop tracks and moves small objects on its surface through electromagnets that run software-based dynamic physical processes. Pico also responds to modifications by users standing around the table. It combines mechanical systems’ usability advantages with modern computers’ abstract computational power.

ZeroN
The ZeroN interface element can be levitated and moved freely in a 3D space through a magnetic control system (see Figure 2). It serves as a tangible representation of a 3D coordinate that lets users see, feel, and control computation. They can place and interact with the ZeroN element in the midair space, just as they can place and interact with objects on surfaces. Removing gravity from tangible interaction, the ZeroN project explores how altering a fundamental rule of the physical world will transform interaction between humans and materials.

Emotional Lip Reading
One thing missing from automatic call-answering systems is the opportunity to vent about dealing with them. Manipal International University researchers might be able to help out with their work on emotion detection based on lip reading.

Their system uses a genetic algorithm to match irregular ellipse-fitting equations to the shape of the human mouth displaying different emotions. The team used photos of individuals from southeast Asia and Japan to train a computer to recognize the six common human emotions—happiness, sadness, fear, anger, disgust, and surprise—plus one neutral expression. When presented with a face, the system analyzes the upper and lower lips as two separate ellipses to determine the appropriate emotion.


Contact department editor David J. Kasik at david.j.kasik@boeing.com.