CS Bits & Bytes
Highlighting Innovative Computer Science Research

CS Bits & Bytes is a bi-weekly newsletter highlighting innovative computer science research. It is our hope that you will use CS Bits & Bytes to engage in the multi-faceted world of computer science to become not just a user, but a creator of technology. Please visit our website at: http://www.nsf.gov/cise/csbytes.

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Sensors in Action

Wouldn't you like to know?! Who walked across your bedroom carpet while you were not home? Or would you like to know if your elderly grandparent or neighbor who spends most of their time alone fell? This is now possible with sensor technology.

MUST SEE!

See the Magic Carpet in action at: http://uk.reuters.com/video/2012/10/08/magic-carpet-a-hi-tech-safety-net-for-el?videoId=238243515&videoChannel=79.

Sensors are mechanical devices that measure a physical quantity (e.g., light, temperature, emission, location, or mass) and convert it to a signal to be read (often by an electronic device, such as a computer). Many sensors not only read the information, but also respond to the signal once sensor nodes exchange data and communicate with the sensor.

When this physical information is cyber-enabled, the resulting combination of cyber and physical components often results in what is known as smart systems. **Smart systems** are being used in a variety of applications. They are used to monitor **physical structural information** like the power consumption of buildings and campuses or the integrity of bridges. For example, cutting-edge sensors were used to monitor the cumulative effects of fatigue on the Liberty Bell as the 250-year old icon was moved 200 yards from its circa-1970s home to the new Liberty Bell Center in Philadelphia in 2003.

Smart systems are also used to detect **health information** such as movement, blood pressure, heart rate, and temperature. In artificial knee replacements, smart sensors are used to record and transmit data about the stresses endured through everyday knee motion.

Another important use of smart systems is sensing **environmental information** such as air quality or beech erosion.

A team at the University of Manchester in the UK led by Dr. Patricia Scully has developed a carpet that can detect when someone has fallen or when unfamiliar feet walk across it. The carpet's padding contains optical fibers that create a 2D tomography pressure map that distorts when someone steps on it. Sensors around the carpet's edges then relay signals to a computer, which is used to analyze the footstep patterns. When a change is detected - such as a sudden stumble and fall - an alarm can be set to sound. By monitoring footsteps over time, the system learns people's walking patterns and can detect subtle changes, possibly predicting the onset of mobility problems in the elderly. The carpet also has applications in security, where it could be used as an intruder alert.

Nurgiyatna Nurgiyatna working on the carpet. Image credit: University of Manchester.

Dr. Patricia Scully hanging out with a rooster. Image courtesy of Dr. Scully.

Who Thinks of this Stuff?! Dr. Patricia Scully is a Senior Lecturer in Sensor Instrumentation and the School of Chemical Engineering and Analytical Science at The University of Manchester in Manchester, England. Her research interests are in optical sensing and measurement. She graduated with a B.S. in Physics, and her Ph.D. project involved the development of optical sensors for monitoring magnetic resonance scanners. In her free time, Dr. Scully likes playing a concertina, which is a type of small accordion often used for Irish and Scottish traditional music, and traveling to the west coast of Ireland to visit her family.

Links:

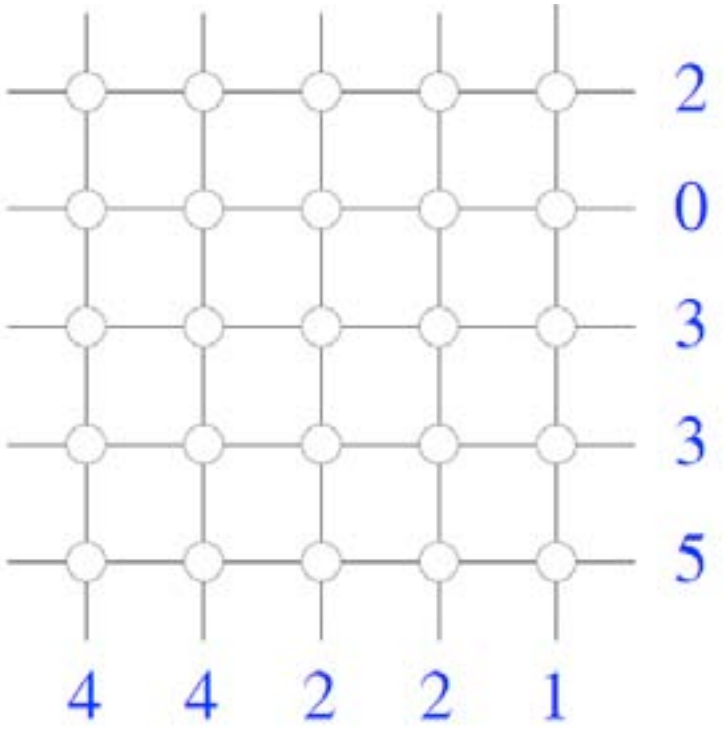
Read about other innovative uses of sensors at: http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=108363.

Watch the carpet collecting data at: http://www.reuters.com/video/2012/10/08/magic-carpet-a-hi-tech-safety-net-for-el?videoId=238243515&videoChannel=5.

For more details on the carpet, visit: http://www.manchester.ac.uk/aboutus/news/display/?id=8648.

Activity:

In general, tomography deals with the problem of determining shape and dimensional information of an object from a set of projections. From the mathematical point of view, the object corresponds to a function and the problem posed is to reconstruct this function from its integrals or sums over subsets of its domain. The name discrete tomography is due to Larry Shepp, who organized the first meeting devoted to this topic (DIMACS Mini-Symposium on Discrete Tomography, September 19, 1994, Rutgers University). Here is a discrete tomography reconstruction problem for two vertical and horizontal directions – have students color some of the white points black so that the number of black points in the rows and columns match the blue numbers:



Note that there are multiple solutions to this activity. For a possible solution, see http://en.wikipedia.org/wiki/File:Discrete_tomography.png.

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