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UM engineer builds bridge sensors to give early warnings

By Michael Dresser, The Baltimore Sun
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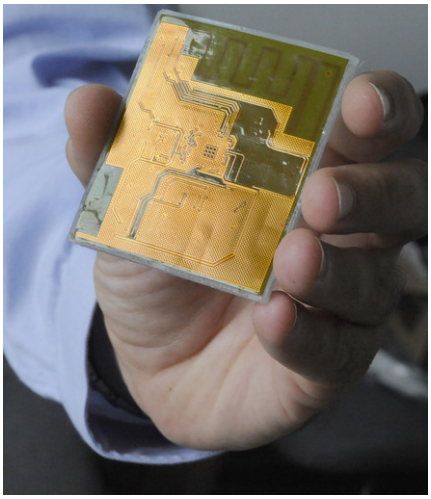
Credit card-sized device would monitor stress, researchers say.



The sensor is about the thickness of a playing card and a bit smaller…. (Baltimore Sun photo by Jed…)

The device that Mehdi Kalantari hopes will revolutionize monitoring of the structural integrity of bridges around the world is about as small and flat as a credit card and is powered by the sun, by ambient light or even by stray radio waves it can pick out of the atmosphere.

An Iranian immigrant and electrical engineer at the University of Maryland, College Park, Kalantari has devised what he calls a lightweight, low-power, wireless sensor that he hopes will detect weaknesses in bridges and other infrastructure before they can turn into calamities such as the collapse of the Interstate 35W bridge that killed 13 people in Minneapolis in 2007.

If they work as imagined, the devices would detect anomalies in the structure of even the most inaccessible parts of bridges and send alerts via cellular frequencies to its human masters. Among the things it would measure would be stress loads, vibration, temperature and the creation and growth of cracks.

"You will have a complete, real-time picture of what's happening on the bridge," said the 35-year-old UM researcher who has lived in the United States since 2001.

Like all new technologies, Kalantari's sensor faces enormous hurdles in finding a market. It would need to win acceptance from the engineers who maintain the nation's transportation infrastructure and it would have to prove itself against the competition that could arise from other universities and corporate laboratories anywhere in the world.

But Kalantari's colleagues and advisers at UM's Technology Advancement Program believe the entrepreneur and his business partner, fellow UM electrical engineer Arash Takshi, might be on to something big.

Kalantari and Takshi's startup company, Resensys, won a $6,000 grant in a business plan challenge from the university in 2008 and a free year of work space on the UM campus. Just this month, Resensys launched a pilot project under which it has installed a half-dozen sensors monitoring conditions on a more-than-50-year-old bridge on the Capital Beltway under an agreement with the State Highway Administration.

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"The technology they offer clearly affords us an entrepreneurial opportunity," said Craig Dye, director of UM's Venture Accelerator program. While designed with bridges in mind, he said, the sensors could be applied to roads, trestles and buildings, too.

Other sensors have been invented to monitor infrastructure for signs of cracking or metal fatigue, but what distinguishes the Resensys device is its miserly use of power — about 4 microwatts, or roughly 100 million times less than a typical light bulb, Kalantari said.

For the little power it does use, the silicone-coated sensors would not rely on batteries but on tiny supercapacitors with no chemical fuel to run out. Kalantari said that for now his company would guarantee the sensors for at least 10 years but suspects they could last much longer with the help of advanced adhesives that would hold them in place through all types of weather.

Individually, the sensors would cost only about $25 to $30 to manufacture, Kalantari said, but it could take thousands to cover a span the size of the Bay Bridge. But the most lucrative opportunity, he said, would be in selling the software and the services of monitoring and interpreting the data the sensors transmit.

Neither Kalantari nor his colleagues envision a product that would replace human inspections. Rather, they say, it would let inspectors track changes in the condition of bridges between the inspections they routinely undergo every year or two.

"The sensor will never 100 percent replace the human intelligence," Kalantari said. "We don't want to give the impression we want to replace the bridge inspectors with our sensors."

But he said that particularly with older bridges, a device that could monitor them constantly for signs of weakness could be useful.

"If a bridge is 35-40 years old and has a history of structural deficiency, it may be time to put on something to give you real-time information," Kalantari said.

Based on that description alone, the market for such a technology could be vast. With an interstate highway system that was largely built out in the 1950s through the 1970s, there are tens of thousands of bridges that fit that description in the United States alone. Takshi said such sensors could be particularly useful in areas of high earthquake activity, providing signals of problems before inspectors could be dispatched.

Kalantari, who lives in Bethesda, said he was on the UM faculty in 2006 — about a year before the Minnesota bridge collapse — when he began to explore some of the potential uses of sensor networking. He said he found there was significant theoretical work being done on the development of sensors but little on the creation of wireless networks of the devices.

"I like to see what can be done in a practical sense," he said. Discussions with friends pointed the way toward monitoring of infrastructure integrity, he said. Two years later, after additional research, he formed his company.

Takshi, 39, an Iranian immigrant who lives in Columbia, came aboard in 2009. The company has two patents pending for technologies connected with the sensors and expects to file for more, Kalantari said.

The next crucial step in Resensys' march to the market is the test on a Maryland bridge.

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Jeff Robert, senior project engineer with the State Highway Administration's Office of Structures, said Kalantari has met with agency officials and explained his technology. He said the fact it is wireless and doesn't require batteries could make it useful.

"It looks promising in the laboratory but he needs to do actual field testing," the official said.

Robert said his agency has given the company the green light to install the sensors on the Interstate 495 bridge over the Northwest Branch in Montgomery County — a large steel truss structure that was built in 1957 and that poses difficulties for human inspectors.

"We thought this would be a good bridge to test it," Robert said.

Kalantari said the early indications from that test are positive and that the sensors have been able to detect the fluctuations in the stresses on the bridge supports between peak and off-peak hours. "We have had a constant stream of reliable data," he said, adding that he expects to add more Maryland bridges to the test program.

If the technology passes muster with the state, Robert said, the company would have to conduct further tests to win approval from the Federal Highway Administration.

Spokeswoman Nancy Singer said the federal agency is interested — but with a caveat.

"Sensor technology is evolving and can be beneficial in monitoring bridge conditions. Such technology represents an additional tool available to bridge owners but does not replace or supersede the need for regular, comprehensive visual and physical bridge inspections," she said.

Kalantari said that once Resensys gets beyond the pilot stage — in about a year or two — he hopes to find investors and expand the company beyond its current staff of four. When the company is ready, Kalantari said, he hopes Dye will help him recruit a chief executive officer.

The Maryland incubator has graduated such successful companies as Columbia-based Martek Biosciences Corp., a Nasdaq-listed company with an estimated market capitalization of $670 million, and Digene, a molecular diagnostics company that was sold in 2007 for $1.6 billion.

Dye suspects that Resensys could have similar potential.

"The state of the infrastructure, bridge, roads, railroads in the United States has not been maintained properly," Dye said.

Kalantari takes it a step further.

"It's not U.S., it's global," he said.