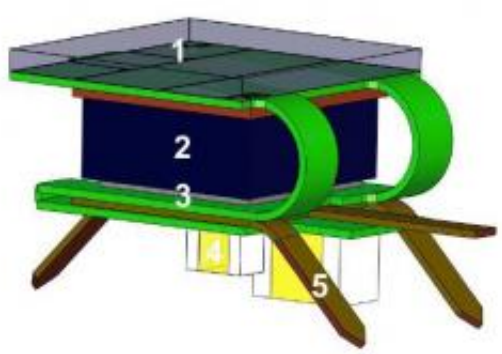
Researchers Hope to Mass-Produce Tiny Robots

August 28 2009, By Lisa Zyga



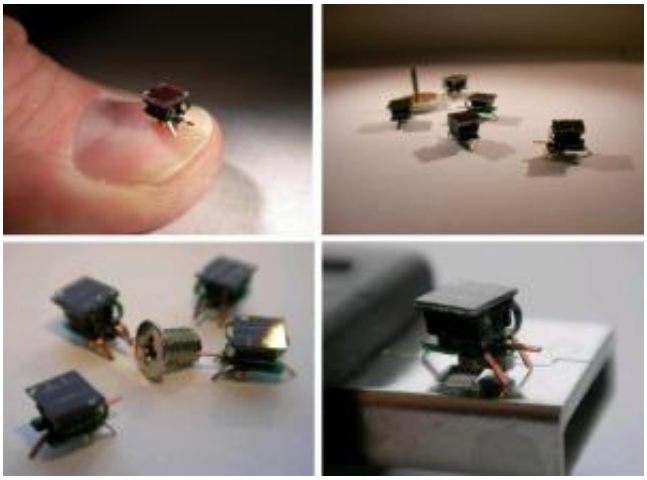
An illustration of the I-SWARM robot: (1) solar cell, (2) IR-communication module, (3) an ASIC, (4) capacitors, (5) locomotion module. Image credit: Edqvist, et al.

(PhysOrg.com) -- Tiny robots the size of a flea could one day be mass-produced, churned out in swarms and programmed for a variety of applications, such as surveillance, micromanufacturing, medicine, cleaning, and more. In an effort to reach this goal, a recent study has demonstrated the initial tests for fabricating microrobots on a large scale.

The researchers, from institutes in Sweden, Spain, Germany, Italy, and Switzerland, explain that their building approach marks a new paradigm of robot development in microrobotics. The technique involves

integrating an entire robot - with communication, locomotion, energy storage, and electronics - in different modules on a single circuit board. In the past, the single-chip robot concept has presented significant limitations in design and manufacturing. However, instead of using solder to mount electrical components on a printed circuit board as in the conventional method, the researchers use conductive adhesive to attach the components to a double-sided flexible printed circuit board using surface mount technology. The circuit board is then folded to create a three-dimensional robot.

The resulting robots are very small, with their length, width, and height each measuring less than 4 mm. The robots are powered by a solar cell on top, and move by three vibrating legs. A fourth vibrating leg is used as a touch sensor. As the researchers explain, a single microrobot by itself is a physically simple individual. But many robots communicating with each other using infrared sensors and interacting with their environment can form a group that is capable of establishing swarm intelligence to generate more complex behavior. The framework for this project, called I-SWARM (intelligent small-world autonomous robots for micro-manipulation) is inspired by the behavior of biological insects.



Images of the robots showing their size proportional to various objects. Image

credit: Edqvist, et al.

“I look upon them more like a manufacturing way for future robots,” Erik Edqvist of Uppsala University in Sweden told *PhysOrg.com*. “There are cool experiments going on with flying insects, swimming robots and so on. But it is time for the miniaturized robots to leave the research laboratories and find useful applications. That is where this work fits in. It is an attempt (with a somewhat small budget) to try to build robots in a mass-fabricated way.”

As this was the first test of this fabrication technique, the researchers noted that they encountered some fabrication problems. The single largest problem was to connect the naked integrated circuit to the flexible printed circuit board by the conductive adhesive. Also, some solar cells did not stick due to weak adhesion. At this stage in the production process, the robots were folded manually, but the researchers hope to design a tool to enable a faster and more accurate alignment when folding. Many of these complications could likely be corrected, with the important result being that the microrobots can be assembled using a surface mounting machine, whereas prior robots have usually been manually assembled with a soldering iron.

In the future, the researchers hope to move from building academic prototypes to manufacturing the robot on a commercial basis, which is necessary for overcoming some of the technical issues. By mass-producing swarms of robots, the loss of some robotic units will be negligible in terms of cost, functionality, and time, yet still achieve a high level of performance. Currently, the researchers hope to find funding to reach these goals.

“Right now the robots need a new ASIC [application-specific integrated

circuit] and some other redesigns to be able to work properly," Edqvist said.

More information: Erik Edqvist, et al. "Evaluation of building technology for mass producible millimeter-sized robots using flexible printed circuit boards." *J. Micromech. Microeng.* 19 (2009) 075011 (11pp).