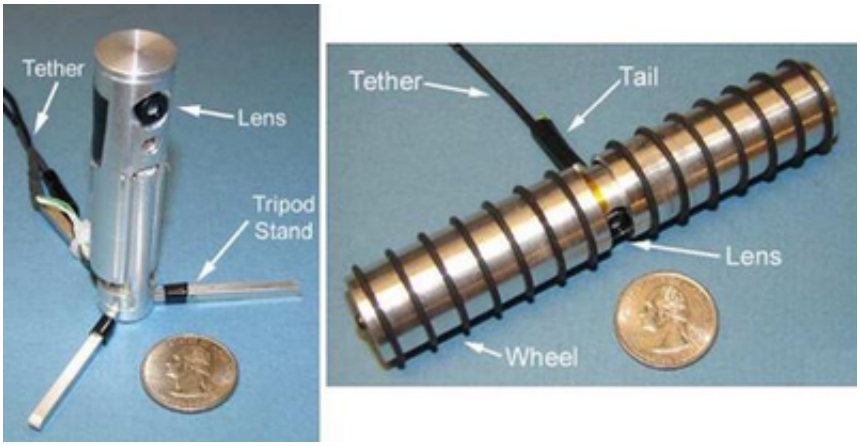
With Mini in vivo Robots, Anyone Can do Surgery

February 5 2008, By Lisa Zyga



Two in vivo camera robots used by the Aquanauts during the NEEMO mission. Image credit: Rentschler, et al. ©IEEE 2008.

By attaching a millimeter-sized camera robot to a tether, scientists have designed a way to allow individuals with non-medical backgrounds to perform minimally invasive surgery in almost any location. Unlike room-size and expensive surgical robots, mini *in vivo* robots are inexpensive and mobile enough to support emergency surgeries almost anywhere, from the battlefield to outer space.

The University of Nebraska researchers hope that the inexpensive version of the da Vinci surgical robot system will make the advantages of robotic-assisted surgery more widely available, and open the doors for telesurgeries that were previously impossible. In a recent study, the team

evaluated the ease of use and time required to perform simple abdominal surgeries with the in vivo camera robots. Their results are published in a recent issue of *IEEE Transactions on Information Technology in Biomedicine*.

“A new area of surgical robotics focuses on placing robots entirely inside the patient,” wrote Mark Rentschler et al. in their study. “*In vivo* robots are small, inexpensive, and easily transported, making it more likely that this technology can be more widely adopted. . . . The use of these robots can potentially reduce patient trauma in traditional medical centers, while the size of the robots makes them ideal for transportation to and use in remote or harsh environments.”

The researchers tested the mini robots on three NASA astronauts and one surgeon who were undergoing long-term training in an underwater habitat called the NASA Extreme Environment Mission Operations (NEEMO), located 20 meters underwater off the coast of Key Largo, Florida. The four “Aquanauts” received brief training on how to perform two surgeries – bowel inspection and stretch-and-dissect – and were also evaluated on how well they could perform another surgery – an appendectomy – for which they received no training.

In the test, the Aquanauts performed the surgeries on synthetic materials inside an abdominal cavity simulator, and were telementored via videoconferencing by the University of Nebraska team in Omaha. The crew used two robots: one was 20 mm in diameter and 110 mm in length, and the other was 15 mm in diameter and 60 mm in length. Both robots were equipped with a CMOS camera and inserted into the abdominal cavity (which measures 20 x 15 x 8 cm when artificially inflated) through a trocar port. Controlling the robots with either a joystick or a switch, the crew members could see various angles and adjust the focus of the images, receiving feedback at 30 frames per second.

The crew members also performed the same surgeries using a standard laparoscope – a tube that's inserted into the body in which a camera can be used. The results showed that the crew members achieved about equal levels of accuracy with both systems, but the camera robots enabled the crew members to work significantly faster at all three surgeries. Performing surgeries quicker could minimize patient trauma and the risk of infection.

Another notable result was that the crew members were able to successfully perform the appendectomy, even though they had not been trained on that procedure. This success demonstrates that telementoring can be used to enable individuals trained on basic skills to build upon their skills to complete more complex procedures.

"The telementoring results demonstrated that nonsurgeons having been trained with a specified skill set can be telementored to build on that skill set and perform a more complex laparoscopic procedure using in vivo robots," the researcher concluded. "The combined results of these tests suggest that the use of miniature surgical robots could be used in place of standard laparoscopic surgical equipment without loss of performance."

In the future, the team hopes to add further developments to the mini *in vivo* robot system, such as task assistance (where the robot can be used to manipulate tissue), telecontrol (where the robot is controlled remotely) and some autonomy (where the robot can make some decisions on its own). Thanks to these tiny robots, emergency surgery may one day be performed in extreme environments, and save lives where it would otherwise be impossible.

More information: Rentschler, Mark E., Platt, Stephen R., Berg, Kyle, Dumpert, Jason, Oleynikov, Dmitry, and Farritor, Shane M. "Miniature in vivo Robots for Remote and Harsh Environments." *IEEE Transactions*

on Information Technology in Biomedicine, Vol. 12, No. 1, January 2008.

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