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Researchers Develop Breast Biopsy Robot

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(PhysOrg.com) -- The results of proof-of-feasibility studies lead the researchers to believe that routine medical procedures such as breast biopsies will be performed in the future with minimal human guidance, and at greater convenience and less cost to patients.

The researchers envision a scenario in the near future where women can get an unassisted one-stop breast exam and biopsy, if needed. For example, a woman would get a mammogram and if anything suspicious is found, a robot could guide a needle to the spot and get a tissue sample.

For their experiments, the engineers started with a rudimentary tabletop robot whose “eyes” used a novel 3-D ultrasound technology developed at Duke. An artificial intelligence program served as the robot’s “brain” by taking the real-time 3-D information, processing it, and giving the robot specific commands to perform.

“After detecting the ‘lesion’ in a simulated breast, the robot was able to calculate its position and then guide a biopsy to its exact location,” said Ned Light, an engineer in the laboratory of Stephen Smith, director of the Duke University Ultrasound Transducer Group and senior member of the research team.

Light presented the results of the Duke experiments, which were carried out by Duke biomedical engineering student A.J. Rogers, at the Society of Photo-Optical Instrumentation Engineers’ annual Medical Imaging scientific sessions in Orlando, Fla.

Since the researchers achieved positive results using a rudimentary robot and a basic artificial intelligence program, they are encouraged that simple and reasonably safe procedures will become routine in the near future as robot and artificial intelligence technology improves.

“The technology behind robotic surgery has grown dramatically, as evidenced by the Da Vinci robot system, which is widely used in U.S. hospitals,” Smith said. “The same is true of artificial intelligence, which was unknown 20 years ago, and is now the standard in screening pathology samples.

“Based on the results we’ve seen in our laboratory, I am confident that within five to 10 years, robots will be performing routine breast biopsies,” Smith said.

Advances in ultrasound technology have made these latest experiments possible, the researchers said, by generating detailed, 3-D moving images in real-time. The Duke team has a long track record of modifying traditional 2-D ultrasound -- like that used to image babies in utero -- into the more advanced 3-D scans. After inventing the technique in 1991, the team also has shown its utility in developing specialized catheters and endoscopes for real-time imaging of blood vessels in the heart and brain.

In the latest experiments, the robot successfully performed its main task: directing a needle on the end of the robotic arm to touch a tiny piece of metal embedded inside simulated sponge breast, or phantom. The tiny pieces of metal were sized to represent microcalcifications, tiny deposits of calcium often found in the breast.

"Most of the time these deposits prove benign, but they can be a precursor to cancer,” Light said. “If the mammogram and follow-up ultrasound show that the microcalcifications are suspicious, a biopsy

may be in order."

The robot used the latest experiments is a tabletop version capable of moving in three axes. For the next series of tests, the Duke researchers plan to use a robotic arm with six-axis capability. The ability of the new robot to find and direct a needle to the appropriate site will next be tested in turkey breasts, which approximate the density of human breast tissue.

Provided by Duke University