New robot could help diagnose breast cancer early

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The device. Credit: George Jenkinson

A device has been created that could carry out clinical breast examinations (CBE).

The manipulator, designed by a team at the University of Bristol and based at the Bristol Robotics Laboratory, is able to apply very specific forces over a range similar to forces used by human examiners and can detect lumps using sensor technology at larger depths than before.

This could revolutionize how women monitor their breast health by giving them access to safe electronic CBEs, located in easily accessible places, such as pharmacies and health centers, which provide accurate results.

Precision, repeatability and accuracy are of paramount importance in these tactile medical examinations to ensure favorable patient outcomes. A range of automatic and semi-automatic devices have been proposed to aid with optimizing this task, particularly for difficult-to-detect and hard-to-reach situations such as during minimally invasive surgery.

The research team included a mix of postgraduate and undergraduate researchers, supervised by Dr. Antonia Tzemanaki from Bristol Robotics Laboratory. Lead author George Jenkinson explained, "There are conflicting ideas about how useful carrying out Clinical Breast Examinations (CBE) are for the health outcomes of the population. It's generally agreed upon that if it is well performed, then it can be a very useful and low risk diagnostic technique."

The team's paper, "A robotIc Radial palpatIon mechaniSm for breast examination (IRIS)," was presented at the RO-MAN conference.

"There have been a few attempts in the past to use technology to improve the standard to which health care professionals can perform a CBE by having a robot or electronic device physically palpate breast tissue. But the last decade or so of technological advances in manipulation and sensor technology mean that we are now in a better position to do this. The first question that we want to answer as part of this is whether a specialized manipulator can be demonstrated to have the dexterity necessary to palpate a realistic breast size and shape," Jenkinson added.

The team created their manipulator using 3D printing and other

computerized numerical control techniques and employed a combination of laboratory experiments and simulated experiments on a fake (silicone) breast and its digital twin, both modeled on a volunteer at the Simulation and Modelling in Medicine and Surgery research group at Imperial College London.

The simulations allowed the team to perform thousands of palpations and test lots of hypothetical scenarios such as calculating the difference in efficiency when using two, three, or four sensors at the same time. In the lab, they were able to carry out the experiments on the silicone breast to demonstrate the simulations were accurate and to experimentally discover the forces for the real equipment.

Jenkinson added, "We hope that the research can contribute to and complement the arsenal of techniques used to diagnose breast cancer, and to generate a large amount of data associated with it that may be useful in trying to identify large scale trends that could help diagnose breast cancer early.

"One advantage that some doctors have mentioned anecdotally is that this could provide a low-risk way to objectively record health data. This could be used, for example, to compare successive examinations more easily, or as part of the information packet sent to a specialist if a patient is referred for further examination."

Graphic of clinical breast examination by device. Credit: George Jenkinson

Device examining fake breast. Credit: George Jenkinson

As a next step, the team will combine CBE techniques learned from professionals with AI, and fully equip the manipulator with sensors to determine the effectiveness of the whole system at identifying potential cancer risks. The ultimate goal is that the device and sensors will have the capability to detect lumps more accurately and deeper than it is possible only from applying human touch. It could also be combined with other existing techniques, such as ultrasound examination.

"So far we have laid all of the groundwork," said Jenkinson. "We have shown that our robotic system has the dexterity necessary to carry out a clinical breast examination—we hope that in the future this could be a real help in diagnosing cancers early."

More information: George Jenkinson et al, A robotIc Radial palpatIon mechaniSm for breast examination (IRIS) (2023)

George P. Jenkinson et al, ESPRESS.0: Eustachian Tube-Inspired Tactile Sensor Exploiting Pneumatics for Range Extension and SenSitivity Tuning, *Sensors* (2023). DOI: 10.3390/s23020567

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