Medical Xpress

Surgery on beating heart thanks to robotic helping hand

December 11 2009

If you've been waiting for the day to arrive when computers actually start performing surgery, that moment might soon be upon us. A French team has developed a computerized 3D model that allows surgeons to use robotics to operate on a beating heart, according to a report in The *International Journal of Robotics Research*.

The robotic technology predicts the movement of the heart as it beats, enabling the surgical tools to move in concert with each beat. It means that the surgeon can perform a procedure as if the heart was stationary. This development could be very important for millions of patients who require less invasive surgical heart procedures, where stopping the heart from beating would cause unnecessary risk.

Rogério Richa, Philippe Poignet and Chao Liu from France's Montpellier Laboratory of Informatics, Robotics, and Microelectronics developed a three-dimensional computerized model that tracks the motion of the heart's surface as it beats. In addition to the heart, this model also accounts for the movement of a patient's chest wall during breathing. Known as the "thin-plate spline deformable model", this new computerized approach allows the robotic arm to continually adjust to heart and chest movements during surgery.

The new approach relies on a mathematical representation of the heart's surface as it moves in three dimensions during pumping. Researchers have made many attempts to use computer modelling to account for heart and breathing motion. However, previous efforts have relied on 2D

imaging combined with other steps, making them to slow to provide instantaneous feedback during an operation. This new 3D imaging predicts the heart movements in a single step, making it faster in real-life surgical environments.

Over the last 10 years, robotic arms have become essential in many kinds of surgical procedures, including microsurgery and operations that require extremely delicate movements. However, these machines also prevent the surgeons from using their sense of touch and coordination to adjust for rapidly changing environments. This new computer-generated model makes it possible for the surgeon to focus on suturing or cutting without having to adjust for the moving surface. Ultimately, this breakthrough will have many potential applications including heart surgery, coronary bypasses, and many kinds of brain surgery.

This is the first successful attempt to effectively isolate the physical movements of the heart and lungs during surgery. This has been particularly difficult given the heart's irregular shape, as well as its tendency to expand outward in all directions during beating. The heart's irregular surface also makes it more difficult to use visual tracking to accurately pinpoint movement.

This important development will allow surgeons to perform less invasive procedures that are not "life-or-death", but that do require a high level of precision and can have life-altering consequences for patients worldwide. To date, patients have gone without many of these procedures because the risk of complications during surgery outweighed the benefits.

More information: Three-dimensional Motion Tracking for Beating Heart Surgery Using a Thin-plate Spline Deformable Model by Rogério Richa, Philippe Poignet and Chao Liu is published today in the *International Journal of Robotics Research*, published by SAGE.

Medical Xpress

Source: SAGE Publications

Citation: Surgery on beating heart thanks to robotic helping hand (2009, December 11) retrieved 26 April 2024 from https://medicalxpress.com/news/2009-12-surgery-heart-robotic.html

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