Delft training system for keyhole surgery provides greater insight into forces

April 2 2014, by Ilona Van Den Brink

Keyhole surgery is particularly difficult, so good training for surgeons is essential. Tim Horeman has improved several aspects of this training. He has demonstrated that force and motion measurements give an objective assessment of a surgeon's skills, and that direct feedback on the force applied enhances the learning effect. On Tuesday 1 April, Horeman will be awarded his PhD at TU Delft for his work on the subject.

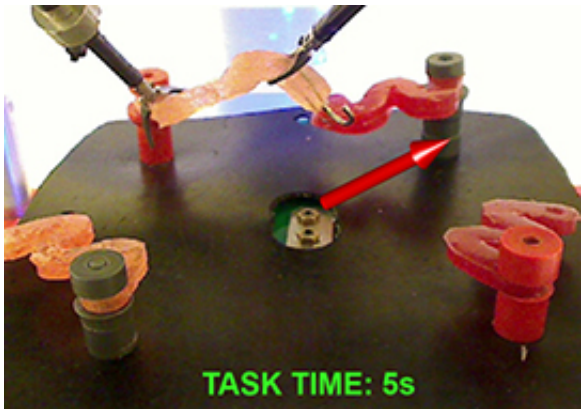
Laparoscopy

Keyhole surgery has a major advantage over 'normal' surgery, namely

that it is less invasive for the patient. However, the disadvantage is that this type of surgery is more difficult for the surgeon, and good training is therefore even more important. Tim Horeman's PhD research focused on improving training systems for exploratory surgery in the abdominal cavity (laparoscopy), and specifically using the 'box trainer'. This is a sort of box in which the surgeon can use instruments to practice a number of basic skills, such as grasping, moving and suturing tissue.

Difficult

'In laparoscopic surgery, special instruments with a long, slender shaft are inserted through small incisions in the abdominal wall. The long slender instruments combined with friction and the resistance of the abdominal wall make it difficult to assess the tissue manipulation force,' explains Horeman. 'The aim of my research was therefore to develop systems that measure the force applied during training, and to combine motion measurements and force measurements to provide an objective assessment of the trainee's basic skills. A further aim was to develop force feedback systems in order to improve force application during training.'



Visual feedback on the force applied helps students to improve their tissue-handling skills.

Sensor

'The first part of my research focuses on the force exerted by the instrument tips during surgical suture tasks. In many training programmes, the suture task is used to test the technical skills of the trainee. We were able to measure the force applied during suture procedures by placing a force sensor in the training box. We also showed that force data can be used to calculate performance parameters that accurately reflect the surgeon's skills. If only force data are used, it is possible to distinguish between surgeons and beginners with an accuracy of more than 80%.'

Force

In the second part of his dissertation, Horeman describes, among other things, a method for reducing the force applied to tissue. 'We generated a virtual arrow in the existing laparoscopy image to show the trainee surgeon the size and direction of the force exerted during suturing. It turned out that this can help the trainee minimise the force applied in the placing and knot-tying of sutures.'

ForMost

The final part of the research involved the development of ForMoST, a new box trainer that measures both tissue handling force and instrument motion. 'We developed two new bimanual tasks for the training box that are designed to train tissue manipulation skills. In a study involving beginners who were given virtual force feedback, the feedback was shown to reduce the force, with no negative effect on task time and

instrument motion. We also saw that training with real-time visual feedback shortens the task time and improves instrument motion but does not reduce the tissue-manipulation force.'

MediShield

Horeman conducted his research in close collaboration with medical specialists at Leiden University Medical Center (LUMC), University Medical Centre Rotterdam (Erasmus MC) and the Academic Medical Center (AMC in Amsterdam. Horeman also runs his own business. In 2009 he established MediShield, a company that develops instruments and sensors for medical use. At TU Delft, Tim now leads the Steerable Punch project, an international collaboration focusing on the development of a new steerable punch for arthroscopy (keyhole surgery in joints).

More information: View the dissertation "Force-Based Assessment of Tissue Handling Skills" here: repository.tudelft.nl/view/ir/uuid%3A0fdc13c0-af9a-4f67-96f5-28107bbec3c0/

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