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When Surgical Robotics Become Wearable

by Tina Tan

A 10-partner research project has won a €4m EU grant to develop a wearable surgical robotic system, the first of its kind. The leader of the project, Sanja Dogramadzi of the Bristol Robotics Laboratory, provided more details on how this new technology would improve on existing systems like Intuitive Surgical's leading *da Vinci*.

A pan-European team of researchers developing what they believe to be the first wearable robotic system for surgery has won a €4m grant from EU's Horizon 2020 research and innovation program. The technology, which includes an exoskeleton glove that surgeons wear to remotely operate surgical instruments inside the patient, is expected to overcome challenges of current generation surgical robotics, like Intuitive Surgical's market-leading *da Vinci* system, and offer far more flexibility so surgeons can perform more complex minimally invasive procedures faster and with more effective outcomes.

The €4m will be shared among the 10 partner organizations involved in the project and will take the technology through to *ex vivo* animal studies around three years from now, *Medtech Insight* has learned. Leading the project is Sanja Dogramadzi of the Bristol Robotics Laboratory (BRL), a collaboration between the University of the West of England and the University of Bristol, and the UK's largest robotics lab.

Dogramadzi explained to *Medtech Insight* that each of the 10 project partners are responsible for different aspects of the initiative: "Some partners are surgeons, the end-users of the technology, and they will provide us with user requirements. Some are commercial partners, who are interested in commercializing the technologies that emerge from this project." Then there are three academic partners, including BRL, that are responsible for different aspects of R&D. BRL will be in charge of designing the surgical instruments used on the patient and the sensing components of the technology, added Dogramadzi. "We also have a partner in Greece and in Milan, and they will be looking at vision and control, and the user interface between the surgeon and the robotics system."

There are three key components to the robotic surgical system. Firstly, there are the advanced surgical instruments that are used on the patient. These instruments, said Dogramadzi, would require "good articulation and good sensing of the environment." They would have haptic abilities that allow the surgeon to "feel" the tissue and organs inside the body, just like they would during conventional surgery.

Second, there is the exoskeleton, the "master" side of the system, that will fit over the surgeon's hands like gloves and will pick up data related to the positioning of the hands, enabling the surgeon to operate the surgical instruments remotely. The wearable exoskeleton will enable movement that is more intuitive, as well as give the surgeon the sense of touch; this would mean training surgeons on the use of the system would be easier, the researchers believe. Additionally, the sense of touch in this system will be dual: current research in haptic systems mainly focuses on the arm/forearm of the user, but the system developed in this project will focus on haptic feedback on the fingers of the surgeon as well, according to the BRL researchers.

The third component to this new robotic surgical system will be smart multifunctional glasses, worn by the surgeon, which will relay live images from inside the body, and provide a realistic view of what is taking place inside the body as the robotic tools are being used on the patient. By pairing the exoskeleton with the smart glasses, this gives surgeons the flexibility to position themselves anywhere in the operating theatre, Dogramadzi told *Medtech Insight*. "They can be closer to the patient; they can sit in another room. There are no limitations," she said. These advances offer an improvement over current systems like the da Vinci, which uses a large, installed master console with a flat TV screen for visuals. This console cannot be moved easily and the doctor is removed and detached from the patient.

Dogramadzi acknowledged that there will be technical challenges ahead, a significant one being to strike a balance between making the surgical instruments capable of performing complex procedures, while keeping them simple for the surgeons to operate. Another is ensuring that the haptic capabilities, which the wearable system are expected to offer, will indeed help the surgeon perform the procedure better and more safely. "We're hoping to develop the surgical instruments so they have sensing capabilities and the surgeon will have haptic feedback from the instruments inside the body. So, we're trying to define and analyze the surgical operation that they are doing, and where the safe and critical parts of the procedure are to see where the haptic feedback is needed. Rather than developing the haptics for two or three fingers, per se, we are developing the haptics to ensure surgeons can safely manipulate the instruments inside the body during the whole procedure, and that they don't make cuts or ruptures where they shouldn't."

Work on the project had already begun in January and the researchers are now at a stage where they are looking at the requirements for certain surgical procedures – procedures which the surgeon currently are not able to or have great difficulties performing accurately, safely and in a short period of time, Dogramadzi said.

"Currently, the da Vinci system is used quite a lot in urology. It is very good for prostate removal, for example. But if you want to do other procedures in that region of the body, da Vinci has its limitations, so we're talking to surgeons to understand what these limitations are and how to improve on the technology," she said. "da Vinci was actually developed from industrial robots, so [that platform technology] is a bit old school. The field of robotics has moved on so much since; we can achieve better control, we have better materials, we can design robots a lot smaller. So, we are trying to exploit these advancements so existing procedures can be improved and also open up new procedures for robotic surgery."

These new procedures would likely be in cardiovascular surgery, where the robots are still rarely used – if at all – and many heart and vascular surgical procedures are still invasive. Another area that the researchers are exploring is in arthroscopy, and using robotics to better restore soft tissue in knee joints, for example.

By developing the wearable surgical robotic system so that it addresses these surgeons' needs, Dogramadzi the technology can "benefit the patient, the surgeon and the health provider. If you can use this system to perform a surgical procedure that has 100% rate of success, patients recover faster, the surgeons can also perform it faster so more procedures can be performed per day, and there will be great improvement for all sides."

With the €4m Horizon 2020 funding taking the project to *ex vivo* animal studies – three years from now – Dogramadzi estimates that it would likely take yet another three years for the technology to be ready for clinical studies.

To find out more about other research conducted on cutting-edge surgical robotics, read Medtech Insight*'s market intelligence feature, "Ever Decreasing Dimensions, Snakes And Origami: The Next-Gen Surgical Robots."*