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Perceive 3D: Augmented Reality Software Kicks Off a New Phase in Knee Surgery and Rehabilitation

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This column will try to describe the characteristics of current cyberpsychology research in Europe. In particular, CyberEurope aims at describing the leading research groups and projects running on the other side of the Ocean.

Knees are a remarkable piece of evolutionary engineering, and can bend and extend as well as exhibit a degree of rotation even if they are very fragile. Every year, more than 700,000 anterior cruciate ligament (ACL) and 2.6 million total knee arthroplasty (TKA) surgeries are performed worldwide. An EU-funded project—Perceive 3D (www.perceive3d.com)—has developed revolutionary software to put just the right amount of movement back into injured knees. Providing motivation for the set-up of the project, there is an average dissatisfaction rate of more than 20–25%, of which 10–15% require revision surgery. ''For the first time, surgeons will use augmented reality [AR] as a support tool to execute complex surgical procedures. The project developed and validated two software applications in post-mortem subjects based on the in.nav technology for knee surgery,'' outlines Rui Melo, chief technical officer of Perceive3D, project coordinator of the Portugal-based company.

Alive and Kicking: The In.Nav Supported Knee Surgery

For ACL surgery using in.navACL, a new ligament graft is inserted into tunnels in the femur and tibia. An application processes the video from an arthroscopy tower, registers the bone surface with a preoperative computed tomography (CT) or magnetic resonance imaging (MRI) scan, and overlays the location of the femoral and tibial tunnels. It relies solely on the processing of the arthroscopic video and specialized tools with fiducial markers (a set of reference points) to track the anatomy and instruments. Kicking off with in.navTKA—for TKA surgery—an application runs on a handheld device, and uses its camera to navigate the surgeon through the multiple steps of image-free knee surgery for precise positioning of the implant. In this case, there is no preoperative CT or MRI scan, and the procedure relies on the processing of the video and small fiducial markers attached to the femur and tibia close to the incision.

Challenges for the Video System

''Having an AR navigation system during ACL surgery that solely relies on video is a perfect fit since surgeons already need to use a camera to visualise the interior of the joint,'' notes Melo. He continues: ''However, the restricted operation space and complexity of the instruments used posed challenges for in.navACL.'' For a system that relies on the actual image contents to present guidance information, inevitably, fluid, debris, lighting artifacts, and multiple instruments are simultaneously present in the vision field, posing a considerable challenge. ''Nevertheless, we were able to reach a point where the usability of the system could be assessed by surgeons in post-mortem experiments for obtaining clinical feedback,'' he explains.

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The Future for the Knees of Europe and the United States

''With the conclusion of this project we have largely de-risked the in.navACL software and progressed with further iterations of the surgical instruments,'' Melo emphasizes. This has placed the company in a position where it can now leverage its contact network for finding the right partner to incorporate the technology into the surgical tower and apply for a license. The company's next objective is to launch its own product for TKA next year in the EU and United States. Bringing the power of AR to knee surgery will solve problems of ergonomics and economics in the operating room, and pave the way for later integration with robotics systems. Up until now, research has mainly focused on improving its metal/plastic implants and instruments. Melo concludes: ''Enabling technologies like in.nav will democratise the use of navigation for all surgeons and healthcare facilities due to their lower upfront investment and improved ergonomics.''

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