Robot-assisted knee arthroscopy in ex-vivo tissue using real-time 3D reconstruction and autonomous tool tracking

The present research arises from the interaction of major, and sometimes considered dissimilar, scientific communities as depicted in figure 1.

Figure 1: The present PhD research lies within the scope of biological and engineering sciences.

The aging population phenomenon is foreseen to impose great social challenges especially in the availability of medical infrastructure and personnel [1, 2, 3]. By 2050, the population aged 60 years or older is expected to reach 2 billion people [4]. Injury is the fifth leading cause of death in elderly population and one of the most common cause for patient’s pain and discomfort [5, 6].

Knee joint injuries arise mainly from forceful twisting or hyper-flexing and are exacerbated by genetic conditions and age among others [7]. Knee arthroscopy is a widely spread minimally invasive orthopedics procedure [8] where a camera, i.e., arthroscope, and a surgical tool are introduced in the knee joint via small incisions as depicted in figure 2.
Doctors use the arthroscope to examine lesions without need of open surgery, but in turn they must rely on 2D imagery projected onto a monitor. Furthermore, doctors have to navigate, i.e., manipulate the arthroscope continuously to ensure that the tissue of interest and the surgical tool remain visible in the screens. This procedure is burdensome and even unintuitive for inexperienced surgeons [10]. Furthermore, the lack of dexterity could be causing unintentional injuries on patients that remain undocumented.

This research aims to facilitate the knee arthroscopy procedure by providing a real-time 3D reconstruction of the knee joint anatomy and an autonomous surgical tool tracking system.

Both these ideas can be achieved by removing the arthroscope from the doctor's hand and manipulating it with a robotic platform. The system will be mostly developed on synthetic knee models (phantoms), while cadavers (ex-vivo tissue) will be used for validation.

List of References


