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New Ultrasonic Technologies for Endoscopic Surgery

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Conventional clinical ultrasound scanners can achieve spatial resolution on the order of 0.3 mm over a penetration depth of up to 20 cm. High-frequency ultrasound, however, is a relatively new form of ultrasound imaging that provides an order of magnitude better resolution than these conventional systems at the expense of decreased penetration depth. The short penetration depth and high resolution make high-frequency ultrasound particularly suitable as an endoscopic visualization tool for minimally invasive key-hole surgeries. This form of surgery is rapidly becoming the standard of care for many surgical procedures including those of the brain, colon, pancreas, uterus, bowel, etc.. In these surgeries, a set of surgical instruments are inserted into a small incision site along with a set of imaging tools for guidance, typically endoscopic optical cameras and light sources. The entire surgical procedure is done solely under image guidance. A major limitation to optical image guidance is that image information is limited to the surface of the tissue impeding the surgical pathway.

Recently, our research team has developed a high-frequency forward-looking ultrasound imaging endoscope that is suitable for guiding endoscopic procedures. It provides high-resolution depth-resolved images in two or three dimensions. Using novel micro-fabrication processes for the transducer, we were able to miniaturize the packaged form factor down to just a few millimetres. In-vivo testing has been ongoing demonstrating its potential for replacing optical-only image guidance. The development and characterization of this imaging technology will be presented.

In addition, recent advancements that we have made in miniaturizing an ultrasonic tissue ablation transducer will be presented along with the steps that are being taken to integrate the miniature imaging transducer and miniature ultrasonic scalpel into the same endoscopic package. Such a device will provide precision tissue ablation with co-registered high-resolution imaging.