Medical Imaging Systems Using Bio-Inspired Fluidic Lenses

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Abstract: The following describes the design of an innovative surgical camera using fluidic lenses to create a variable zoom system and LED lighting for minimally invasive surgery.

Summary: Current methods for performing minimally invasive surgery (MIS) include making multiple incisions through the abdomen for entry of laparoscopic instruments (e.g. laparoscope, cauterizer, etc). In the field of MIS a new technique is being pioneered by UCSD School of Medicine which is called Natural Orifice Transendolumenal Endoscopic Surgery. This technique allows for surgeons to perform operations by going through an orifice and minimizing the amount of trauma in comparison to conventional laparoscopy, and reduces the risk of infection. Our group has designed a surgical camera intended for this very operation. By employing fluidic lenses into our optical assembly, we are able to create a variable zoom surgical camera system that can view the interior of the abdomen at a distance and obtain both a wide angle and microscopic view (5~6x zoom) without inhibiting the surgeon ability to continue operating. Our system includes an efficient LED illumination source that operates on less than 1 watt and replaces the 300 watt xenon light source that conventional laparoscopes employ. Below is an image taken of the stomach during a pig surgery using Surgicam that demonstrates Surgicam's imaging, lighting, and optical zoom capabilities (Figure 1). In addition, we have also been able to demonstrate that our system can also be used for detection of fluorescence tumor imaging in mice and have obtained results that are comparable to current bench top fluorescence imaging instruments (e.g. CRi Maestro).
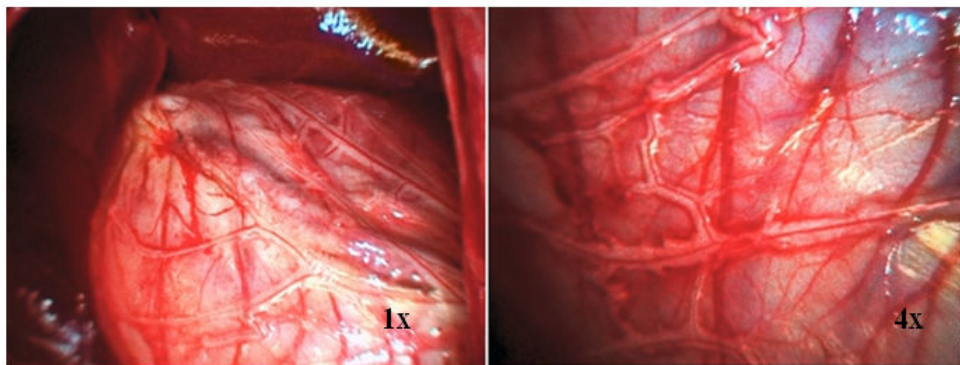

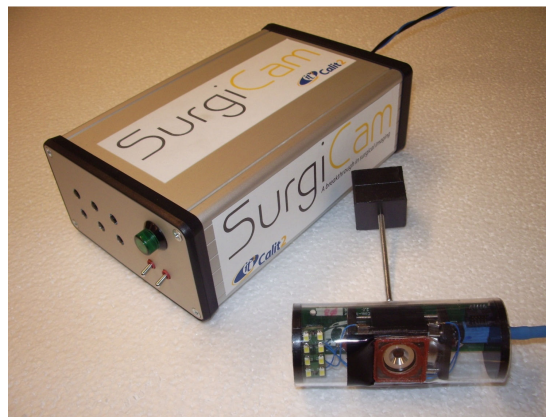Figure 1. (Left) Image taken of stomach from pig surgery using Surgicam, (Right) Zoomed in image of stomach from pig surgery using Surgicam

Figure 2. Surgicam with control box