Development of Tactile Sensor for Soft Tissue Stiffness Measurements in Medical Applications

Dr. Ahmed Mohamed Rashad Fath El-Bab
Faculty of Engineering, Assiut University
ahmed_rashad@yahoo.com

Today, much attention is paid to tactile sensing in medical applications such as minimally invasive surgery-MIS. In MIS the surgeon operates through small openings in the abdominal wall of the patient. In such surgery, it is of concern that much of the tactile information available in open surgery will be lost. Artificial tactile sensing can restore some of this lost tactile information. It is very useful for clinicians who depend on their sense of touch in many physical examinations. It can be used for the detection of cancerous lumps or for determining the healthiness of a tissue. Because cancerous lumps, in most of the cases, are harder than the normal tissue and the healthiness of a tissue may be decided according to its softness such as obstructive liver diseases, therefore, tissue stiffness measurement becomes essential.

Realizing a sensor for tissue compliance measurement in MIS is limited by some conditions. Firstly, the dimension of the surgical entry port, which size ranged between 3 to 12 mm. So, the sensor should be miniaturized. Here, the Micro Electro Mechanical System (MEMS) technology should be applied. Secondly, because the sensor may operate inside the abdominal wall of a body, the measuring process should not rely on external frame (reference coordinate). In other words the sensor reading should be independent of the applied distance or the inclination angle between the sensor and the measured tissue. Finally, the sensor material and packaging process should be biocompatible.

The objective of this project is to design, fabricate, and test a micro tactile sensor for tissue stiffness measurements in medical applications.

In order to detect soft tissue stiffness many sensors have been introduced. The previous trials suffer from one or more of the following; a) the sensor reading depends on the pushing distance/force between the sensor and the measured object, b) the sensor design process is carried out without taking into account the physical properties of the soft tissue elasticity. No record for the effect of the inclination angle between the sensor and the measured object.

In this project the development process of the sensor will be started by designing the sensor (selecting suitable material, shape, and dimensions), then simulating the sensor by finite element method for primarily examine the sensor performance. Based on the sensor material the fabrication and packaging processes will be chosen. Finally, the sensor performance will be evaluated.

For executing the sensor developing process the following tools are needed; a) finite element software for the designing stage, b) micro fabrication facility (photolithography, wet and dry etching, deposition, spin coating, furnaces, etc...), for the fabrication stage, c) x-y-z table (1μm resolution) with indentation tip capable of indent object with different inclination angles, for testing the sensor.

The expected outcome is to develop a micro-tactile sensor in the commercial level, capable of measuring the stiffness of soft tissues independent of the applied distance or the inclination angle between the sensor and the measured tissue.