Handheld Stiffness Measuring Device (HHSMD) for Tumor Detection

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Introduction

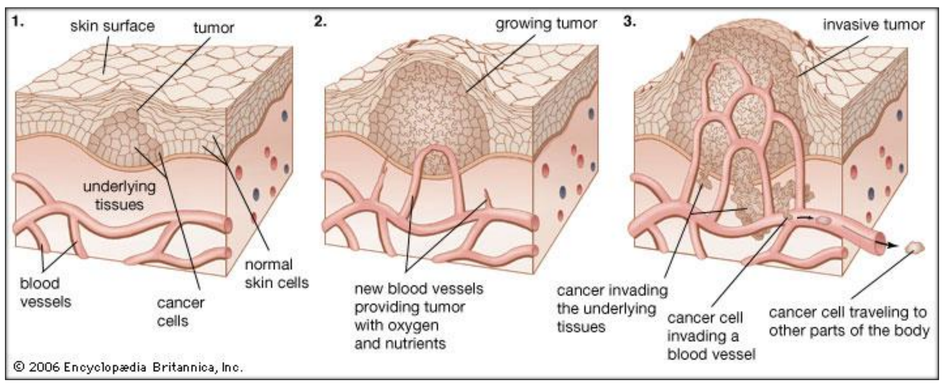

Figure 1. Malignant Tumor formation.

Tumor is an uncontrolled growth of cells forming a lump which is stiffness than the normal tissue. The tumor may press against vital organs or may turn into cancer. Early detection of tumors helps in decreasing the morbidity rate.

Figure 2. MRI scan of a patient

Existing methods like MRI, CT scan are time consuming, expensive and need expertise to handle the equipment. Hence for preliminary analysis of tumors, palpation techniques are used. These techniques are qualitative and may lead to ambiguity. To provide a qualitative measurement of stiffness of tissue, we have developed HHSMD.

Related Work

Jari P A Arokoski *et al.* [1] and Hakan Oflaf *et al.* [2] measure force for a constant deformation of the organ.

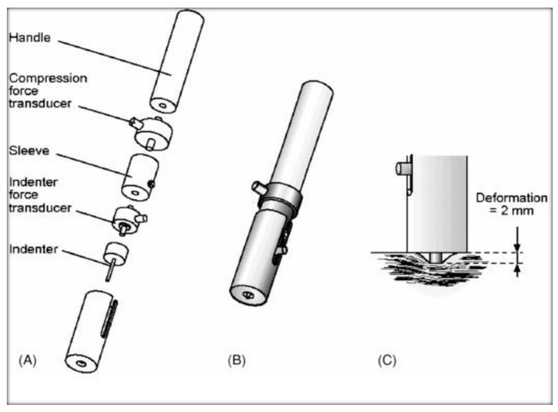

Figure 3. The Stiffness measuring device by Arokoski *et al.*

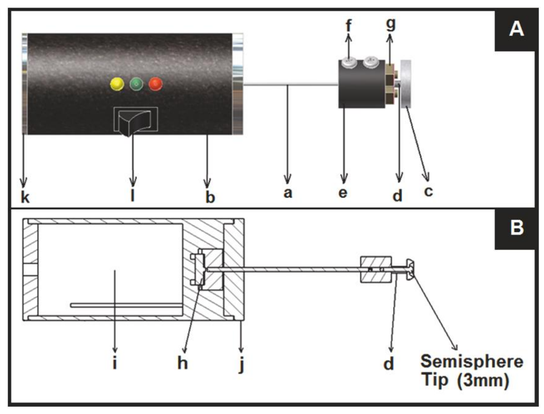

Figure 4. The Stiffness measuring device by Oflaf *et al.*

Our Approach

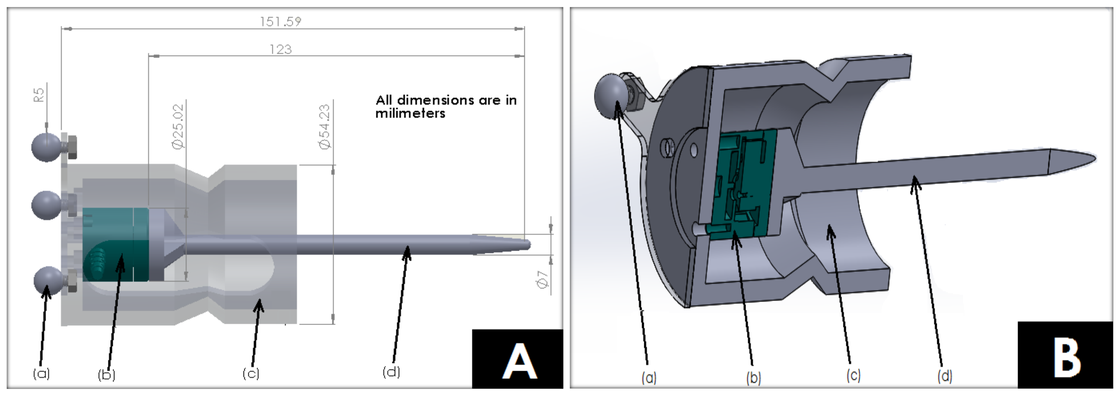

Figure 5: (A) CAD model of handheld stiffness measuring device. (B) Cross sectional view of the handheld stiffness measuring device. (a) IR reflector markers to detect position of the device. (b) Force-torque sensor. (c) 3D printed container. (d) 3D printed Indentation probe.

- Independent force and position measurement makes the device robust
- Force-Torque Sensor : ATI nano 25 E Transducer
- Position Sensor : Optitrack Flex 13 cameras

Experiments

Figure 5: HHSMD tested on the silicon tissue sample

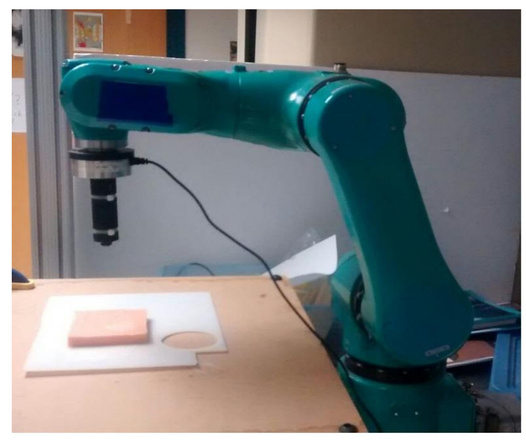

Figure 6: Using an industrial robot arm to find the ground truth stiffness map.

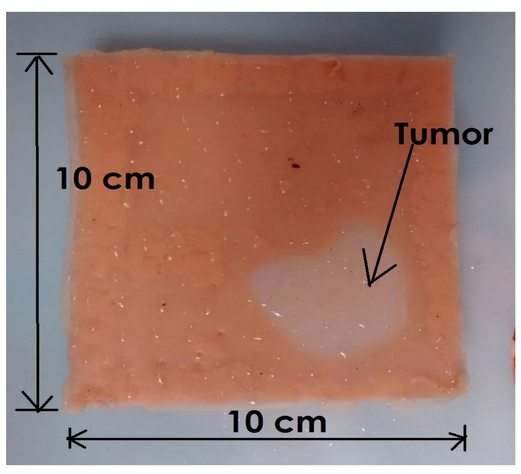

Figure 7: Specimen for experiment embedded with stiff inclusion

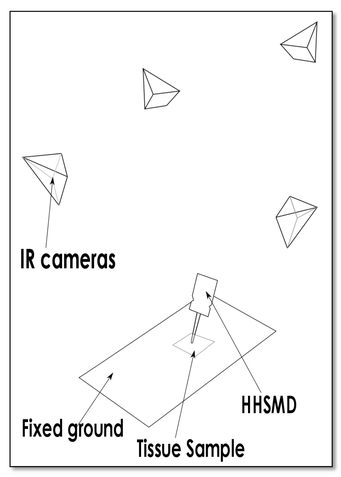

Figure 8: Camera positioning for experiments with our device

- Probed the silicon organ at 78 points with the HHSMD and at 100 points with the foxcon robot.

Results

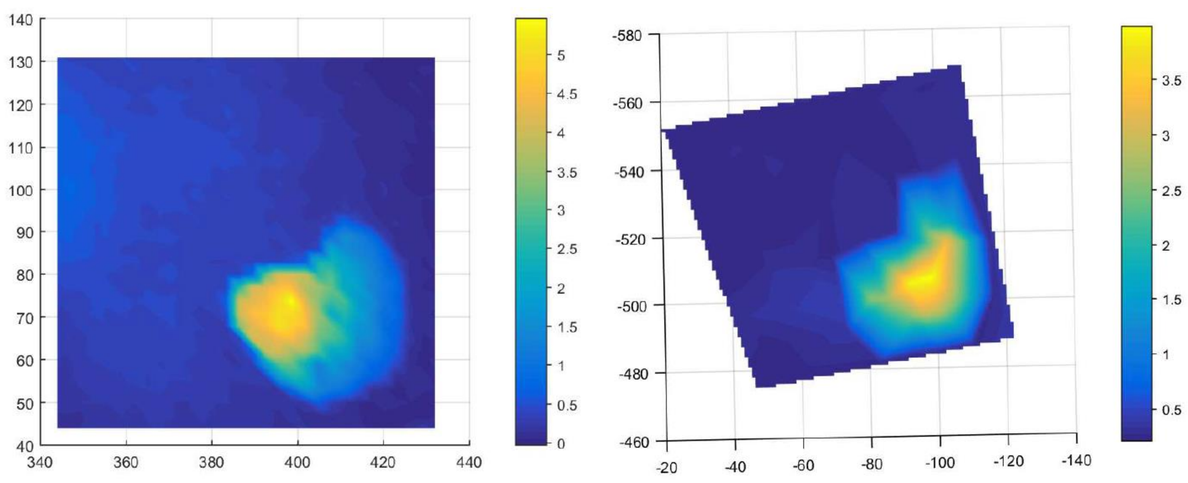

Fig 9: Ground truth stiffness map obtained by probing with industrial robot

Fig 11: Stiffness map obtained by our device.

Discussion

- Total time taken for the probing for HHSMD experiment was around 3 mins
- Our device can differentiate between regions with high and low stiffness
- Our device can reveal the shape and size of the tumor
- The time taken by our device to collect the data is much less than that of MRI (20-60min). Hence it is feasible to use this method for the preliminary analysis of tumor

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References

1. Jari P A Arokoski, Jarkko Surakka, Tuula Ojala, Pertti Kolari and Jukka S Jurvelin “Feasibility of the use of a novel soft tissue stiffness meter”, *2005 Physiol. Meas. 26 215*
2. Hakan Oflaz, “A new medical device to measure a stiffness of soft materials” Acta of bioengineering and biomechanics” *Wroclaw University of Technology 16(1):125-31 · April 2014*