Design And Development Of A Flexible Robotic Operative Microscope For Surgical Applications

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***Abstract*— The surgical flexible operative microscope is primarily designed with an aim to enhance the range of view for surgeons during surgical practices. The existing surgical tools do not allow an angular field of view, thereby limiting depth information, which is critical for neurosurgical analysis and any further surgical actions. The proposed neurosurgical setup offers 5 degrees of freedom (DOF) which allows the movement of the probe in three translational directions to reach a specific region of interest, and enables additional angular motion in *pitch* and *yaw* direction to view the depth information.**

SYSTEM DESIGN AND RESULTS

Surgical endoscopy probe have found prominence in urologic surgery, and recently in orthopedic surgery. Advances of robotic technology in neurosurgery is also explored recently [1]. The paper discusses the design of a surgical operating microscope, and experimental validation by employing the novel device as a microscope for a series of brain dissection experiments. In addition, retracing of the saved microscope orientation with acceptable angular errors are reported in this paper. The surgical microscopic probe was developed as a series of hollow entities, mounted on each other and held together tightly by a set of compact threads that forms the pulley systems as shown in the Figure 1.

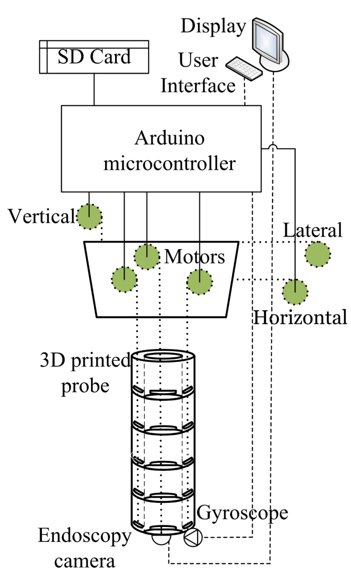

Fig. 1: Schematic of a novel robotic flexible microscope

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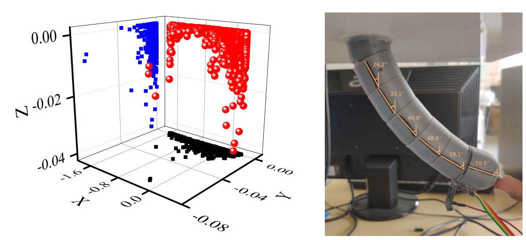
Each of these hollow entity is configured to have 3 slots to carry threads. The 3 pulley configurations provide 3 directional movements between a series of hollow structures. The dimension of the individual 3D printed part is 3.2 cm in length, 3 cm of outer diameter, 1.5 cm of inner diameter, with a slot arc length of 2.8 cm each, that are equally spaced at 0.34 cm.

For experimental validation, 15 brain dissections were performed on different brains provided by NIMHANS. During the brain dissection, a gyroscope sensor was placed at the tip of the probe and the dissection regions were captured by an endoscopy camera mounted as payload to the probe and interfaced with a display. The procured endoscopy camera had a resolution of 2M pixels, focal length of 8 cm, and view angle of 60 °. The path and trajectory of the probe's tip, while performing one such brain dissection, is shown in the Figure 2 (a). The flexible optical microscope formed by series of continuum probe is shown in the Figure 2 (b).



(a) (b)

Fig. 2: (a) Gyroscope plot showing path (b) Maximum angle made by flexible robotic microscope.

The re-positioning capability of the surgical probe was investigated and the sensor values were acquired to validate the same. The device successfully regained the orientation in all the saved positions with maximum orientation errors reported to be 0.464° 0.072° 1.32° with respect to X, Y, Z planes of the gyroscope axis.

CONCLUSIONS

The proposed design will help in providing competent field of view to surgeons to locate tumours or lesions deep inside the brain. The operating microscope will also aid in inserting tools through hollow space of the microscope body especially in lieu of small and tight surgical workspace.

REFERENCES

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