Design and Simulation of MEMS Based Gyroscope for Vestibular Prosthesis

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Introduction: The primary function of the vestibular system is to provide the brain with information about the body's motion and orientation. In this work we design a part of the vestibular prosthesis for body balance. In the prosthesis, the three semicircular canals are replaced by 3-axis MEMS gyroscopes. The microscopic gyroscope senses angular motion of the head and generates voltages proportional to the corresponding angular accelerations.

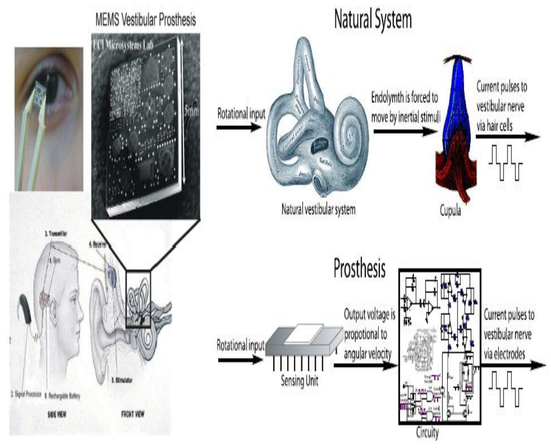

Figure 1: A conceptual model of a totally implantable vestibular prosthesis.

Computational Methods:

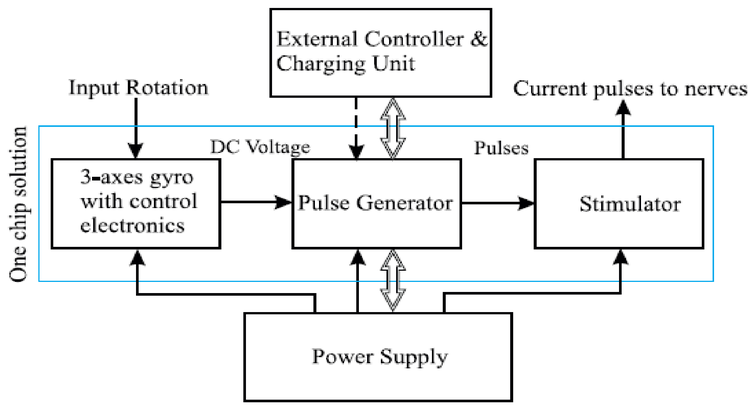

Figure 2:Functional diagram of the vestibular implant

The 3D geometry was designed using COMSOL Multiphysics 4.2a. Here, the piezoelectric material was used for the sensing the motion.

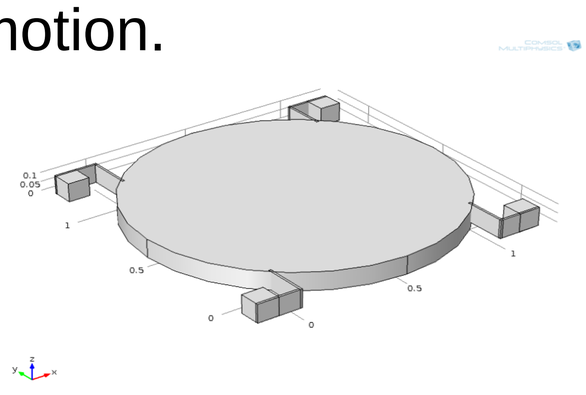

Figure 3. 3D Model of MEMS based Gyroscope

Results: The simulation result shows that when a force is applied an electric potential is produced due to displacement of sensing layer and that can be regained by applying the same electric potential to the opposite side of the sensing layer.

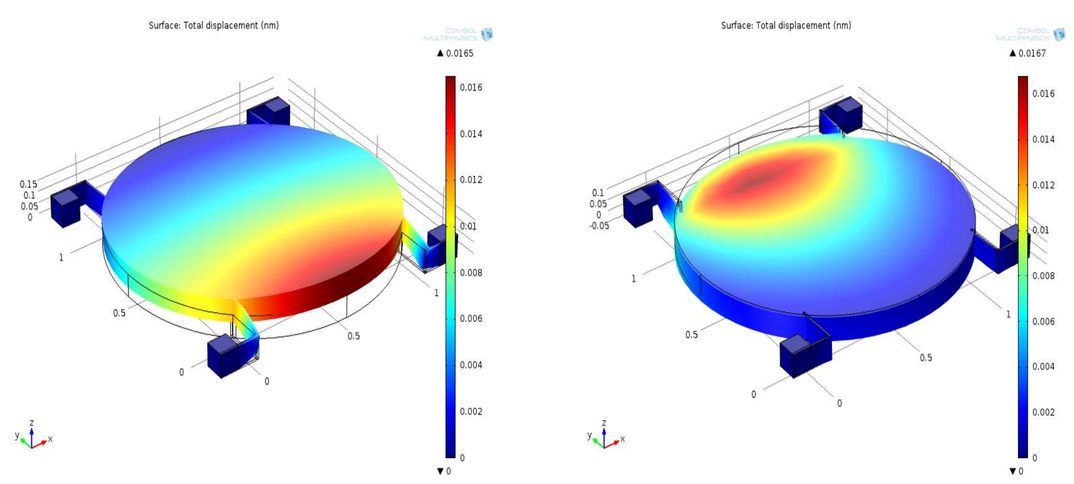

Figure 4. Displacement due to Coriolis Force in 3D model(left), Displacement due to Electric field in 3Dmodel (right)

S.No	Force (nN)	Total displacement (µm)	Electric potential (V)
1)	1	0.0165	0
2)	0	0.0165	0.45

Table 1: Simulation results

Conclusions:The purpose of the work was to develop an effective gyroscope for vestibular prosthesis. MEMS based Gyroscope using COMSOL provide design of bio-compatible package for the prosthesis, and interface of the prosthesis with neurons.

Reference:

1. Jiayin Liu et al , “System Design and Experimental Evaluation of a MEMS-based Semicircular Canal Prosthesis”, proceedings of the 1st International IEEE EMBS ,Conference on Neural Engineering ,20-22, 2003.