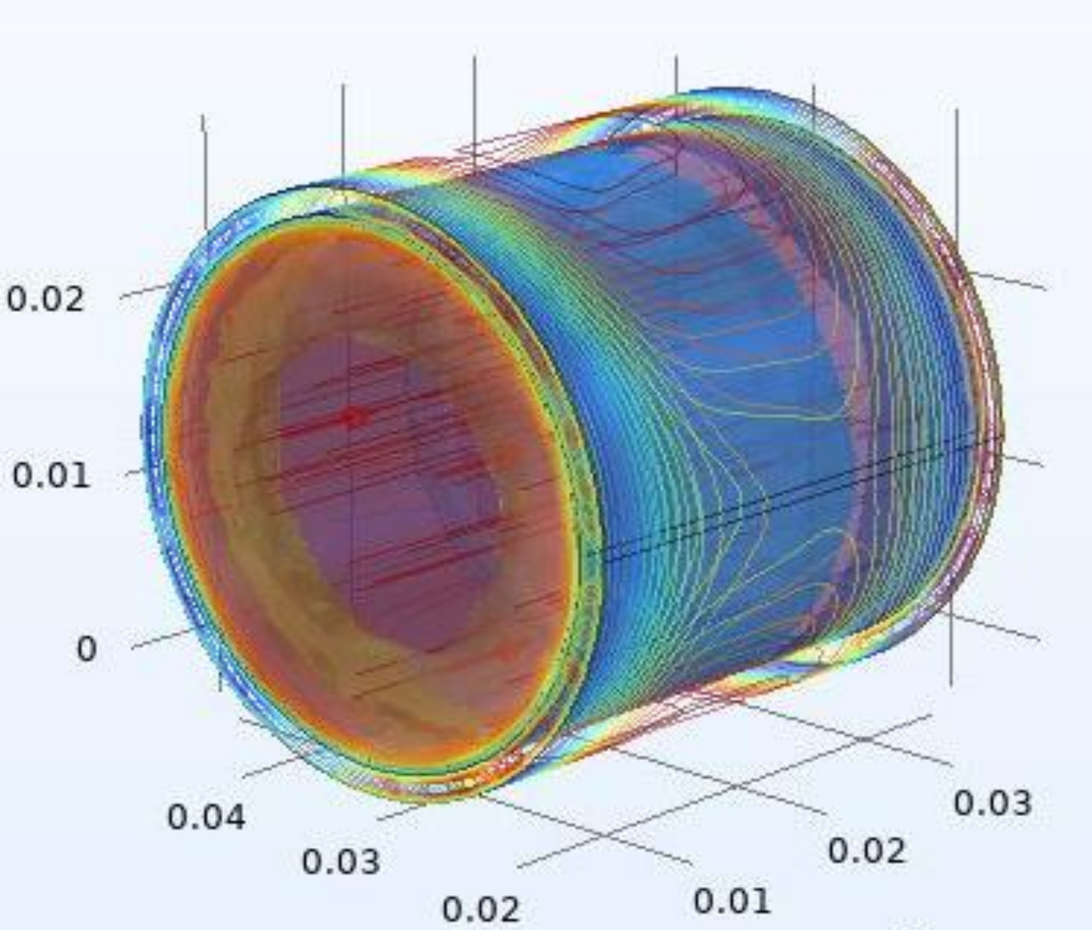

Hybrid Piezoelectric And Pyroelectric Energy Harvester/sensor For Medical Applications

A hybrid energy harvester is a device that can convert both mechanical and thermal energy of blood into electrical energy. The harvester is made from a material that exhibits both piezoelectric and pyroelectric behavior simulated using COMSOL Multiphysics.

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Abstract

Some piezoelectric materials can also exhibit pyroelectric behavior. This means they can generate an electric charge when they are deformed (piezoelectric effect) or when their temperature changes (pyroelectric effect). This hybrid behavior of piezoelectric materials is very interesting because it means that they can be used to harvest both mechanical and thermal energy. They can be used to generate electricity from vibrations/pressure, such as those caused by human body movements . They can also be used to generate electricity from heat, such as that generated by the human body.

In the present study, the hot blood dynamics are used for the multiple energy capturing source. The proposed hybrid harvester harvests the electrical energy from the blood dynamics (piezoelectric effect) and blood temperature (pyroelectric effect). This hybrid harvester system is used as a harvester and sensor in various medical applications. The development of hybrid energy harvesters is an active area of research. As the technology continues to improve, hybrid energy harvesters could become a valuable source of renewable energy. The simulation studies consist of time domain analysis of a hybrid energy harvester.

Methodology

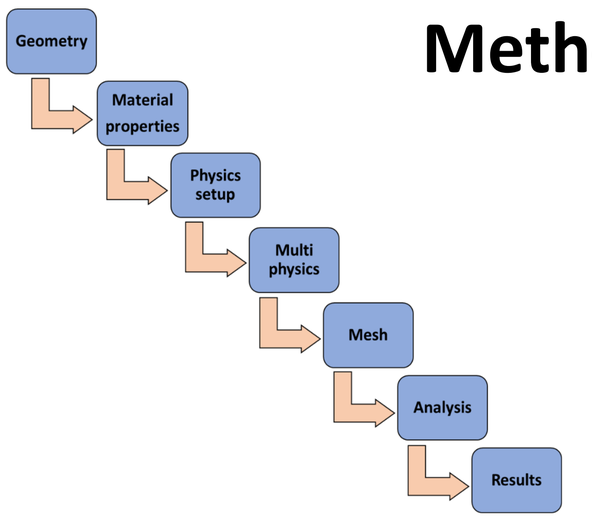

Figure 1. The flow chart of the step-by-step simulation procedure for COMSOL Multiphysics.

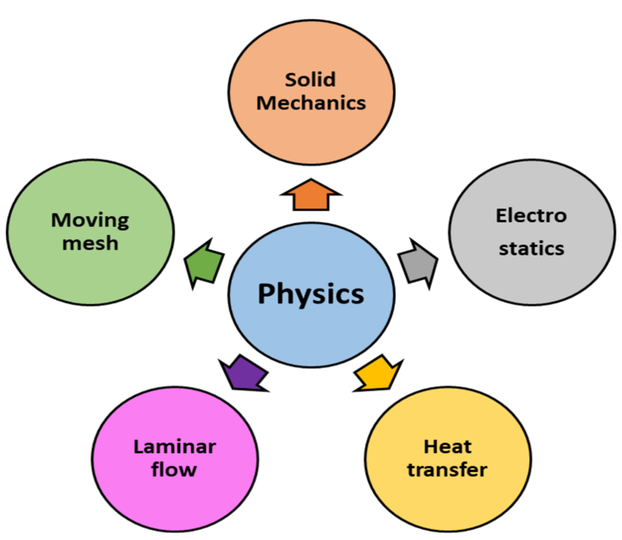

Figure 2. The physics involved in the current simulation model.

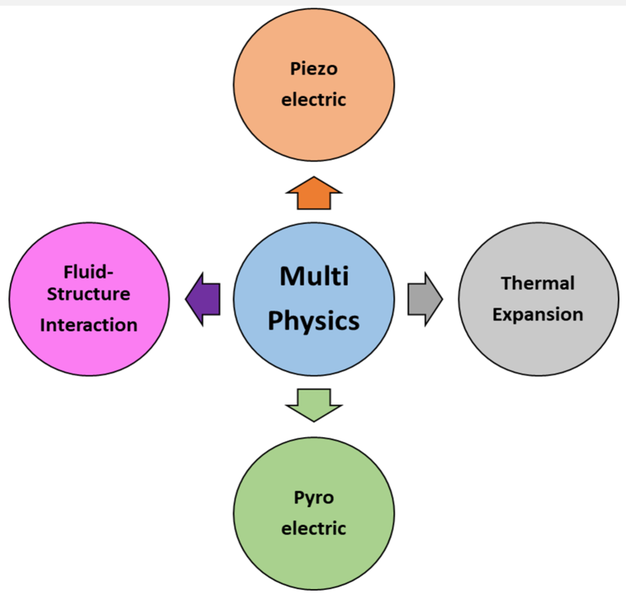

Figure 3. The Multiphysics involved in the present simulation model.

Results

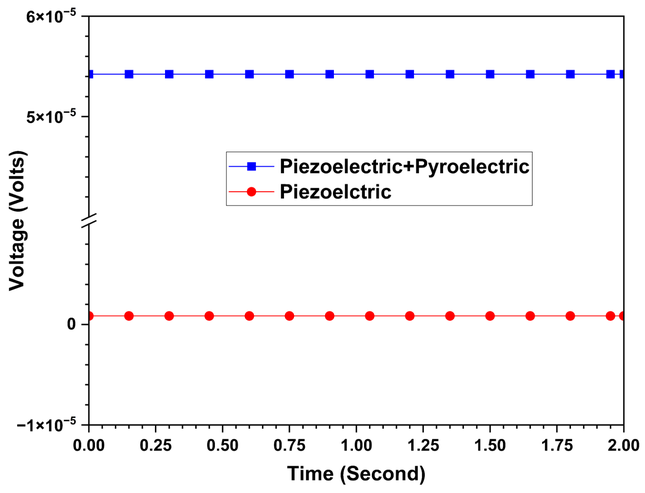

Figure 4. The voltage response of the harvesters considering piezoelectric and pyroelectric properties

Property	Values
Material	Lithium Niobate
Blood velocity	0.05 m/s
Blood temperature	310.15 K
Blood thermal conductivity	0.52 W/m.K
Blood vessel diameter & Length	30 mm & 30 mm
Lithium Niobate Thickness & length	1.5 mm & 30 mm

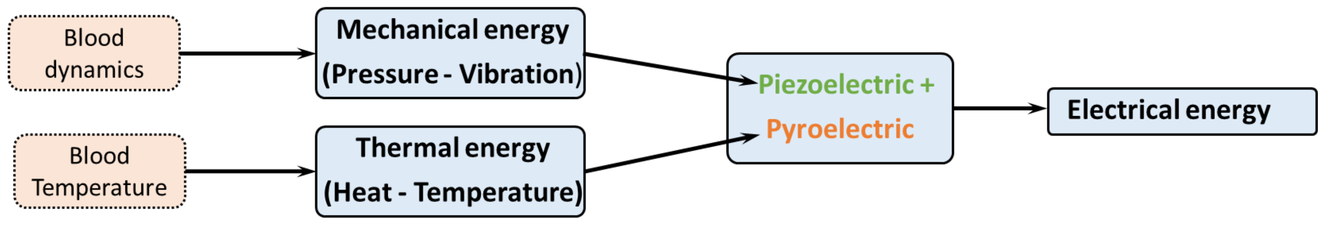

Figure 5. Energy conversion of the blood dynamics and temperature.

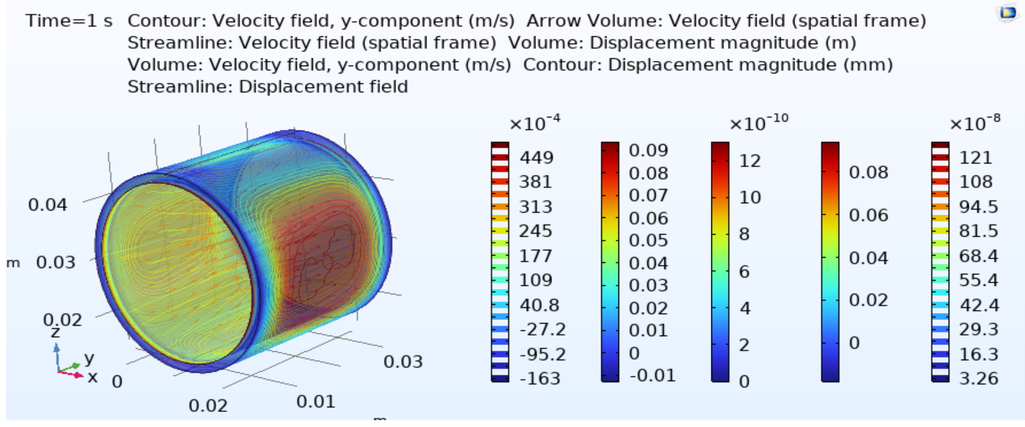

Figure 6. The hybrid harvester simulation plot at 1 second time step.

REFERENCES

[1] Upendra B, Panigrahi B, Sabareesh GR. Effect of geometric non-linearity and tip mass on the frequency bandwidth of a cantilever piezoelectric energy harvester under tip excitation. Physica Scripta. 2023 May 3;98(6):065203.
[2] Upendra, B., Panigrahi, B., Singh, K. and Sabareesh, G.R., 2023. Recent advancements in piezoelectric energy harvesting for implantable medical devices. Journal of Intelligent Material Systems and Structures, p.1045389X231200144.

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