Harvesting Human Body Energy for Bioelectronic Applications: A Focus on Piezoelectric Nanogenerators

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Abstract

This research explores the potential of harnessing and converting untapped energy from the human body into electricity to power bioelectronic devices. Focusing on piezoelectric nanogenerators (PENGs) and triboelectric nanogenerators (TENGs), the study discusses the various forms of energy flow within the body and the principles behind energy conversion. It addresses challenges such as sustainability, efficiency, safety, and ethical considerations. Despite technical and regulatory hurdles, ongoing research demonstrates the potential for integrating human body energy into real-life applications and advancing self-powered bioelectronic devices.

Introduction

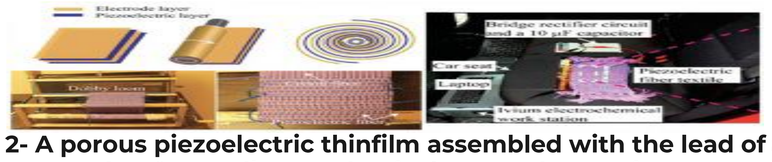
The human body converts natural energy through eating, walking, breathing, and emotions. It encompasses three energy forms: thermal, chemical, and mechanical. Thermal energy maintains body temperature, mostly released through heat exchange and sweating. Chemical energy comes from digestion, converting food into glucose for energy. Mechanical energy arises from movements, including limb actions, breathing, heartbeat, and muscle contractions. Researchers estimate energy strengths but caution that harvested energy must be less than consumed energy. Energy conversion methods include thermal and photovoltaic generators, biofuel cells, hydrovoltaic effect generators, and piezoelectric nanogenerators**. <u>This poster focuses on harvesting mechanical energy for bioelectronics</u>**.

Application of mechanical energy harvesting

Applications of PENG

1- Energy harvesting textiles based on flexible all-polymer piezoelectric fiber

flexible all-polymer piezoelectric fiber based on thermoplastic piezoelectric nanocomposites using thermal drawing technique which consists of alternating layers of piezoelectric nanocomposites When the fiber is stretched or bent, it can effectively generate piezoelectricity, with an output voltage of 6 V. The fibers can be woven into energy harvesting textiles to collect mechanical energy in daily life, such as wearable clothing or car seat cushions.



2- A porous piezoelectric thinfilm assembled with the lead of a pacemaker for cardiac mechanical energy harvesting.

cardiac mechanical energy harvesting strategy by integrating the energy harvesting device with the existing pacemaker lead The strategy is compatible with the pacemaker lead implantation surgery and does not contact the heart directly, so it will not affect cardiovascular function.

3- An ultrathin epidermal piezoelectric sensor for real-time pulse monitoring.

ultrathin epidermal piezoelectric sensor for real-time monitoring radial/carotid pulse signal the device can convert the tiny vibration of human pulse into electrical signal output. A real-time wirelessly pulse signal transmission system is also demonstrated by integrated with a Bluetooth transmitter and an MCU

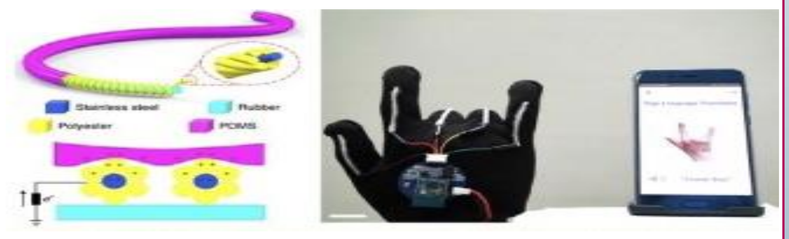
Applications of TENG

1- A fabric wearable TENG based on silver-coated textile

fabric wearable triboelectric nanogenerator . By collecting human mechanical energy, can drive commercial LEDs and LCD screen successfully.

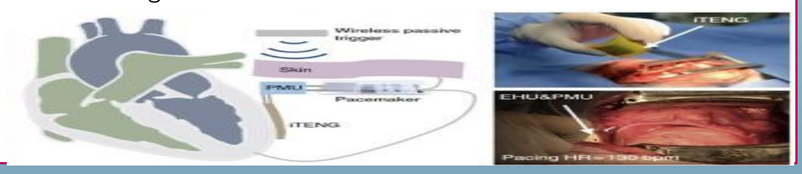
2- A symbiotic <u>cardiac pacemaker</u> integrated by an implantable TENG and a commercial pacemaker.

Symbiotic pacemaker. The energy collected from each heartbeat can be up to 0.495 microjoules, which is above the energy threshold required to regulate a heartbeat (0.377 microjoules for humans). This device is of great importance to extend the service life and even completely eliminate the battery limitations of commercial pacemakers.



3- A wearable sign-to-speech translation system based on stretchable sensor arrays and machine learning

wearable sign-to-speech translation system based on stretchable sensor arrays and assisted by machine learning, which can translate gestures into speech in real-time which can sense the movement of human fingers and convert it into electrical signal



Suggestions

After our study and knowledge of the great development in applications for harvesting the energy of the human body, we have realized that the energy produced from the human heart was also a great source of energy. This is why we propose creating a flashlight that operates with the heartbeat and any other factors inside the human body. Also, after we learned about the electrical conduction system of the heart, we discovered that there is electrical energy in the heart whose strength is greater than any energy outside, and we realized that we can use this energy to generate energy for our flashlight. Manual. This is done by using the techniques that we talked about previously and using them to make the lamp. The idea is that holding the lamp from the outside helps to sense the electricity present in the heart, and thus the energy resulting from sensing the heartbeat is sufficient to operate the LED lamp, and this process requires a high voltage to generate electrical energy. This proposal will be useful in that it is able to preserve light for more than several minutes, which makes it useful for some people, including 1- poor countries, specifically at times of weather problems, floods, or earthquakes 2- explorers of caves or mountains 3- also in emergency situations.

Conclusion

At the end, although the path to building a system A closed-loop bioelectronic or self-powered flashlight is full of challenges, but it is also accompanied by great opportunities. The future of SCBS is full of promise and has great prospects for applications. It is believed that through the joint efforts of researchers in various fields, SCBS will one day become a reality and change the current lifestyles of humans. Finally, in my opinion, it is good to learn about the greatness of God's creation and the strength of the human heart and to benefit from this small organ. Through this research, we discovered that the organs have vital and physical functions for the benefit of humanity.

References

Recent progress in human body energy harvesting for smart bioelectronic system

Powerful curved piezoelectric generator for wearable applications

15-year-old Canadian girl invents flashlight powered only by body heat and earns spot in Google Science Fair finals

Anatomy of the cardiac conduction system

Discuss pulse generator applications