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Wireless Sensing Using Biomechanical Energy for Food Storage

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Introduction

A promising sustainable energy source for self-powered wireless sensing that ensures the food's freshness and safety through door status monitoring is biomechanical energy in cold storage for food. This research suggests a wireless biomechanical energy-harvested sensing system for cold preservation of food. The biomechanical energy harvester (BEH), micro-supercapacitor, wireless transmitter, and wireless receiver are all components of the system. The BEH used an electromagnetic generator (EMG) as the electric generator, which was powered by a crank, to generate the biomechanical energy from the door opening and closing. A micro-supercapacitor was then used to store the produced electricity. In order to communicate door status sensor data to a wireless receiver using 433 MHz, the wireless transmitter was powered by a micro-supercapacitor. In addition to using Bluetooth to wirelessly broadcast to a smartphone, the wireless receiver might use light emitting diodes (LEDs) to display the state of the door. By capturing the biomechanical energy from door opening and closing, the system could monitor door status in real-time, increase the sustainability of the wireless sensing system, and ensure the quality and safety of the food stored in cold storage.

One of the most crucial ways to ensure the quality and safety of food is through cold storage. During the cold chain, food is kept at a continuous low temperature. To maintain a continuous low storage temperature, the door in cold storage should constantly be closed. However, because to the intricate cold chain system, the food would need to be routinely loaded and uploaded by opening and closing the door with biomechanical power from the staff. Once the door is always open, it greatly affects the food quality and safety in the cold storage. It is essential to keep track of the door's state in real time. Often used for door status monitoring are wireless sensors. They can all wirelessly keep an eye on whether the door is opening or closing in real time. Nevertheless, in order to operate the wireless sensing system, these wireless sensors require additional energy, such as city electricity or a battery. That is not a method that the wireless sensing system can use indefinitely. It requires intricate power wire installation by the city's electric company and frequent battery replacement if the battery's charge is depleted [1].

A promising sustainable energy source is the biomechanical energy generated by the workers in food cold storage. When food is frequently loaded and uploaded into cold storage by opening and closing the door, biomechanical energy is always present. By harvesting the biomechanical energy from the regularly occurring door opening and closing in food cold storage, it could offer an effective method for accomplishing the sustainable and self-powered wireless sensing for door status monitoring. Several techniques, like the electromagnetic generator (EMG) and triboelectric nanogenerator, could be used to extract the biomechanical energy (TENG). The TENG was capable of producing high voltage but not much current. The TENG's overall power output is proportional. The conventional generation for daily life is the EMG. In the majority of situations, the EMG's total generation power is more than the TENG's and it is also steadier. The low frequency biomechanical energy harvesting is more suited for the TENG [2].

Description

This research suggests a biomechanical energy collected wireless sensor system for cold storage of food, as was previously discussed. The biomechanical energy harvester (BEH), micro-supercapacitor, wireless transmitter, and wireless receiver are all components of the system. The BEH with four gear sets as the speed increaser and an EMG as the electric generator powered by a crank gathered the biomechanical energy from the door opening and closing. A micro-supercapacitor was then used to store the produced electricity. In order to communicate door status sensor data to a wireless receiver using a 433 MHz wireless radio frequency, the wireless transmitter was powered by a micro-supercapacitor (RF). In addition to using Bluetooth to wirelessly broadcast to a smartphone, the wireless receiver might use light emitting diodes (LEDs) to display the state of the door. By capturing the biomechanical energy from door opening and closing, the system could monitor door status in real-time, increase the sustainability of the wireless sensing system, and ensure the quality and safety of the food stored in cold storage [3].

An electrochemical workstation was used to measure the open circuit voltage, short circuit current, and micro-supercapacitor charging capability of the EMG (CHI 760E, CH21 Instruments Inc., USA). The open circuit voltage and micro-supercapacitor charging efficiency was measured using the open circuit potential time curve. The short circuit current characteristic was measured using the amperometric it curves. A stepper motor was used to measure the EMG's open circuit voltage and short circuit current at various pulse frequencies between 400 Hz and 4000 Hz (the motor's speed ranged from 1 r/s to 10 r/s). Commercial micro-supercapacitors with 100 F, 1000 F, 20 mF, and 220 mF were used to gauge how well they charged other micro-supercapacitors. The architecture of the BEH-based wireless sensing system is depicted. The BEH, a micro-supercapacitor, a wireless transmitter, and a wireless receiver are all components of the system. The EMG and gear system are both part of the BEH. The BEH captured the biomechanical energy from the door opening and closing. The door's crank was coupled to four gear sets with bearings, steel plates, and screws as a speed increaser. The first and second gear sets in the first-stage gear system had a transmission ratio of 70:17. The second and third gear sets, with a transmission ratio of 60:17, formed up the second-stage gear system. The third and fourth gear sets made up the third-stage gear system [4,5].

Conclusion

The three-stage gear system's final transmission ratio was around 42:1. With the first gear set being pushed by the crank from the biomechanical energy when the door was opened and closed, the three-stage gear system could accelerate by almost 42 times. The stators, rotors, magnets, Cu coils, joint and fixed shafts, bearings, and screws make composed the EMG. 16 magnets were adhered to the rotors on either side of the stator, which held the

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8 Cu coils in place. Screw bolts and an acrylic plate substrate were used to integrate the gear system and EMG. Using switch sensors, encoders, and 433 MHz RF, a wireless transmitter with food cold storage door status monitoring was used.

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