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Bluetooth sneaker with Arduino embedded in it based on lattice structure

Yan Shi[1], Xinxin Wang[2], Xiaofeng Chen[3], Yujian Tang[4], Jinyuan Jia[5]

[1]Lanzhou University of Technology School of Science, Lanzhou, Gansu, 730050, China
[2]Lanzhou University of technology school of civil engineering, Lanzhou, Gansu, 730050, China
[3]Lanzhou University of Technology School of Economics and Management, Lanzhou, Gansu, 730050, China
[4]Lanzhou University of Technology School of Computer and Communication, Lanzhou, Gansu, 730050, China
[5]Lanzhou University of Technology School of Electrical engineering and Information Engineering, Lanzhou, Gansu, 730050, China

Abstract: *Energy crisis has become a worldwide problem, and clean energy, new energy and renewable energy are the focus of attention today. With the continuous improvement of people's living standards, more and more people participate in fitness. At this time, the stampede pressure generated by human walking will be a form of energy dissipation. Secondly, people's pursuit of quality of life is also increasing day by day, in the process of daily walking shoes are expected to have massage, temperature regulation and other multi-functional characteristics. According to the existing survey, this kind of shoes with multi-function is more attractive in the market, and it is easier to get the unanimous praise of consumers. This kind of multifunctional sports shoes takes into account the various possibilities of people when they are exercising. Under the basic conditions of ensuring safety, they pay more attention to comfort and save energy, giving full play to the maximum function of sports shoes. However, the current research and development of multi-functional sports shoes need to use the battery for power supply, the function is not perfect, large quality, low efficiency of electromechanical conversion and independent load and power generation function, so there is an urgent need for a high-efficiency intelligent sports shoes to meet the needs of the market. People in the process of walking, the foot will have corresponding pressure on the soles, namely the vibration source produces vibration, and multi-functional sports shoes mainly through the matrix collection equipment energy collection, when the lattice structure, piezoelectric material deformation and generate electric field, on the surface of piezoelectric materials under vibration force can reduce charge spacing, polarization is reduced, at this point, electric current can be generated by connecting wires, thus realizing the conversion of mechanical energy into electrical energy, which can power the graphene heating plate.*

Keywords: *Piezoelectric intelligent material, lattice structure*

1. Introduction

1.1 Lattice structure

Lattice material is a new type of lightweight functional structural material proposed in the early 21st century. It can be used to design materials with different functions and mechanical properties by adjusting the number and connection mode of rods as well as the arrangement rule in space. Since this concept was proposed, people have carried out the design, preparation, mechanical properties characterization and application of different topological lattice materials, from Eg-truss and octahedral lattice to tetrahedron, pyramid, Kagome, prism and diamond lattice structures. Lattice material not only has excellent mechanical properties, but also its internal open and through space is easy to realize the integration of load bearing and thermal control, stealth, energy absorption, actuation, energy storage and damping, which has a huge application potential in energy absorption, energy storage and aerospace fields.

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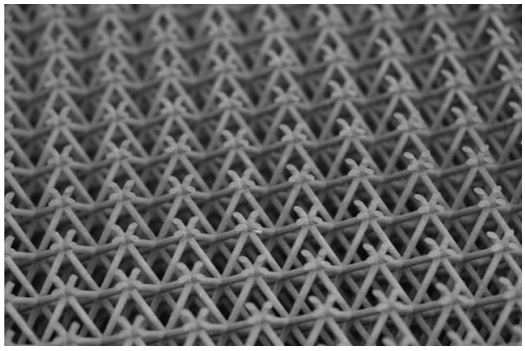

Figure 1 Lattice material has excellent mechanical properties

1.2 Piezoelectric intelligent materials

Piezoelectric smart material is a kind of material with piezoelectric effect, which can quickly convert pressure, vibration and so on into electrical signals, or the electrical signals into vibration signals, that is to say, the piezoelectric element can be used as both a sensor and a driver, to achieve the unity of sensing elements and action elements. Therefore, it can be easily used in intelligent materials and structures, especially in material damage self-diagnosis, self-adaptation, vibration reduction and noise control. When the piezoelectric material is stressed, the piezoelectric material will deform and generate an electric field in its interior, and the piezoelectric plate will undergo polarization effect. At this time, the surface of the piezoelectric plate will form a charge of opposite polarity. When the vibration force of the vibration source disappears, the piezoelectric plate returns to the original state of no charge. Under the vibration force, the distance between the charges attached to the surface of the piezoelectric material decreases and the polarization intensity decreases. At this time, if there is a wire connection, the charge will move along the wire in a directional way.In this process, piezoelectric material is used to convert vibration energy into electrical energy. Among them, polymer piezoelectric materials with its light weight, soft, high specific strength, wear resistance, corrosion resistance and other characteristics, has been widely concerned. The main commonly used polyvinylidene fluoride, vinylidene fluoride one trifluoroethylene copolymer, nylon 1L.Alternate copolymer of ethylene dicyanoethylene acetate, etc.

Figure 2: Piezoelectric quartz crystal material

Figure 3: Inorganic piezoelectric materials

1.3 Existing technology and design

Publicly in the existing technology to convert mechanical energy into electricity multifunctional power shoes, including the overall frame structure, and installation within the overall framework of piezoelectric power generation device, electromagnetic induction generators, solar power generation device, rectifier voltage regulator, super capacitor circuit, heating device, pedometer device, automatic lacing device, battery display device, photographic lighting device, The components work together to collect and convert the body's dissipated mechanical energy into electrical energy.Insufficiency of raised structure in massage device.In view of the above actual situation, the invention comprehensively uses the functional characteristics of lattice material and piezoelectric material, converts the mechanical energy generated by human walking into the electric energy required by the multi-functional shoes, and proposes a lightweight multi-functional shoes with the function of self-electricity without additional power supply and battery.The multifunctional sports shoes designed have the functions of regulating temperature, massaging the sole of the foot, communication, anti-pressure and high energy efficiency, which will have great development potential and application value in improving energy utilization and

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promoting sports economy.

2. Our Product

2.1 Product introduction

This project intends to use 3D printing piezoelectric polymer preparation into the lattice structure, and embedding the structure movement in the sole, the comprehensive use of dot matrix material and the functional characteristics of piezoelectric materials, walking to the human body to produce the electricity required to mechanical energy is converted into a multi-functional shoes, produce a kind of spontaneous electric function, no additional power supply and battery light multifunctional shoes.

Figure 4: 3D modeling diagram

2.2 Key technology introduction

In the process of walking, the feet will produce the corresponding pressure on the sole, that is, the vibration source generates the vibration force, and the multi-functional sports shoes mainly through the dot matrix collection device for energy collection. When using piezoelectric polymer preparation into the lattice structure deformation occurs, the piezoelectric material and produce electric field, on the surface of piezoelectric materials under vibration force can reduce charge spacing, polarization is reduced, wires can be used as an electrical current, so as to realize the mechanical energy into electrical energy, achieve the function of multifunctional shoes spontaneous electric. After the power management module to generate the power supply is sorted out, can be used for electric massage structure (massage column, 4 biaxial motor, CAM, transmission rod) energy, through the sole massage, can promote human blood circulation and metabolism.

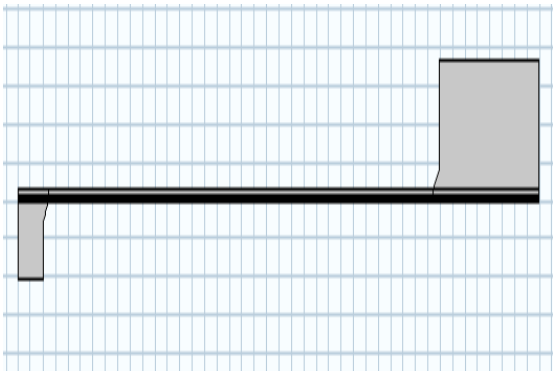

Figure 5: The established geometric model of piezoelectric energy harvesting device with cantilever beam structure

At the same time, two modes of automatic temperature regulation and manual temperature regulation are realized by sensors in the sole to give people the best wearing experience. By embedding the communication module, the movement data and health data of the human body can be interacted with the mobile phone to realize the communication function. Combining the advantages of piezoelectric polymer and lattice structure, this project puts forward a new type of lightweight multi-functional shoes with self-electricity ability. The lattice structure prepared by piezoelectric polymer material is innovatively embedded into the sole to realize the integration of load bearing and self-electricity function.

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On the basis of this, the paper puts forward the shoes with the functions of regulating temperature, massaging the sole of the foot, communication and so on, and gets a kind of lightweight multi-functional sports shoes. The piezoelectric energy harvesting device, the core structure of the multifunctional shoe, is designed and analyzed by finite element method. Geometric model and finite element model are established based on COMSOL multi-physical field finite element analysis software, as shown in Fig. 5.Fig. 6 shows the stress distribution of the piezoelectric energy harvesting device with cantilever beam structure. Figure 7 shows the printing model of a 3D printer.

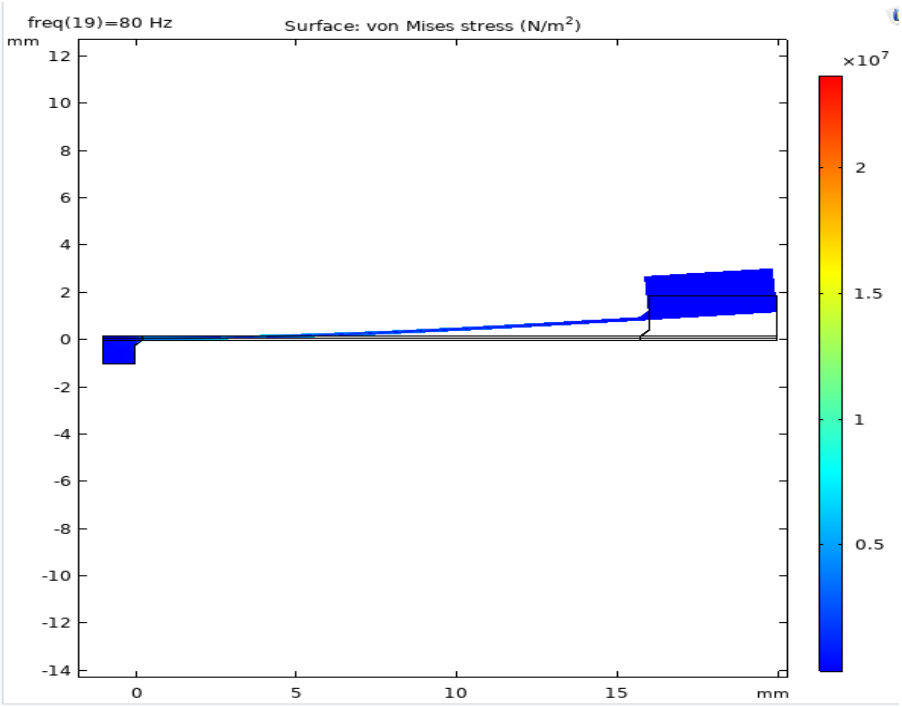

Figure 6: Stress distribution of piezoelectric energy harvesting device with cantilever beam structure

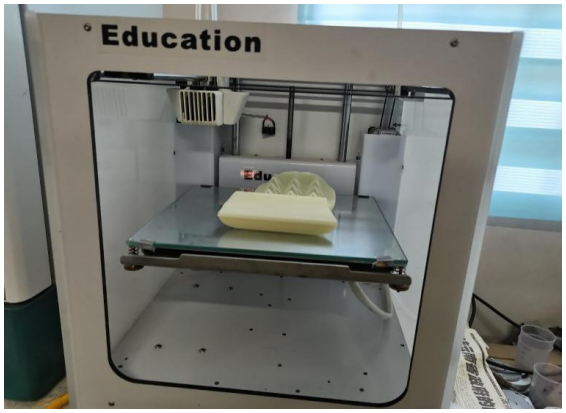

Figure 7: Print the physical drawing

2.3 Advantage analysis

The multifunctional sports shoes have a special device compared to other smart sports shoes do not have the function.

(1) Self-generating function: the piezoelectric polymer is used to prepare a lattice structure, which is embedded in a specific part of the sole to convert the mechanical energy stepped on by the human body every time it walks into electrical energy. In order to maximize the utilization of energy, different lattice materials with different structures are set according to the different forces on different parts of the sole. The generated energy is stored in the power management module to ensure the endurance energy of other function modules. Lattice structures include tetrahedron, octahedron, pyramid, Kagome, prism and diamond, etc.

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(2) Massage function: paste micro-electric massage paste on the center of the foot to realize micro-electric stimulation on the sole of multi-functional sports shoes, which can play the role of lowering blood pressure and relieving fatigue foot therapy.

(3) Heating function: in winter, the heat preservation effect of ordinary shoes is far from enough, and multi-functional running shoes can ensure the temperature inside the shoes is stable, so that people feel comfortable and can promote blood circulation; Using a graphene heater as a sole layer, the entire shoe is heated.

(4) Positioning function: timely grasp the children's trends, to a certain extent, can reduce the psychological pressure of parents, but also to reduce the number of missing children in China every year has a significant effect.

(5) Communication function: Bluetooth module is installed to communicate with other smart devices (smart phones, etc.).Multi-functional sports shoes set their own power generation, massage function, automatic insulation and other excellent performance in one, in the movement at the same time to achieve health care, can continue to encourage people to walk instead of the car, to a certain extent to reduce the air pollution of automobile exhaust; The use of piezoelectric materials for energy collection is no pollution, no emissions, the product is very good to achieve the effect of energy saving and emission reduction, contribution to the sustainable development of society and the environment.

3. Conclusion

This project through carefully designed the structure of the sole and the configuration of piezoelectric smart materials, the comprehensive use of dot matrix material and the functional characteristics of piezoelectric materials, walking to the human body to produce the electricity required to mechanical energy is converted into a multi-functional shoes, put forward a kind of spontaneous electric function, no additional power supply and battery light multifunctional shoes. The designed multifunctional shoes have the functions of regulating temperature, massaging the sole of the foot, communication, anti-pressure and high energy efficiency, which will have great development potential and application value in improving energy utilization and promoting sports economy. Energy crisis has become a worldwide problem, clean energy, new energy and renewable energy are the focus of attention today. With the continuous improvement of people's living standards, more and more people participate in fitness. At this time, the stampede pressure generated by human walking will be a form of energy dissipation. Secondly, people's pursuit of quality of life is also increasing day by day, in the process of daily walking shoes are expected to have massage, temperature regulation and other multi-functional characteristics. According to the existing survey, this kind of shoes with multi-function is more attractive in the market, and it is easier to get the unanimous praise of consumers. This kind of multifunctional sports shoes takes into account the various possibilities of people when they are exercising. Under the basic conditions of ensuring safety, they pay more attention to comfort and save energy, giving full play to the maximum function of sports shoes.

Massage through the sole can promote the blood circulation and metabolism of human body. At the same time, two modes of automatic temperature regulation and manual temperature regulation are realized by sensors in the sole to give people the best wearing experience. This project through carefully designed the structure of the sole and the configuration of piezoelectric smart materials, the comprehensive use of dot matrix material and the functional characteristics of piezoelectric materials, walking to the human body to produce the electricity required to mechanical energy is converted into a multi-functional shoe, put forward a kind of spontaneous electric function, no additional power supply and battery light multifunctional shoes. The designed multifunctional shoes have the functions of regulating temperature, massaging the sole of the foot, communication, anti-pressure and high energy efficiency, which will have great development potential and application value in improving energy utilization and promoting sports economy. Energy crisis has become a worldwide problem, clean energy, new energy and renewable energy are the focus of attention today. With the continuous improvement of people's living standards, more and more people participate in fitness. At this time, the stampede pressure generated by human walking will be a form of energy dissipation. Secondly, people's pursuit of quality of life is also increasing day by day, in the process of daily walking shoes are expected to have massage, temperature regulation and other multi-functional characteristics. According to the existing survey, this kind of shoes with multi-function is more attractive in the market, and it is easier to get the unanimous praise of consumers. This kind of multifunctional sports shoes takes into account the various possibilities of people when they are exercising. Under the basic conditions of ensuring safety, they pay more attention

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to comfort and save energy, giving full play to the maximum function of sports shoes.

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