A New Type of Self Driven Door Handle

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ABSTRACT

In this article, authors report on a smart door handle that can efficiently collect and utilize ambient energy to power itself. A Triboelectric Nanogenerator which presents characteristics including easy fabrication, small size and light weight is embedded in the door. When begin to turn the handle, the TENG can convert the mechanical energy into the electrical energy, and the power can up to 0.023W. At the same time, the internal circuit will send a single to identify the action of opening the door, and then the wireless receiver will make appropriate responses after receiving the signal. In this article, the authors designed a wireless transmission circuit to ensure that the transmitter and receiver can communicate in real time. Due to the TENG’s output is AC signal which can’t power the device directly, so the power management circuit was designed to process the signal. To analyze and compare the output signal, the authors designed two power management circuits. Both the circuits can convert the AC signal into the DC signal, the voltage can up to 5V and the current can up to 3mA.

KEYWORDS

Intelligent Control, Internet of Things, Self-Powered System, Smart Home, Tribonanogenerator (TENG)

1. INTRODUCTION

With the development of science and technology, Intelligent products are becoming more and more favored by people, and most of them rely on wireless communication technology for data transmission. However, the application and development of Intelligent products are limited by the available power sources, traditional power supplies need to be wired around the appliance, it is not only affect the appearance but also increase the workload and cost. If the battery is used, it is necessary to replace the battery irregularly, this also brings inconvenience to the user. The vast majority of these intelligent electronic devices are limited by the available power sources, such as batteries, which cannot be easily reduced in size and weight. If there is no continuous power supply to the equipment for some unknown reasons, the equipment will not be able to work properly, or even will bring us some serious unpredictable consequences, which poses a new challenge to the endurance of electronic products.

DOI: 10.4018/IJSSCI.2017100105

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In this work, we report an intelligent door handle which combined with Triboelectric nanotechnology (TENG) (Wang, 2012) and RF radio frequency technology. This door handle can convert human biomechanical energy into electricity and when someone opens the door by this handle, the lights or other appliances in the house will be automatically awakened, which brings great convenience to the owner of the house. It is undoubtedly this device with the simple structure and superior performance will bring more convenience for people’s life. The intelligent door handle is driven by a rotary triboelectric nanogenerator that harvests energy from mechanical movement. This kind of mechanical movement can be seen everywhere in life, such as the people’s walking or running. Due to the TENG’s high voltage and low current, two power management modules are designed to manage power from the TENG. Wireless transmitting module is triggered by the movement of the hand. As someone turns the door handle, an 433MHZ electromagnetic wave wireless signal will be emitted to trigger the wireless receiver module. Therefore, the door handle not only plays the role of power but also as a switch trigger signal (Zhu, 2013). In order to test the stability and reliability of the door handle, we did the relevant experiments and collected experimental data to verify the excellent performance of the door handle. The technology can be used in smart homes, environment monitoring and security surveillance. In this work, a light bulb was used to be the operation object, the detailed experiment data and output performance were observed which proves the door handle’s high efficiency and feasibility.

2. THE MECHANISM OF FRICTION POWER GENERATION

Actually, the phenomenon of friction power generation has always been in our side, the friction effect is one of the most common phenomena in nature when two different materials are rubbed against each other and contacted with the surface. According to the previous experimental basis, it can be found that the performance of friction mainly depends on the material and structure. The perfect combination of structural precision design and special materials will play a role in generating electricity. First, their surface will produce positive and negative electrostatic charge due to the triboelectrification and electrostatic induction when two different materials contacts each other, as shown in Figure 1. When the two materials separated due to external mechanical force, the positive and negative charges generated by the contact effect are separated, which will result in an induced electromotive force on the upper and lower electrodes of the material. If the load is connected between the two electrodes or in a short circuit, this potential difference will drive the electrons between the two electrodes flowing through the external circuit. In this mechanism, the electrical energy can be used on the RF signal trigger processing circuit. This process is shown in Figure 1.

The structure mentioned in this paper is a face-to-face stack of dielectric films of two different materials, with their respective back surfaces plated with metal electrodes. The two dielectric films are in contact with each other and form opposite surface charges on both contact surfaces. When the two dielectric films are in contact, under the action of external force, there will be a relative slip between the two materials in a horizontal direction parallel to the surface, so the triboelectric charge can be generated on both surfaces. In this way, polarization is formed in the horizontal direction, and electrons can be driven to flow between the upper and lower electrodes to balance the electrostatic field generated by the triboelectric charge. An alternating current output can be generated by periodic sliding separation and closure, and it can be converted to the direct current so that meet the different needs. Such slippage may take place in a variety of forms, including planar sliding, cylindrical sliding and disc sliding. Considering the internal structure of the door handle, the disk sliding structure is used in the device. In this article, we use this grid-like wheel structure, and this structure is embedded in the door frame. When opening the door, the door handle under the action of the force to drive the structure to rotate.
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