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Development of Biomechanical Energy Harvesting Device using Heel strike

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Abstract

Harvesting energy from biomechanical motion of a human poses a promising replacement for batteries in a modern day where portable devices ran out of batteries much faster than before. We developed an energy harvesting device that is focused on heel strike of a gait cycle. The device works by converting the vertical motion of a heel strike to a rotational motion that would generate power from an AC motor. AC motor was used instead of DC because of its capability to generate power in two directions. To further increase the power generation, spur gears were attached to the device as to amplify the rotational motion with a ratio of 27.5:1. The device managed to generate a power of 1.1W throughout a gait cycle. Biomechanical energy harvesting proved to be capable of storing powers in exchange of putting an extra effort and discomfort to the user while wearing it. Nevertheless, future versions of energy harvester should pose no problems and is a promising source of energy to power up portable modern gadgets such as cell phones and mp3 players.

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*Keywords:*Bio mechanical ;Harvester ;Motor ;gait cycle

1. Introduction

Even in this modern society where technology advances exponentially, the gadgets which people always brought with them everywhere seems to lack the ability preserve its energy. The power consumption of those features they provide were still too big compared to the power provided by the batteries they had. It could be seen from modern teenager and even young adults with at least a Smartphone with them were having trouble when their

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gadgets suddenly ran out of power, to counter this problem, a portable charger was brought in place. The problem with this portable charger is, portable charger is apparently just a chunk of bigger batteries that outputs current to other batteries. In other words, it was still a battery that will run out of energy sooner or later. Even though they managed to build a higher capacity e.g. 20000mAh, the time that it took to charge the portable batteries are just too long. While some people are busy finding out new source of energy, people sometimes forget that an unlimited source of energy lies in human body itself. A normal human with average size could have energy equal to 1000 kg of batteries stores in their fat[1]. The calories stored in human are easily dissipated into heat energy which could waste around 5 W/sec[2]. Some researches about converting these energies exerted from human to electrical energy had been done numerously in recent years, either using body heat or human mechanical motion. Among these, walking had been viewed as the most convenient and flexible way of energy harvesting due to a lot of energies could be converted during the motion[3].While some had proposed using a backpack type[4, 6], there are also some ideas about using piezoelectric on the shoes[3].According to U.S. Energy Information Administration (EIA), the total of renewable energy consumption as per 2011 as per Fig.1 is about 9%, in which the biomechanical motion did not even contribute 1% to it.The reason behind this could be seen from the researches done previously. Even though human motion has a potential to be the most reliable source of renewable energy, human has yet to achieve the maximum potential of it. This particular research will be focusing towards finding the more efficient way to harvest energy from human motion. The proposed method was to develop a device that focuses on the heel strikes.

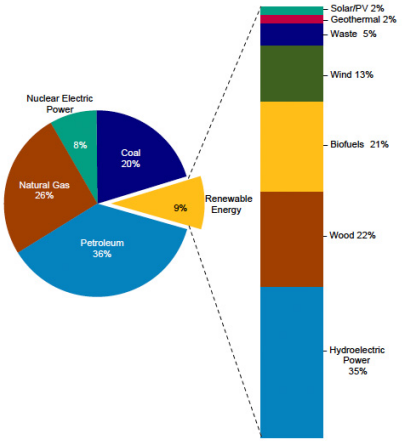

Fig. 1 Total energy consumption 2011

2. Methods

2.1 Power generation

There have been a lot of researches on harvesting energy using human energy, particularly in using human biomechanical motion such as arm motion, centre of mass, knee motion and heel strike[8]. There were also researches on using human perspiration system by using epidermal bio fuel cells based on temporary transfer tattoos, as demonstrated by Wenzhao Jia and colleagues[9].

Using the centre of mass had proven to generate the most power out of all the design, by using suspended-loaded backpack as proposed by L. Rome et al.[8], they have managed to generate power as much as 7.4 W during fast walking using a 38-kg load on the backpack. The idea of the design was to make the load to move freely up and down during walking motion, and that load helps to generate electricity by attaching a toothed rack to the load plate. By attaching a geared dc motor to the backpack frame and connect it to the toothed rack on the load plate, the system acts as a generator. Another similar approach had been done by Granstrom et al., they managed to generate an extra 50 mW by attaching a piezoelectric material on the shoulder strap of a 44-kg backpack[5]. The downside of