SELF-POWERED PORTABLE ELECTRONIC DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of application Ser. No. 60/797,962, filed May 5, 2006, the entirety of which is incorporated herein by reference.

TECHNOLOGY FIELD

[0002] The subject matter described herein relates generally to self-powered devices and systems, and in particular to devices and systems having piezoelectric materials for the harvesting of mechanical energy and conversion of the mechanical energy into usable electrical energy for powering a portable electronic device.

BACKGROUND

[0003] One of the biggest problems in designing and operating electronic devices is power. One manner in which to power an electronic device is for the device to be connected to an external source of electric power, such as, for example, a power cord connected to the device that can be plugged into a wall receptacle. A problem with electronic devices that must be physically connected to an external and fixed power source is that these electronic devices are tethered to the power source and hence are not portable.

[0004] For portable electronic devices the power problem is even more pronounced. The most common power source for portable electronic devices is batteries. Typically, the batteries may be replaceable or rechargeable. With replaceable batteries, the batteries contained in the electronic devices are depleted or exhausted as the device operates and consumes power. As a result, the batteries need to be continuously monitored and replaced periodically. Monitoring batteries is inconvenient and replacing batteries can be expensive.

[0005] Similar to replaceable batteries, rechargeable batteries contained in electronic devices are also depleted or exhausted as the device operates and consumes power. As a result, the device must be connected to an external power source so that the batteries may be recharged periodically. While the batteries are being recharged, the electronic device is no longer portable. Recharging batteries is also inconvenient.

[0006] If the user forgets to replace and/or recharge low batteries, then the electronic device may not work properly, and in the case of depleted batteries the device may not work at all. This can be burdensome and inconvenient for the user of the portable wireless device if the batteries drain at unexpected and/or inappropriate times.

[0007] Another disadvantage of batteries for powering an electronic device is that batteries typically take up a significant amount of space and add unwanted weight to the portable electronic device. This results in the wireless device being larger and heavier than similar devices not having batteries. In addition, batteries are expensive and can add significantly to the cost of purchasing and operating a portable electronic device.

[0008] Energy harvesting systems for self-powering devices are known. For example, harvesting kinetic energy from vibrations in the environment using electromechanical system consisting of an arrangement of magnets on a vibrating beam is known. As the device vibrates, the magnets move past a coil generating power for small sensors, microprocessors, and transmitters. These electromechanical systems, however, are relatively large in size, heavy in weight, and expensive. In addition, electromechanical energy harvesting systems are relatively inefficient at harvesting, converting, and storing power.

[0009] For example, U.S. Pat. No. 6,943,476, entitled "MAGNETO GENERATOR FOR SELF-POWERED APPARATUSES" and issued to Regazzi, et al. discloses a magneto generator for self-powered apparatuses. The magneto generator of Regazzi, et al. comprises a stator provided with an electric winding, and a permanent magnet rotor coaxially arranged to the stator. The stator and the rotor have a first, and respectively a second pole system which together with the electric winding define a multiphase electromagnetic system connected to a bridge rectifier, secured to the stator. The poles of the stator and the poles of the rotor have opposite polar surfaces in which the axis of each polar surface of the rotor is slanted with respect to a reference line parallel to the longitudinal axes of the polar surfaces of the stator.

[0010] In addition, harvesting energy from a flow of water in the environment is known. For example, U.S. Pat. No. 6,927,501, entitled "SELF-POWERED MINIATURE LIQUID TREATMENT SYSTEM" and issued to Baarman, et al. discloses a liquid treatment system that may be self-powered and includes a filter, an ultraviolet light source and a hydro-generator in the fluid flow path. The housing may be mounted at the end of a faucet. The hydro-generator may generate electric power for use by the ultraviolet light source and a processor. But a water source is an unreliable and inconvenient source for harvesting energy.

[0011] Further, harvesting solar or light energy is known. In theory, devices having solar cells never need batteries and can work forever. Photovoltaic cells or modules (a grouping of electrically connected cells) can be provided in a device to convert sunlight into energy for powering a device. However, because the sun does not always shine, i.e., at night and during cloudy days, and auxiliary sources of light energy are not always available, this type of self-power is not reliable. Also, solar cells are relatively inefficient energy harvesters. Typically, solar systems include some type of energy storage (e.g., batteries) as a back-up system for providing power when the sun isn't shining. The various disadvantages of batteries and battery-life issues have been discussed supra.

[0012] An example of a self-powered solar system includes U.S. Pat. No. 6,914,411, entitled "POWER SUPPLY AND METHOD FOR CONTROLLING IT" and issued to Couch et al. Couch et al. discloses a self-powered apparatus including a solar power cell, a battery, and a load. The load may include one or more load functions performed using power provided by one or both of the solar power cell and the battery. Switching circuitry, controlled by the programmable controller, selectively couples one or both of the battery and the solar cell to supply energy for powering the load. In a preferred embodiment taught by Couch et al., the controller couples the battery and/or solar cell to charge a super capacitor, which then is selectively controlled to