

SOLE POWER SHOES

Wan Mohd Zamri Bin Wan Ab Rahman¹, Faizatul Absharizan Binti Abu Bakar²

¹Jabatan Kejuruteraan Elektrik, Politeknik Sultan Salahuddin Abdul Aziz Shah, Malaysia;
Email: zamri@psa.edu.my

²Jabatan Perdagangan, Politeknik Sultan Azlan Shah, Malaysia;
Email: faizatul@psas.edu.my

Abstract - Sole Power Shoe is a power-generating shoe insole for charging portable electronics like cell phones, music players, or GPS devices. It is based on the concept green energy which harvest the electricity from the kinetic energy. The electricity stored can be used for electrical gadget that uses small amount of electricity. The piezoelectric transmitter is embedded inside the shoe to convert the mechanical stress applied into electrical energy to power, This electrical energy is further stored in a device like lithium polymer batteries so that it can be used in portable devices such as mobile phones or other hand held electrical which is as a receiver doesn't need to be embedded in a shoe, so that it can be removable depend on users. It is ideal for anyone who doesn't have access to any source of power supply. The specialty of Sole Power Shoe will use the renewable energy to produce the electricity, waterproof and weather resistant. Therefore, it can contribute in emergency environment and critical situation that don't have the power supply.

Index Terms— Sole Power, Charging, Renewable energy

I. INTRODUCTION

Energy resources have become an importance when we are out for outdoor activities. If it rains, camp fires will die out and torch light batteries usually do not last long. The world is full of alternative energies such as the heat from the sun, wind and hydro power. These energies can be harnessing to reduce relying totally on the supplied electricity. Moreover, some of the electrical devices and home lightings use only little power. Harnessing the natural energies can save money paid for the electricity and help to save our world. Hence the purpose of this project is to design a fully automated power generation system that will harness kinetic energy and then convert it into electrical energy to power some of the electrical devices at home and for hawkers. An additional feature is the battery level indicator that will show the life span of the battery.

The cost for the project will be emphasizing on low cost to produce so that it will be affordable. Moreover, the design of the Sole Power Shoes will be convenient to be carried around to places where availability for electricity is an issue.

In recent year, people especially workers and students is busy with their busy daily life to complete the task or project. When they are out station there is some difficulty to find the switch to plug in charger to charge power bank which is important devices to charges other gadget to make sure the battery in optimum condition. So when the smart phone battery run out there is problem for them to access the smart phone to keep in touch to others or updated to important information.

Based on the current situation described above is likely to people have problem to get the power supply that will cause their phone to run out of the battery. For that reason, the suitable solution is developed the new concept of generation and friendly user for everybody and any situation also easy to carry and light. This Sole Power Shoes will use the renewable energy to produce the electricity. This Sole Power also can generate the ac current than convert to the dc current by bridge rectifier. The best concept to solve this problem is develop the portable electricity generator.

Hence this Sole Power Shoes also can help in severely environment cannot have the power supply using to have some energy where it can help in emergency or critical situation.

The objective for the project is to develop a Sole Power Shoes generator system that based on the concept green energy which harvest the electricity from the kinetic energy that can be used for the human benefits. Besides that, the electricity stored can be used for electrical gadget that uses small amount of electricity which will minimize the monthly electricity bill payment. This project will help graduates be more competent in future as the experience gained in completing the project will be highly evaluated by the industry.

This project will include working with both hardware and software. The hardware will include the materials such as the piezoelectric, Power Bank, Arduino microcontroller, printed circuit board (PCB), buzzer and so on. The hardware materials will be purchased either locally or used from our house appliances.

The hardware will then be set up by connecting the system in a correct sequence. The mechanical design for the project will be studied such as the piezoelectric to the desired position.

This will include the hardware and software implementation for the system. Software programming and hardware design will be deterministic for the overall outcome of the project.

II. LITERATURE REVIEW

2.1 Piezoelectricity is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and various proteins)[1] in response to applied mechanical stress. The word piezoelectricity means electricity resulting from pressure and heat. It is derived from the Greek which means to squeeze or press, and ἤλεκτρον electron, which means amber, an ancient source of electric charge. Piezoelectricity was discovered in 1880 by French physicists Jacques and Pierre Curie. The piezoelectric effect is understood as the linear electromechanical interaction between the mechanical and the electrical state in crystalline materials with no inversion symmetry.

The piezoelectric effect is a reversible process in that materials exhibiting the direct piezoelectric effect (the internal generation of electrical charge resulting from an applied mechanical force) also exhibit the reverse piezoelectric effect (the internal generation of a mechanical strain resulting from an applied electrical field). For example, lead zirconate titanate crystals will generate measurable piezoelectricity when their static structure is deformed by about 0.1% of the original dimension. Conversely, those same crystals will change about 0.1% of their static dimension when an external electric field is applied to the material.

The inverse piezoelectric effect is used in the production of ultrasonic sound waves. Piezoelectricity is found in useful applications, such as the production and detection of sound, generation of high voltages, electronic frequency generation, microbalances, to drive an ultrasonic nozzle, and ultrafine focusing of optical assemblies. It is also the basis of a number of scientific instrumental techniques with atomic resolution, the scanning probe microscopies, such as STM, AFM, MTA, SNOM, etc., and everyday uses, such as acting as the ignition source for cigarette lighters, and push-start propane barbecues, as well as the time reference source in quartz watches.

2.2 Sensor

The principle of operation of a piezoelectric sensor is that a physical dimension, transformed into a force, acts on two opposing faces of the sensing element. Depending on the design of a sensor, different "modes" to load the piezoelectric element can be used: longitudinal, transversal and shear. Detection of pressure variations in the form of sound is the most common sensor application, e.g. piezoelectric microphones (sound waves bend the piezoelectric material, creating a changing voltage) and piezoelectric pickups for acoustic-electric guitars. A piezo sensor attached to the body of an instrument is known

as a contact microphone. Piezoelectric sensors especially are used with high frequency sound in ultrasonic transducers for medical imaging and also industrial nondestructive testing (NDT).

For many sensing techniques, the sensor can act as both a sensor and an actuator – often the term transducer is preferred when the device acts in this dual capacity, but most piezo devices have this property of reversibility whether it is used or not. Ultrasonic transducers, for example, can inject ultrasound waves into the body, receive the returned wave, and convert it to an electrical signal (a voltage). Most medical ultrasound transducers are piezoelectric. In addition to those mentioned above, various sensor applications include: Piezoelectric elements are also used in the detection and generation of sonar waves. Piezoelectric materials are used in single-axis and dual-axis tilt sensing.[42]Power monitoring in high power applications (e.g. medical treatment, sonochemistry and industrial processing).Piezoelectric microbalances are used as very sensitive chemical and biological sensors.

Piezoceramic material—non-conductive piezoelectric ceramic or crystal—is placed between the two metal plates. For piezoelectricity to be generated, it needs that material to be compressed or squeezed. Mechanical stress applied to piezoelectric ceramic material generates electricity.

As shown in Fig. 2.3, there's a voltage potential across the material. The two metal plates sandwich the piezo crystal. The metal plates collect the charges, which creates/produces voltage (lightning bolt symbol), i.e., piezoelectricity. In this way, the piezoelectric effect acts like a miniature battery, because it produces electricity. This is the direct piezoelectric effect. Devices that use the direct piezoelectric effect include microphones, pressure sensors, hydrophones, and many other sensing types of devices.

III. METHODOLOGY

3.1 Arduino UNO.

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself kits.



Figure 3.1

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

The Arduino project started in 2003 as a program for students at the Interaction Design Institute Ivrea in Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

3.2 Hardware



Figure 3.1

Arduino is open-source hardware. The hardware reference designs are distributed under a Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduino

website. Layout and production files for some versions of the hardware are also available. The source code for the IDE is released under the GNU General Public License, version 2. Nevertheless, an official Bill of Materials of Arduino boards has never been released by Arduino staff.

Although the hardware and software designs are freely available under copyleft licenses, the developers have requested the name Arduino to be exclusive to the official product and not be used for derived works without permission. The official policy document on use of the Arduino name emphasizes that the project is open to incorporating work by others into the official product. Several Arduino-compatible products commercially released have avoided the project name by using various names ending in-duino.

An early Arduino board with an RS-232 serial interface (upper left) and an Atmel ATmega8 microcontroller chip (black, lower right); the 14 digital I/O pins are at the top, the 6 analog input pins at the lower right, and the power connector at the lower left.

Most Arduino boards consist of an Atmel 8-bit AVR microcontroller (ATmega8, ATmega168, ATmega328, ATmega1280, ATmega2560) with varying amounts of flash memory, pins, and features. The 32-bit Arduino Due, based on the Atmel SAM3X8E was introduced in 2012. The boards use single or double-row pins or female headers that facilitate connections for programming and incorporation into other circuits. These may connect with add-on modules termed shields. Multiple, and possibly stacked shields may be individually addressable via an I²C serial bus. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator or ceramic resonator. Some designs, such as the LilyPad, run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions.

3.3 Software development

A program for Arduino may be written in any programming language for a compiler that produces binary machine code for the target processor. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio.

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus.

A program written with the IDE for Arduino is called a sketch. Sketches are saved on the development computer as text files

with the file extension `.ino`. Arduino Software (IDE) pre-1.0 saved sketches with the extension `.pde`. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub `main()` into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program `avrdude` to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

Arduino Software IDE



Screenshot of the Arduino IDE showing the *Blink* simple beginner program

Developer(s)	Arduino Software
Stable release	1.8.4 / 23 August 2017; 48 days

Figure 3.3

A minimal Arduino C/C++ sketch, as seen by the Arduino IDE programmer, consist of only two functions:

`setup()`: This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch.

`loop()`: After `setup()` has been called, function `loop()` is executed repeatedly in the main program. It controls the board until the board is powered off or is reset.

Most Arduino boards contain a light-emitting diode (LED) and a load resistor connected between pin 13 and ground, which is a convenient feature for many tests and program functions. A typical program for a beginning Arduino programmer blinks a LED repeatedly.



Power LED (red) and User LED (green) attached to Pin 13 on an Arduino compatible board

Figure 3.4

```

#define LED_PIN 13 // Pin number attached to LED.

void setup() {
  pinMode(LED_PIN, OUTPUT); // Configure pin 13 to be a digital output.
}

void loop() {
  digitalWrite(LED_PIN, HIGH); // Turn on the LED.
  delay(1000);                // Wait 1 second (1000 milliseconds).
  digitalWrite(LED_PIN, LOW); // Turn off the LED.
  delay(1000);                // Wait 1 second.
}

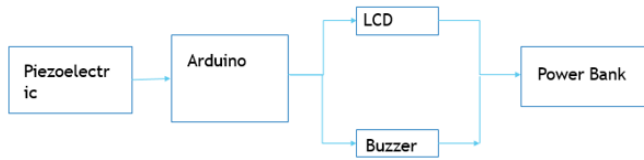
```

Figure 3.5

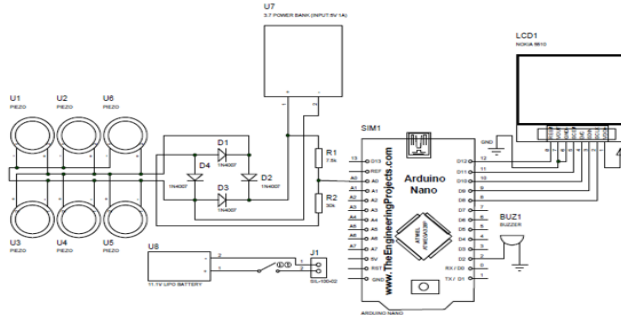
This program uses the functions `pinMode()`, `digitalWrite()`, and `delay()`, which are provided by the internal libraries included in the IDE environment. The program is usually loaded in the Arduino by the manufacturer. Arduino IDE and C language allow the programming of the low level registers in the `atmega328P`. instructions like `DDRB=0b00000001` for changing `PORTB` input/output pins are allowed.

IV. RESULTS AND DISCUSSION

This section were discusses on the results of Sole Power Shoe.



4.1 BLOCK DIAGRAM



4.2 SCHEMATIC CIRCUIT

DESCRIPTION OF THE BLOCK DIAGRAM AND SCHEMATIC CIRCUIT

Piezoelectric is a device that convert kinetic energy to AC current while we walk. Then, the full wave rectifier which contain four diodes also known as bridge will convert AC current to DC current .The DC current will flow to resistors. A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 offers the same connectivity and specs of the UNO board in a smaller form factor. The Arduino Nano is programmed using the Arduino Software (IDE), our Integrated Development Environment common to all our boards and running both online and offline At the same time, Arduino Nano will read the amount of voltage produce by piezoelectric and will display the percentage of battery and time on display .If the powerbank charge already full, the buzzer will alert the user by produce sound.

V. CONCLUSION

After simulating the sole power shoe out there and make comparison with socket charger and sole power shoe. We calculate how many step and percentage for 1km, 2km and so on. To get battery percentage 100%, must walk 20.8km.To measure voltage, we use millivoltmeter. Not only step that

affect the percentage, the body weight can bring impact, the heavier the body will increase the percentage.

1 km = 1250 steps

Battery percentage 100% = 26 000 steps (20.8km)

1mA=0.001V

The total capacity of power bank is 2600mAh

Distance (km)	Percentage (%)
2	10
4	20
6	30

Body Weight (kg)	Voltage(mV) for 1 step
50-60	0.1
60-70	0.12
70-80	0.15

Table 4.1: Tandem Cell layer of the CIS / CIGS

ACKNOWLEDGMENT

The authors would like to express gratitude to the Jabatan Kejuruteraan Elektrik, Politeknik Sultan Salahuddin Abdul Aziz Shah, for their support and also to all lecturer of Jabatan Kejuruteraan Elektrik.

REFERENCES

- Walker, M. M. (2001). Convert kinetic to electrical in sole power shoe. Final year project, 93 (1), 257-267
- Dodd, Annabel Z., The Essential Guide to Sole Power Shoe. Prentice Hall PTR, 2002, p. 183.
- Burnham, Gerald O.; et al. (October 2001). "The First Telecommunications Engineering Program in the United States" (PDF). Journal of Engineering Education (American Society for Engineering Education) 90 (4): 653–657. Retrieved September 22, 2012