Jackit: Power Generating Jacket

Buondi Davide
ISIA Firenze
davide.buondi@isiadesign.fi.it

Equizi Giacomo
ISIA Firenze
giacomo.equizi@isiadesign.fi.it

Bolognesi Linda
ISIA Firenze
linda.bolognesi@isiadesign.fi.it

Fazzi Maria Adelaide
ISIA Firenze
mariaadelaide.fazzi@isiadesign.fi.it

Abstract
Today our life is dominated by technology. It happens often that we trust our devices too much and when they run down we are completely floored. In this case we just desire a bit of extra energy to solve our troubles.

Jackit is a jacket made of a new textile combination of knitted copper and constantan and a textile fiber that can change depending on the use of the jacket. This textile uses the Seebeck effect to produce energy and recharges a power bank connected inside the jacket. The See beck effect uses the different temperature between the one of the human body and the external temperature to produce energy.

The energy of the power bank can then be used to charge various electric devices. The amount of energy obtained depends on the outside air temperature.

Permission to make digital or hard copies of part or all of this work for personal classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. for all other used contact the Owner/Author.
Copyright is held by the authors.
ISWC'14 Adjunct, September 13 - 17, 2014, Seattle, WA, USA
ACM 978-1-4503-3048-0/14/09.
http://dx.doi.org/10.1145/2641248.2641274

Author Keywords
Energy Harvesting; Textile; Knitting; Seebeck Effect

ACM Classification Keywords
H.5.1; J.7

Introduction
This Jackit is a jacket made of a new textile combination of knitted copper and constantan and a textile fiber that can change depending on the use of the jacket. This textile uses the Seebeck effect to produce energy and recharge a power bank connected inside the jacket.

The energy of the power bank can then be used to charge various electric devices. The amount of energy obtained depends on the outside air temperature.

Moreover, the Seebeck effect helps to keep the body temperature at a more stable temperature.

Reasearch

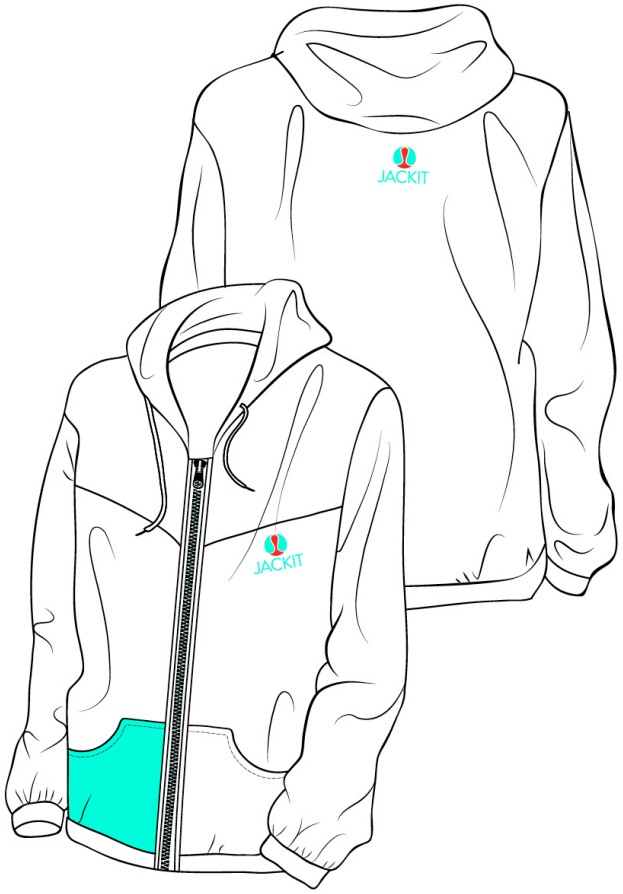


Figure 2. Jacket Sketch

In the last few years the topic of reinventing conventional batteries to make them greener, got a lot of attention. Starting from nickel-cadmium or lithium batteries, fuel cells, prototypes based on glucose solution, we are now approaching new technologies which aim to involve the energy produced by the human body.

The human body is like a machine that keeps running and the output is easily turned into waste once the amount of energy needed for all the vital functions are satisfied. We could recycle this "waste" for powering our electronic devices, or simply regaining some energy ready to use.

We did focus on the heat directly produced by our body and we looked for the right tool to harvest it. Humans are homothermic mammals which means that they are able to maintain their temperature relatively stable in most situations. This balance is maintained thanks to the proportion between production, absorption and elimination of thermal energy. Some of the main sources of energy in the human body are the basal metabolic rate, the specific dynamic action of food, the muscular activity, the release of waste substance and emotional stress.

The body temperature is conventionally fixed at 37°C, but it can be slightly different in each person depending on multiple factors such as external temperature, time of the day, age of the person and other situations. This temperature variation can be up to 0,6°C and ranges between 36,1° C and 37,2°C changing body section to another.

Seebeck effect

One of the thermoelectric effects that converts heat into energy is the Seebeck effect. The basis of this effect is to transform temperature difference directly into electricity.

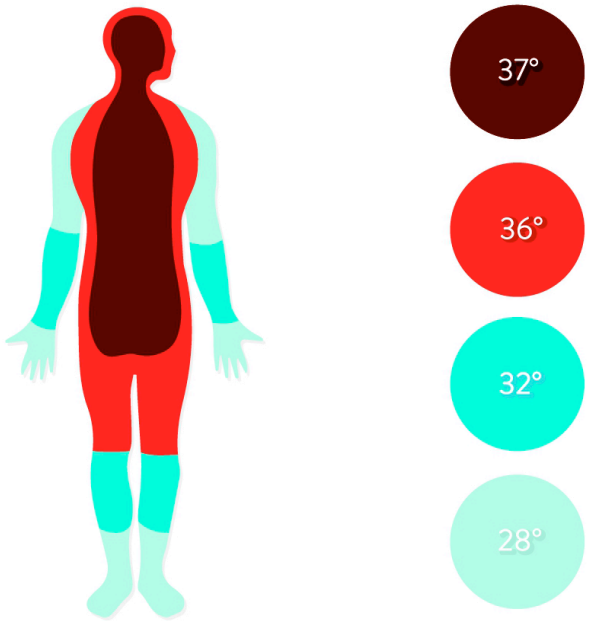


Figure 2. Body Temperatures

In a circuit made of two different metals and exposed to different temperatures the metals does not react at the same way, generating different tensions, this creates a current loop and a magnetic field between the two junctions.

The different tension created by the Seebeck effect variates when changing materials, their absolute temperature and their molecular structure. So the Seebeck effect depends on the Seebeck coefficient of the two metals, A and B, and the difference of temperature between the two junctions.

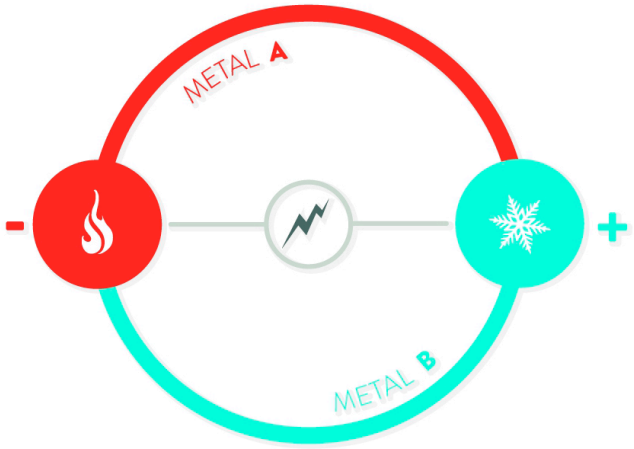


Figure 3. **Seebeck Effect**

Project

We thought that the Seebeck effect could be used efficiently to transform our body temperature into electricity. This is why we decided to design a jacket able to produce energy using the temperature difference between our body and the external temperature.

The goals

We identified two main goals. The first one is charging electric devices: it often occur to have your mp3 or smartphone running out of battery and not having the chance to charge them by plugging them into a wall socket. That's why we thought it was important having a tool that would come in handy in these situations, enabling us to power our favorite device. The jacket includes a 5 ampere power bank able to charge (at list partially) many electrical devices. The power bank takes about 3-4 hours to fully recharge and it is inserted right inside the jacket. Like the battery of a

smartphone this tool can be recharged at list 500 times before its performance starts to decrease, anyway you can easily replace it with a new one.

The second goal was to maintain body temperature as stable as possible, which happens thanks to the Seebeck effect. The Seebeck effect would ideally act like a thermostat burning the excess heat preventing the body from getting too hot. Maintaining a stable body temperature, also means not needing to activate our natural thermostatic strategies such as sweating. As a result the frequency and depth of the respiration will be reduced because of a smaller amount of oxygen needed by thermogenic organs.

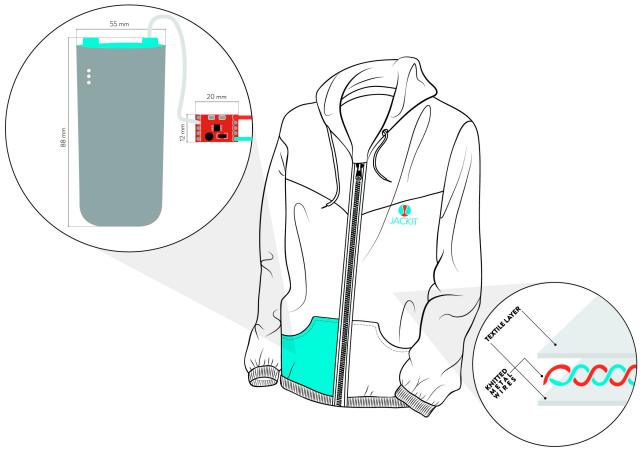


Figure 4. Design Concept Overview

The textile

The jacket is made of an innovative textile in which wires of copper and constantan (a copper-nickel alloy usually consisting of 55% copper and 45% nickel) are interweaved. To make it lighter and less stiff the diameter of the wires floats around 0,125mm.

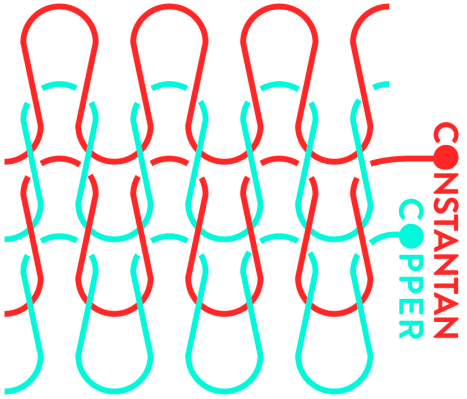


Figure 5. Knitting Wire Illustration

We chose not to adopt the conventional structure for the textile and go for a knitted type, in order to maximize the capacity of generating energy. Every single wire is coated with plastic to prevent the metals from oxidation and to avoid contacts between them. Since the constantan is partially made of nickel, the plastic coating also protects final users from potential allergic reactions. Unlike other fabric-like energy harvester, this textile is way more efficient. When exposed to a temperature difference of 20°C it is able to generate up to 2 volt per square meter.

How it works

The textile chosen to design Jackit, as explained before, produces energy thanks to the difference of temperature between its inside and outside layer. The output energy moves through the metal wires until it reaches the central part, and flows down into the

energy harvester. The energy harvester we chose measures 1,3x2cm ca. and is connected to a power bank. The energy accumulated inside the power bank is then ready to use, it has a 3.6V input maximum and act like every other battery being charged through an USB cable.

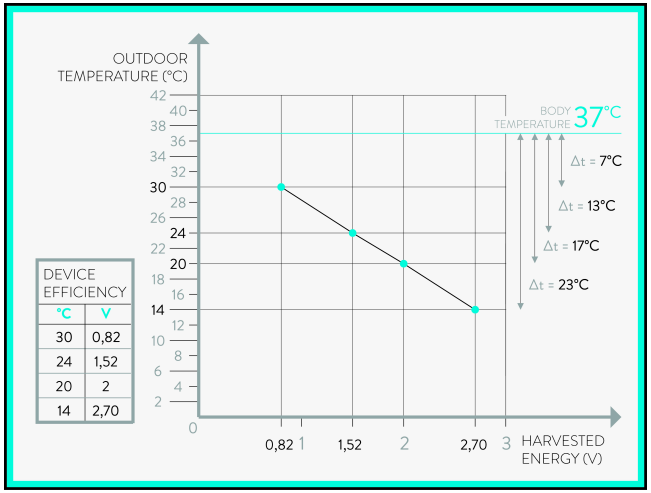


Figure 6. Energy produced per m2

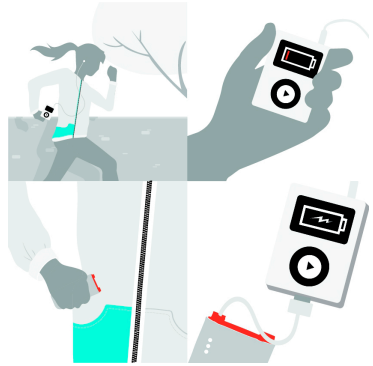
Energy possibilities
Based on the data of the textile designed at E-Textile Summer Camp, where the 1m^2 produced 1V at a thermal gradient of 17°C.

Considering the same thermal gradient, the textile we designed generates approximately 2V each m^2, this is because we doubled the thermal coupples. Jackit is made with 2m^2 of this fabric, so we presume that it generates approximately 4V at the thermal gradient of 17°C.

For an adequate energy production the outdoor temperature should be ≤ 24°C. The energy is transported directly from the knitted wire to an energy harvester.

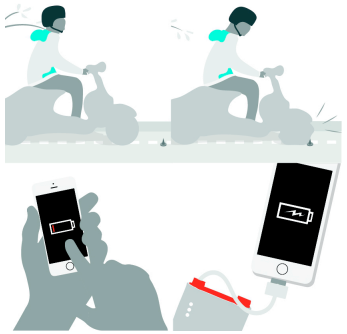
Scenarios

Jogging
While we run our body temperature increases. It often happens our Music Devices run out of battery when we go jogging. Our project aims to work things out, supplying energy on the go to charge your device directly from a lower bank powered by your own body heat.

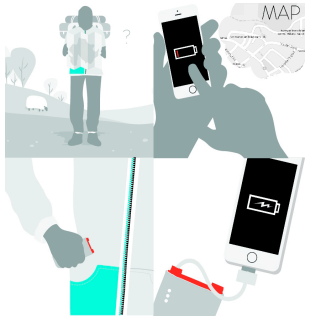


While riding your motorcycle

Iit happens when you ride your motorcycle that you punch a hole in a tire. Then you can not call for help because your phone has discharged.
The power bank incorporated in Jakit will enable you to power you phone with green energy and get you out of trouble.



On a journey
It is always nice to go out for a walk but it is sometime hard to find your way back home. If you find yourself lost in the middle of nowhere or simply if you have any trouble speaking a foreign language and your device runs out of battery, Jackit will be able to help you out.



Conclusions

The difference between the textile of E-textile summer camp and our textile is the energy produced. Indeed, our textile produces 1 Vm2 more, because it woven differently. We switched from a warp weave to a knitted weave. We put this textile into a usual jacket. With Jackit you will be able to recharge your small devices everywhere.

This textile can be used with every kind of jacket, so that it is not subject to the changes of fashion world. So the life of his product will be lasting much longer.

References

[1] Seebeck Effect, Wikipedia, 28/04/2014 http://en.wikipedia.org/wiki/Seebeck_coefficient

[2] Seebeck coefficent, Wikipedia, 28/04/2014 http://en.wikipedia.org/wiki/Seebeck_coefficient

[3] Dr. Möhring, U., Dr. Neudeck, A., Dr. Scheibner, W., Dipl-Ing. Thurner, F., Dr. Zimmermann, Y. *Textile Mikrosysteme zur Energieumwandlung und –speicherung.* http://etextile-summercamp.org/2013/wp-content/uploads/2013/07/TITV_Greiz_Paper_MicroSySDD.pdf

[4] Grant, M., Nachtigall, T.R., Romano, Z., *Power Generating Textiles* http://etextile-summercamp.org/2013/?p=1330

[5] Energy Harvester, Sparkfun http://www.sparkfun.com/products/9946

[6] Termoregolazione, My-Personaltrainer, http://www.sparkfun.com/products/9946