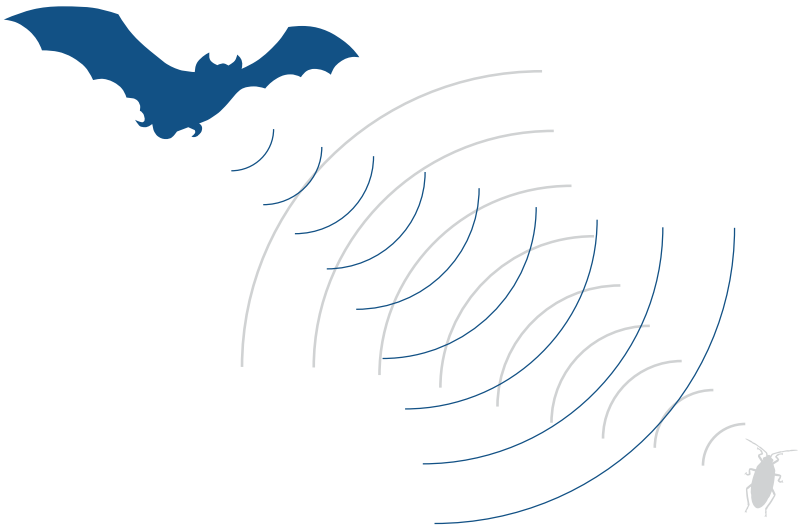
echolocation shoes

IFD:AMBIENT TANGIBLE AND PERVASIVE

Azucena Sánchez
Matrikel Nr. 115601

INSPIRATION



bats and echolocation

Echolocation is the sophisticated, biological, sonar-like system used by dolphins, bats and other animals to detect and locate objects by emitting ultrasonic high pitched sounds that reflect off the object and return to the animal's sensory receptors.

While hunting, bats make noises that humans cannot hear but that can be translated as sound waves, these sound waves travel through space and hit an object bouncing back ultrasonic sound waves producing echo. This echo is perceptible to bats and this is how they echolocate themselves. With this ability they can know where the insects (their food) are, the distance, size and in what direction it is moving.[1]

humans and echolocation

Animals are not the only ones that can echolocate themselves. There are some uncommonly human beings that had been able to develop this ability, specially blind people. There have been cases in which humans that were born blind or went blind through the use of tongue clicks have taught themselves to echolocate themselves in space. They can live normal lives, play basketball, ride a bike, identify objects like trees and even tell how tall they are.

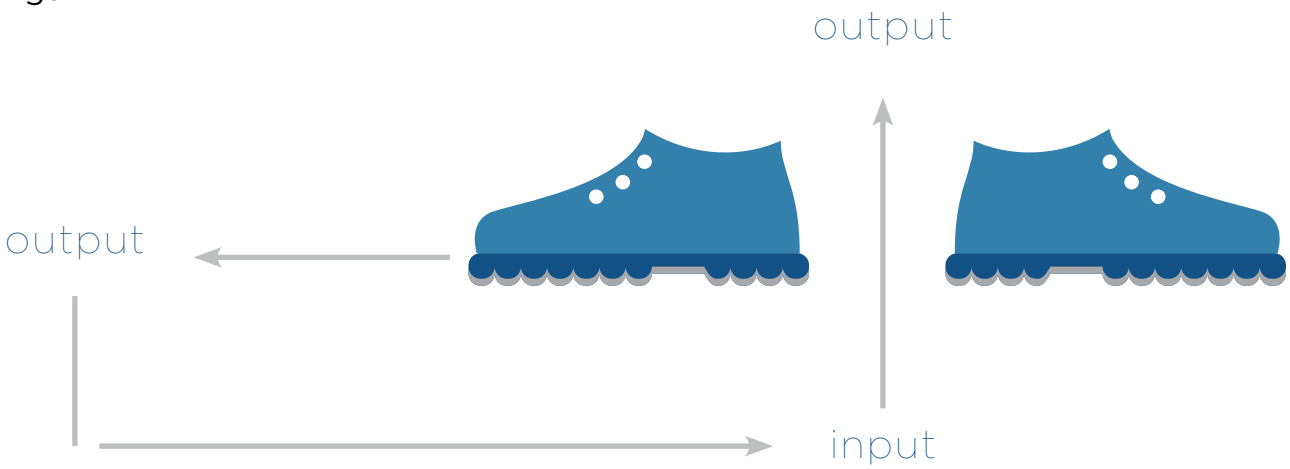
Examples of human echolocation: Daniel Kish https://www.youtube.com/watch?v=uH0aihGWB8U and Ben Underwood https://www.youtube.com/watch?v=Te-FRkAYb1uk

IDEA

let's think about shoes

The idea is to design a pair of comfortable shoes that would produce ultrasonic waves to help humans echolocate themselves with no need of any sound produced from their own body. These ultrasonic waves, based on the theory that bats echolocate themselves through ultrasonic waves, could be either audible or non-audible for human beings.

The shoes would work like it follows. We would need to start with an output (sound waves), an input (echo from the objects around) to produce another output for the human being (vibrations either in the left or right side of the feet, depending the location of the objects.

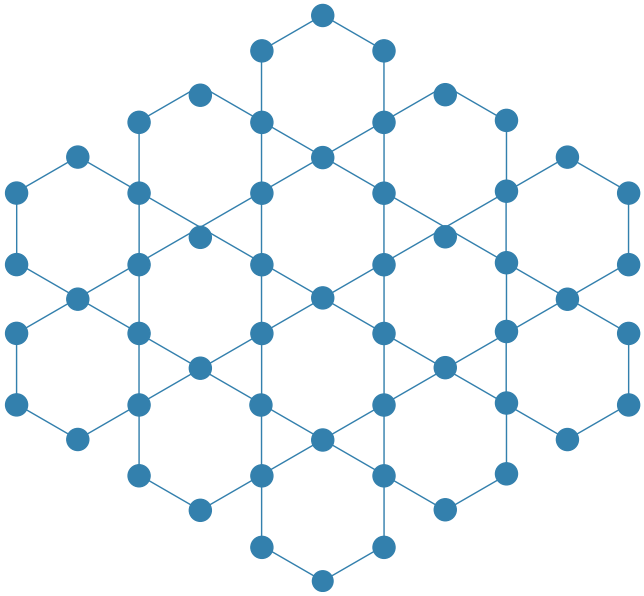


BACKGROUND

similar projects

Many investigations around bats and echolocation had been made in order to develop not only prototypes but actual products that help blind people echolocate themselves. [2]

I came across a similar project in which they built up an echolocation stick. It is made for the blind and it is not a replacement for the blind stick but more like an upgrade, it follows the same echolocation principle triggered by sounds.



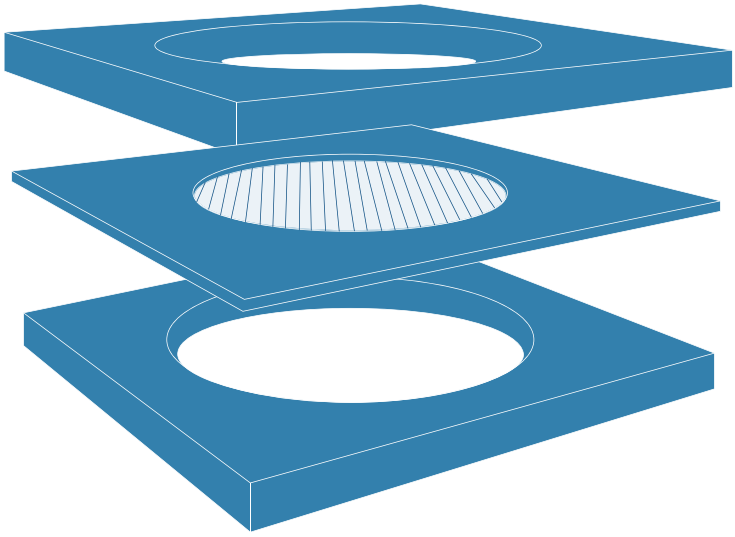
graphene

Graphene is a form of carbon consisting of planar sheets which are one atom thick, with the atoms arranged in a honeycomb-shaped lattice.[3] It had been first observed in the year 1962 but not further investigation was made until 2004 and in 2010 researchers from the manchester university managed to find a way of easily isolating these material making a breakthrough in the research and development of many daily products.[4]

microphone and speakers

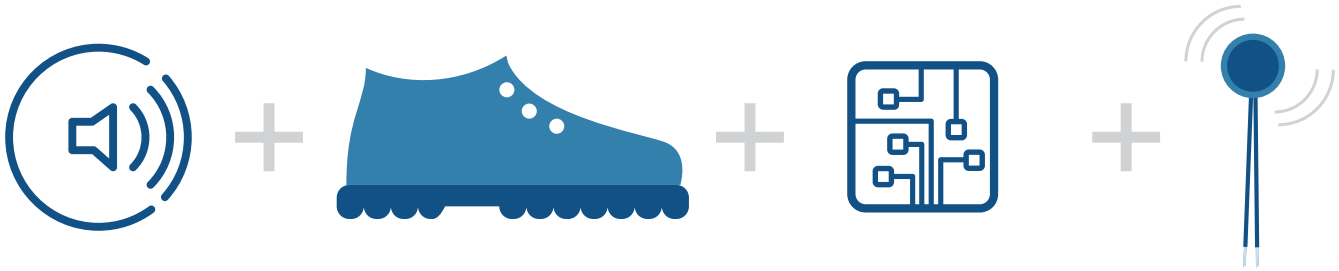
There had been many papers and articles on bats through the years. Also many people have had some ideas about how to translate their abilities into humans. Some questions came to mind: Which are the sound frequencies used by bats? How can these frequencies be measured? Have there been previous recordings of the bats' sounds?

Bats make ultrasonic sounds, there is a sensor that can actually be connected to Arduino to help us measure these sound waves but it is too big for the implementation of such sensor into a shoe. I came across an article from the UC Berkley University that gave me the answer to both matters, bats and technology. A couple of researchers developed a graphene microphone and a speaker which allowed them to record and listen the sounds bats make.[3] Though some people had already developed or pondered on the idea of imitating and recording bats, graphene gives human beings the opportunity to develop micro instruments that can even be placed on the bat itself to measure the frequencies received by these peculiar animals. This is why the incorporation of graphene speakers and microphones to the shoes would be the best and more accurate instrument to be use.



Inside a graphene speaker.

SHOES ACTIVITY



how would the shoes work?

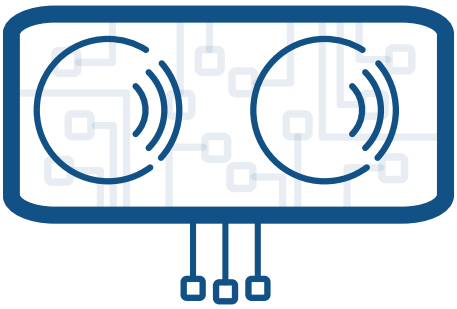
The graphene speaker would make sounds that, as we know, would be translated into ultrasonic waves. When these waves hit the object they would then generate echo through the objects around the shoes, giving feedback to an ultrasound sensor or a graphene speaker. The data received would be run through a circuit that would then trigger a signal to the vibration motors (one on each side of the shoe). The motors would move faster or slower according to the distance and location of the object.

The shoe would be able not only to produce ultrasonic waves but also sounds that be audible for human beings. The incorporation of an on and off switch would be made so blind people have control in case they wish to hear a sound or not. The sound would be a click, similar to the one made by humans that have the ability to echolocate themselves, a tongue click.

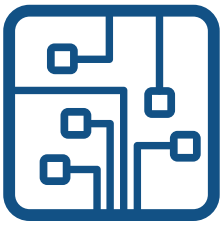
cyborgs vs super humans

With the incorporation of the on/off switch humans would be given the opportunity to listen or not the sounds produced by the shoes. By playing with this feature of listening to a clicking sound, blind people could actually start training themselves to not be dependent on the shoes. The system would help them enhance themselves and their bodies in a natural way. Instead of being a so-called cyborg, they could be super humans.

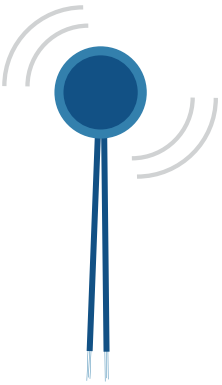
PROTOTYPE



ultrasonic sensor



circuit



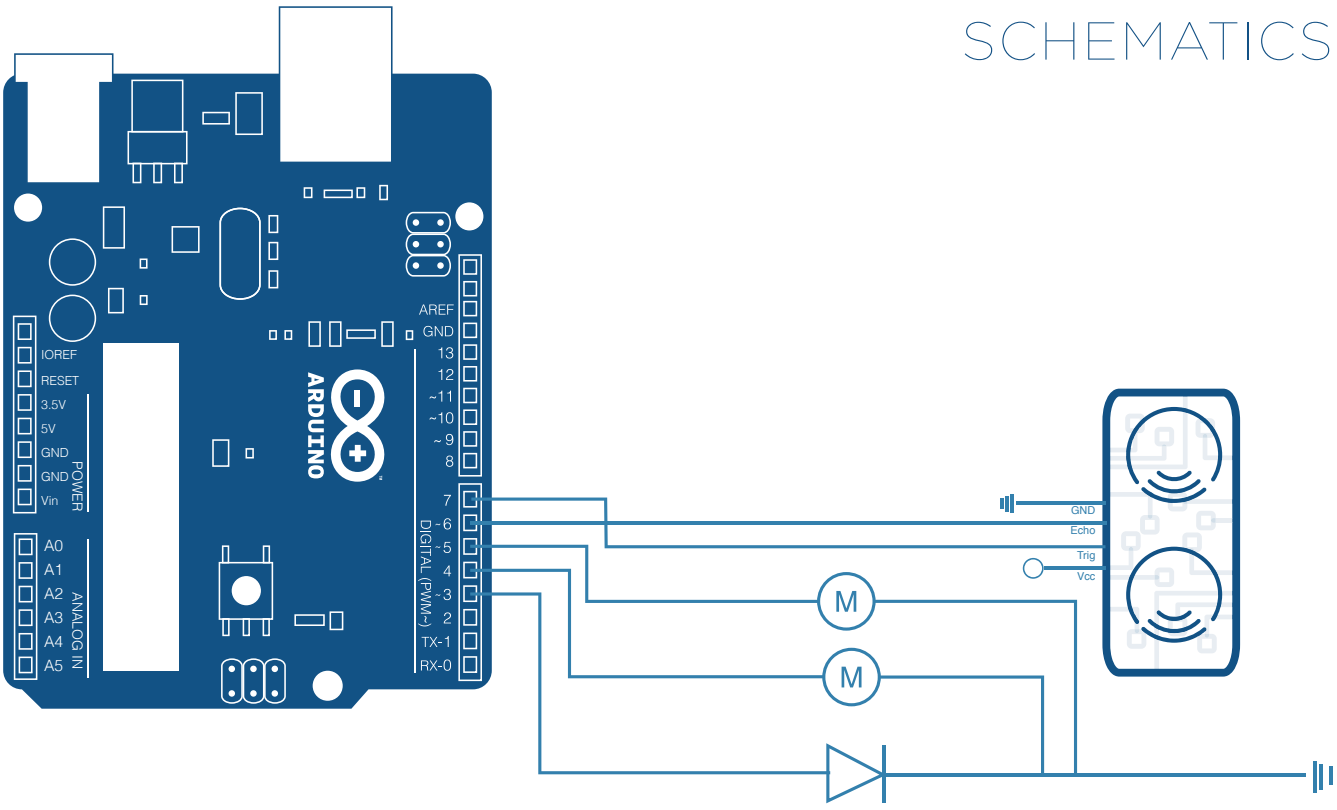
vibration motor

For the development of the prototype I am using:

- Ultrasonic Sensor HC-SR04, 4 Pin
- Mini Vibrations Motor 3V
- Red Led
- Green Led
- Arduino

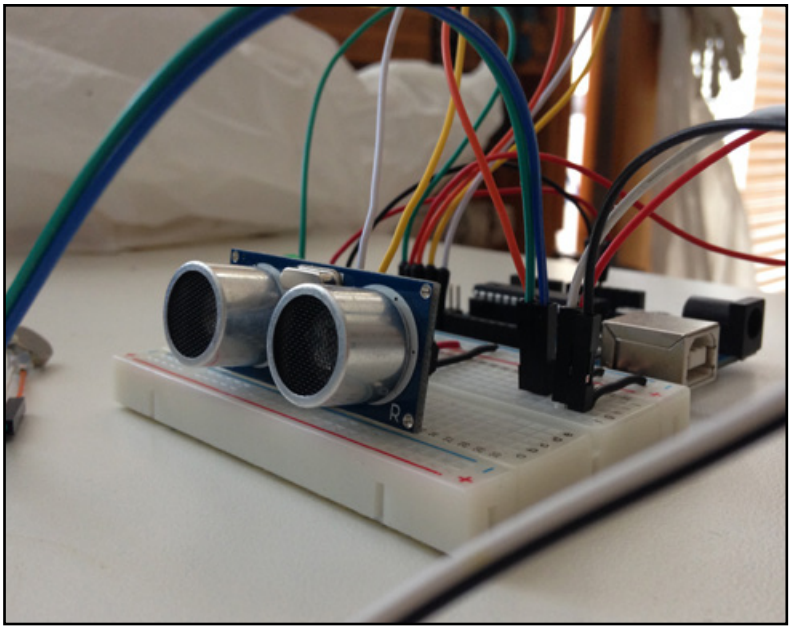
The Ultrasonic sensor will sense the waves coming back from the objects when the person approaches to it. This will give an output signal in a form of light telling us if an object is close or not.

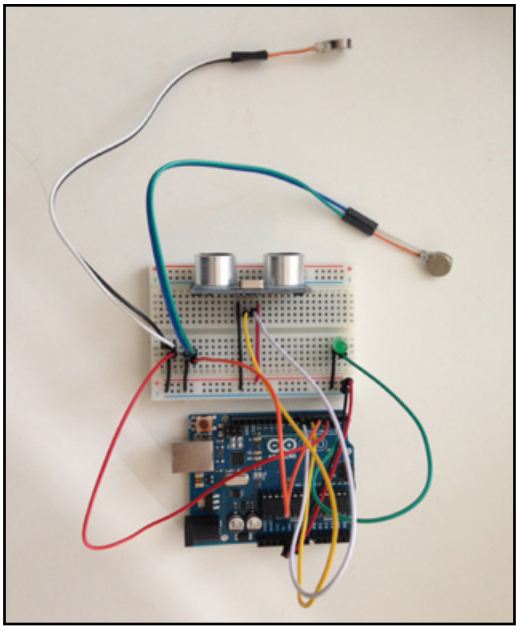
SCHEMATICS

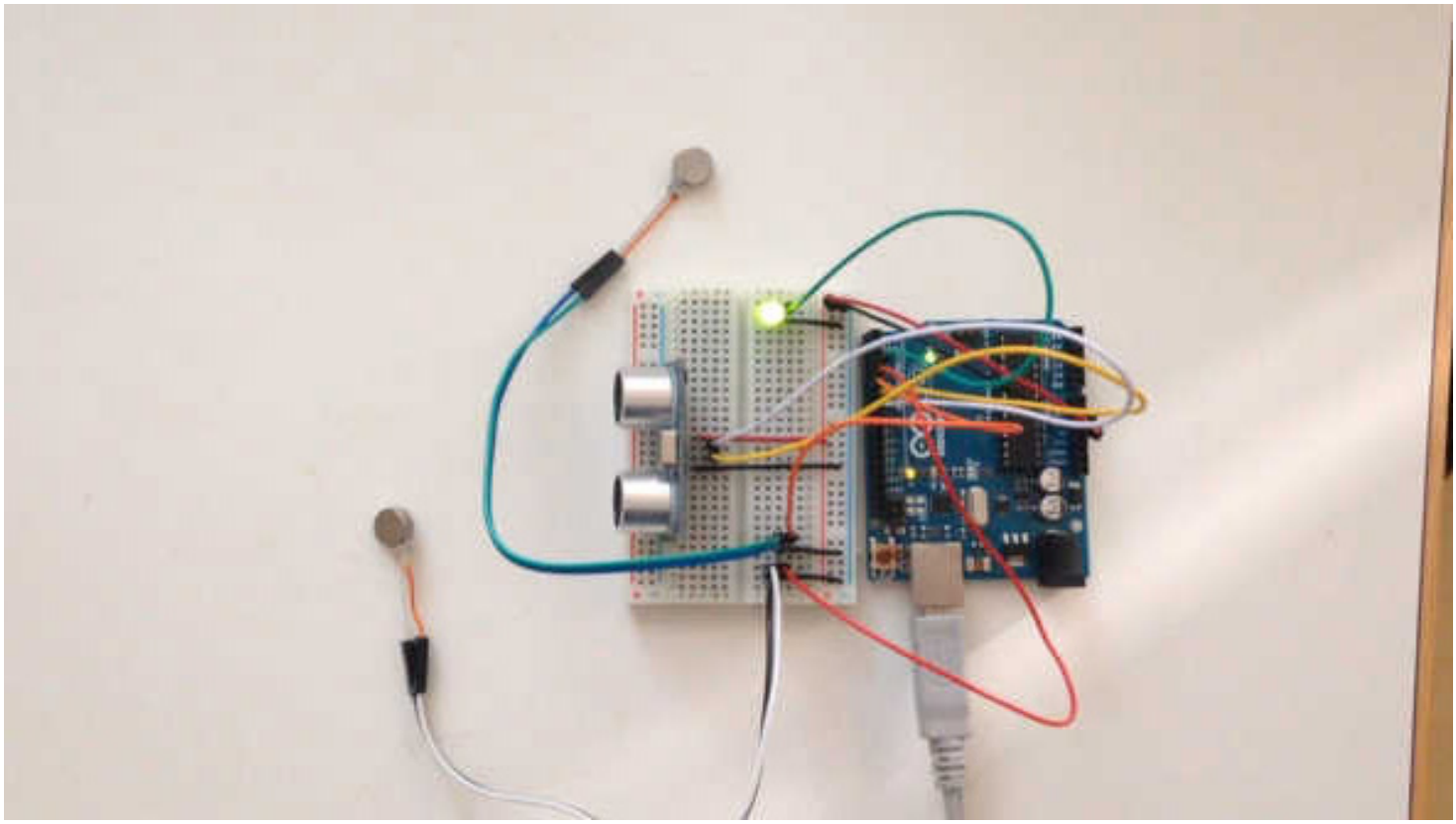


CODE

```
#define trigPin 7
#define echoPin 6
#define led 3 //led
#define mot 5 //motor left
#define mot2 4 //motor right
long duration, distance;

void setup() {
  Serial.begin (9600);
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(led, OUTPUT);
  pinMode(mot, OUTPUT);
  pinMode(mot2, OUTPUT);
}

void loop() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  //digitalWrite (trigPin, HIGH);
  //delayMicroseconds (2);
  //igitalWrite(trigPin, LOW);

  duration = pulseIn (echoPin, HIGH);
  distance = (duration / 2) / 29.1;

  if (distance < 50) {
    digitalWrite(mot, HIGH);
    digitalWrite (mot2, HIGH);
    delay(50);
    digitalWrite (mot, LOW);
    digitalWrite (mot2, LOW);
    delay (duration / 3);

    digitalWrite(led, LOW);
  }
  else {
    digitalWrite (mot, LOW);
    digitalWrite (mot2, LOW);
    digitalWrite (led, HIGH);
  }

Serial.print(distance);
Serial.println(" cm");
}
```







The shoes are right now only sensing objects upfront, both motors are vibrating to each side of the leg, right and left. Both motors increase their oscillation according to how close an object is approaching. For the echolocation shoe to work better two more ultrasonics should be incorporated, one sensor for the right side and one for the left. As a prototype it works fine but probably more debugging is needed. I am glad with the results I got, when I came up with the idea I did not actually thought I could build a prototype, as simple as it may be.

I fell in love with the idea of helping blind people through electronics. Though we may think in the future about wearable technology that can even turn humans into cyborgs, I like to think of human beings with super skills developed. I took my inspiration from nature, form bats. We are always turning into nature for an advice, and most of the times the advice given helps us to think of new ways of interacting with our world, of enhancing our senses and becoming super humans. Some other times we are just a poor imitation of nature, but just as close as we get it is also fine.

I want to continue working with this project, the next step to take would be to actually get the graphene speaker and microphone and work with both of them. I will try to develop my skills in Arduino to eventually be able to connect two more ultrasonic sensors and have a better prototype. Right now I am very happy with the idea and the development of it and I believe my approach to wearable technology though it was very simple, for me was a start and very helpful.

REFERENCE

[1] http://animals.howstuffworks.com/mammals/bat2.htm

[2] http://www.pbs.org/wgbh/nova/next/body/bioinspired-assistive-devices/

[3] http://www.graphenea.com/pages/graphene#.VsxeCZMrJE4

[4] http://grapheneus.com/category/graphene-uses/

[5] http://news.berkeley.edu/2015/07/06/bats-do-it-dolphins-do-it-now-humans-can-do-it-too/