KickSoul: A Wearable System for Feet Interactions with Digital Devices

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ABSTRACT
In this paper we present a wearable device that maps natural feet movements into inputs for digital devices. KickSoul consists of an insole with sensors embedded that tracks movements and triggers actions in devices that surround us. We present a novel approach to use our feet as input devices in mobile situations when our hands are busy. We analyze natural feet's movements and their meaning before activating an action. This paper discusses different applications for this technology as well as the implementation of our prototype.

Author Keywords
DIY; gesture recognition; wearable electronics.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation].

INTRODUCTION
We are surrounded by a large number of devices in almost every context of our life. We use computers, TVs, phones and wearable devices that offer the possibility of performing daily activities faster and more effectively than ever before. Most of these devices have visual interfaces that rely on hand gestures and touch interaction, as they are easy and natural for us. However, there are occasions when our hands are busy or it is not acceptable to make use of them, preventing us from interacting with our devices.

This same problem also occurs in other situations of our life, and we tend to use our feet as a substitute. With our feet we can perform easy actions while our hands are focused on other tasks. As an example, we use them to open and close doors or move objects that are on the floor. These actions can be divided in two main groups; actions where we move objects closer in order to use them and actions where we kick an object that we no longer need and want to move it further away. In this paper we want to connect these natural feet interactions with actions in our digital devices, for example, so that we can kick our foot to delete a file from the computer, or perform the opposite gesture (pulling our foot towards us) to save a document.

UIST '15 Adjunct, November 08-11, 2015, Charlotte, NC, USA
ACM 978-1-4503-3780-9/15/11.
http://dx.doi.org/10.1145/2815585.2815730

KickSoul is a wearable device in the form of an insole. It has sensors embedded to track the user's movements, understand the intended actions, and transmit this information to devices around us. The work contributes in (1) mapping real-world feet interactions to our devices, (2) the development of the software and hardware, and (3) implementation of a set of applications.

RELATED WORK
There is research that uses feet movements to interact with devices [4]. One closely related project is Kick [1], which captures the kick gesture of the foot with a Kinect in order to enable interaction with mobile devices. Kickables [2] is another related project that introduces tangible objects that users manipulate with their feet to interact with digital content projected on the floor. A project by Paelke [3] proves that the rear camera of a smartphone can be used to capture feet movements that can be used in phone games.

Our project differs from previous work by (1) offering a mobile and portable solution, (2) being based in natural interactions rather than creating a new language of interaction, and (3) showing a set of compelling applications.

INTERACTIONS SUPPORTED
The system supports two types of interactions: "move closer" and "move away" (Figure 3). An action is triggered when the system detects one of these gestures. The system maps the outcome of these gestures to actions that can be performed with our digital devices. Some examples that may be triggered with the "move closer" while working in a computer are zooming in or saving a document. On the other hand, when the "move away" gesture is detected, we could zoom out or delete a file.

IMPLEMENTATION
In order to develop the system, we sewed electronic components onto an insole placed inside of a shoe. To endow the insole with data collection capabilities, we embedded a 6-axis IMU (gyroscope and accelerometer) that tracks the movements of the foot. The data is collected by a

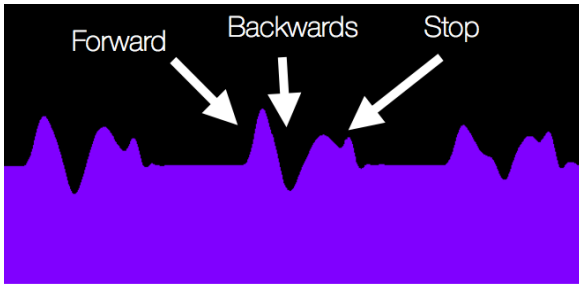

Figure 1. Data obtained from the accelerometer after applying the LPF. We can distinguish three stages while walking: walking forward, backward and stop movement.

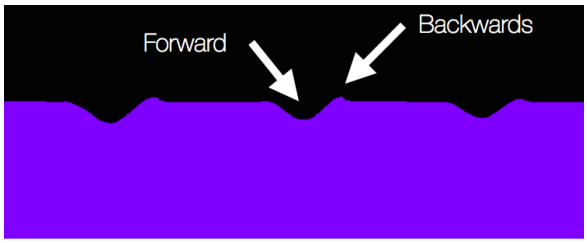

Figure 2. Data obtained from the gyroscope, where we can see the forward and backward movement.

microcontroller that analyzes and transmits the information over Bluetooth to a smartphone application. The smartphone is used as a bridge between the actions performed by the user and the nearest device that surround us.

In order to detect gestures and avoid errors in the system, we applied a low-pass filter to the raw data collected from the accelerometer (Figure 1). After that, we combine the information from the gyroscope (Figure 2) and accelerometer. Finally, an algorithm analyzes the resulting data and detects the movement performed using predefined patterns.

USAGE SCENARIOS

KickSoul enables users to interact with smart devices using our feet. As an example, sometimes we arrive home carrying bags from the supermarket, which makes difficult to turn on a light. With our system, we just need to be close enough to the light and perform the "move closer" gesture with our foot to turn on the light.

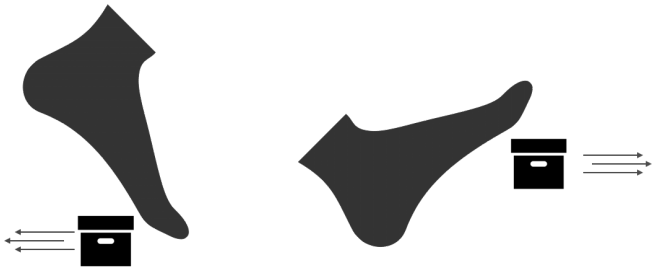

Figure 3. "Move closer" and "Move away" gesture.

Figure 4. The user is moving his foot backwards to make the screen of the phone move accordingly.

Another application is related with *phones with big screens*. As a consequence, it is becoming difficult to interact with them using just one hand. However, we can use our foot gesture to move the screen up/down and right/left, so that we are able to hold the phone and interact with it using only one hand (Figure 4).

The system can be used to reject *phone calls* when it is not possible to use our hands, or we are using them for other tasks.

Finally, we can use the feet movements as *shortcuts* while interacting with a computer. In a map application, we can zoom in and out by performing the "move closer" and "move away" gesture. If we are writing a document, we can use our foot to save or delete the file.

CONCLUSIONS

We demonstrated an easy to deploy technology and described usage scenarios to interact with digital devices when our hands are busy. Most of these interactions are short in time and not very complex. As a consequence, feet become a suitable substitute or complement to hands, as they tend to be free when our hands are not.

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