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BIO-ACOUSTIC SENSING OF SKINPUT TECHNOLOGY

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ABSTRACT: Skinput is a technology that appropriates the human body for acoustic transmission, allowing the skin to be used as an input surface. Skinput is a new skin-based interface that allows users to use their own arms and hands as touch screens by sensing different ultra low-frequency sounds that are generated when knocking various parts of skin. The feature of providing input using this projection is a boost.

The scientists explain that the changes in bone density, mass, and size along with the filtering effects from joints and soft tissues mean various skin spots are acoustically discrete. The software goes with sound frequencies to particular skin spots, permitting the system to decide the skin button pressed by the user. Following this, the prototype system makes use of a wireless technology like Bluetooth to send the commands to the device that is controlled (ex: iPod, phone or computer).

KEYWORDS: Bio-Acoustic,Buttons, Acoustic Detector, Body Interaction, Pico Projector, Armband Prototype, Bluetooth.

1. INTRODUCTION

Skin put is a technology which uses the surface of the skin as an input device. Our skin produces natural and distinct mechanical vibrations when tapped at different places. However, skin is fundamentally different from conventional, off-body touch surfaces. As skin is stretchable, it allows for additional input modalities, such as pulling, pressing and squeezing.

This increases the input space for on-skin interactions and enables more varied forms of interaction, for instance more varied gestures.

This opens up a new interaction space, which is largely unexplored. We aim to contribute to the systematic understanding of skin as an input modality and of its specific capabilities. To start with, we focus on input on the upper limb (i.e. upper arm, forearm, hand and fingers), for this is the most frequently used location.

Devices with significant computational power and capabilities can now be easily carried on our bodies.

1.2 DEFINITION OF SKINPUT TECHNOLOGY

The Microsoft Company has developed Skinput, a technology that appropriates the human body for acoustic transmission, allowing the skin to be used as an input surface. In particular, we resolve the location of finger taps on the arm and hand by analyzing mechanical vibrations that propagate through the body. We collect these signals using a novel array of sensors worn as an armband.

This approach provides an always available, naturally portable, and on-body finger input system. We assess the capabilities, accuracy and limitations of our technique through a two-part, twenty-participant user study. To further illustrate the utility of our approach, we conclude with several proof-of-concept applications we developed

1.3 WORKING WITH SIXTH SENSE DEVICE

The Sixth Sense project proposes a mobile, always available input/output capability by combining projected information with a color-marker-based vision tracking system. This approach is feasible, but suffers from serious occlusion and accuracy limitations. For example, determining whether, e.g., a finger has tapped a button, or is merely hovering above it, is extraordinarily difficult new kinds of skinput interfaces involve technology that is able to locate and sense finger taps on the skin.

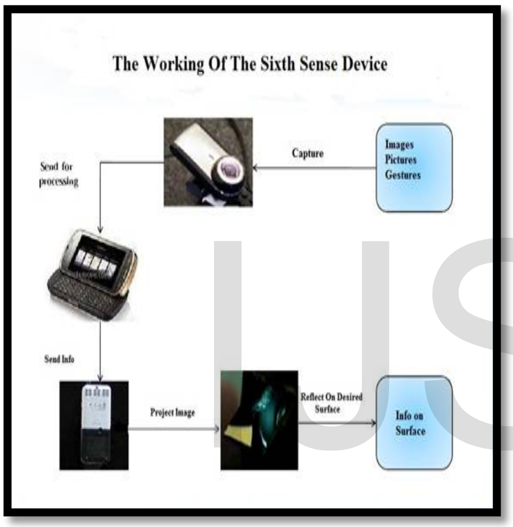

Figure 1. Working of the Sixth Sense Device

The sixth sense technology finds a lot of application in the modern world. The sixth sense devices bridge the gap by bringing the digital world into the real world and in that process allowing the users to interact with the information without the help of any machine interfaces. Prototypes of the sixth sense device have demonstrated viability, usefulness and flexibility of this new technology.

1.4 APPLICATION OF THE SKINPUT TECHNOLOGY

- **Bio-Acoustics and Sensors**: It's the armband sensing element that captures the various sort of the vibrations once users faucet their fingers at the skin surface.

- **Bluetooth:** It's used to connect the Bio-Acoustic sensing element for mobile in order so that information will be transferred to many being controlled devices like mobile, iPod or laptop.

- **Pico-Projector:** Pico-Projector is employed as Output device that show menu. It's employed in mobile and camera to show the project.

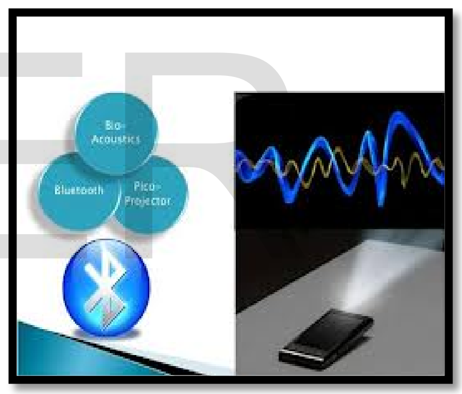

Figure 1.2 Skinput Parts

2. RELATED WORKS

2.1 ALWAYS AVAILABLE MOBILE INPUT

The primary goal of Skinput is to provide an always available mobile input system - that is, an input system that does not require a user to carry or pick up a device. A number of alternative approaches have been proposed that operate in this space. Techniques based on computer vision are popular these, however, are computationally expensive and error prone in mobile scenarios (where, e.g., non-input optical flow is prevalent). Speech input is a logical choice for always-available input, but is limited in its precision in unpredictable acoustic environments, and suffers from privacy and scalability issues in shared environments. Other approaches have taken the form of wearable computing.

2.2 PICO-PROJECTOR

Pico projectors are tiny battery powered projectors - as small as a mobile phone - or even smaller: these projectors can even be embedded inside phones or digital cameras.

Pico-projectors are small, but they can show large displays (sometimes up to 100"). The MP180 features a design that is rather unconventional when it comes to projectors and this especially due to the fact that it features an LCD display. This screen on the top of the projector can be used to navigate though the different options as well as have the ability to access the different settings

Figure 1.3 Pico-Projector

3. WORKING OF SKINPUT

3.1 WORKING WITH SKINPUT

Skinput is a technology that appropriates the human body for acoustic transmission, allowing the skin to be used as an input surface.

The location of finger taps on the arm and hand is resolved by analyzing mechanical vibrations that propagate through the body. These signals are collected using a novel array of sensors worn as an armband. This approach provides an always available, naturally portable and on-body finger input system.

To expand the range of sensing modalities for always available input systems, we introduce Skinput, a novel input technique that allows the skin to be used as a finger input surface.

3.2 BIO-ACOUSTICS

Acoustics is the interdisciplinary science that deals with the study of all mechanical waves in gases, liquids, and solids including vibration, sound, ultrasound and infrasound. A scientist who works in the field of acoustics is an acoustician while someone working in the field of acoustics technology may be called an acoustical engineer.

The application of acoustics can be seen in almost all aspects of modern society with the most obvious being the audio and noise control industries. Bioacoustics is a cross-disciplinary science that combines biology and acoustics. Usually it refers to the investigation of sound production, dispersion through elastic media, and reception in animals, including humans.

Figure 1.4 Skinput Uses Bio-Acoustic Sensor

When a finger taps the skin, several distinct forms of acoustic energy are produced. Some energy is radiated into the air as sound waves; this energy is not captured by the Skinput system. Among the acoustic energy transmitted through the arm, the most readily visible are transverse waves, created by the displacement of the skin from a finger impact. When shot with a high-speed camera, these appear as ripples, which propagate outward from the point of contact.

3.3 TRANSVERSE WAVE PROPAGATION

When shot with a high-speed camera, these appear as ripples, which propagate outward from the point of contact. The amplitude of these ripples is correlated to both the tapping force and to the volume and compliance of soft tissues under the impact area. In general, tapping on sof trig-ions of the arm creates higher amplitude transverse waves than tapping on boney areas which have negligible compliance. In addition to the energy that propagates on the surface of the arm, some energy is transmitted inward, toward the skeleton.

The Sensor Is Activated As The Wave Passes Underneath It.

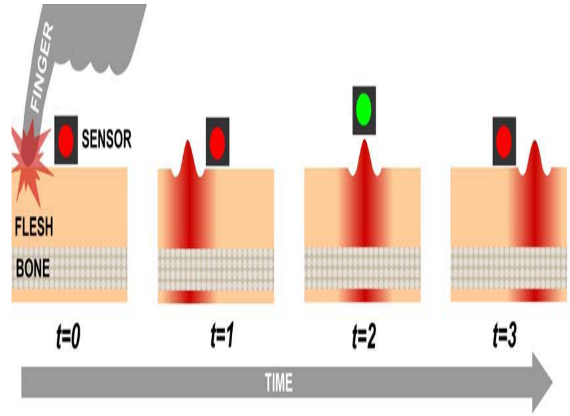

Figure 1.5 Transverse Wave Propagation

3.4 LONGITUDINAL WAVE PROPAGATION

These longitudinal (compressive) waves travel through the soft tissues of the arm, exciting the bone, which is much less deformable then the soft tissue but can respond to mechanical excitation by rotating and translating as a rigid body. This excitation vibrates soft tissues surrounding the entire length of the bone, resulting in new longitudinal waves that propagate outward to the skin.

We highlight these two separate forms of conduction – transverse waves moving directly along the arm surface, and longitudinal waves moving into and out of the bone through soft tissues – because these mechanisms carry energy at different frequencies and over different distances.

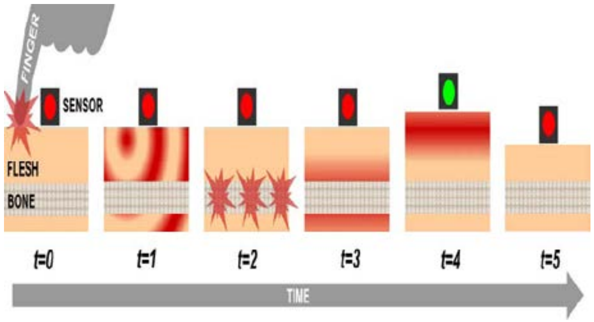

Figure 1.6 Longitudinal Wave Propagation

3.5 BIO-ACOUSTIC SENSOR

The Minisense 100 is a low-cost cantilever-type vibration sensor loaded by a mass to offer high sensitivity at low frequencies. The pins are designed for easy installation and are solder able. Horizontal and vertical mounting options are offered as well as a reduced height version.

The active sensor area is shielded for improved RFI/EMI rejection. Rugged, flexible PVDF sensing element withstands high shock overload. Sensor has excellent linearity and dynamic range, and may be used for detecting either continuous vibration or impacts.

Some features of Minisense 100 are given below:

- High Voltage Sensitivity (1 V/g)
- Over 5 V/g at Resonance
- Horizontal or Vertical Mounting
- Shielded Construction

3.6 ARMBAND PROTOTYPE

- Our final prototype features two arrays of five sensing elements, incorporated into an arm-band form factor. The decision to have two sensor packages was motivated by our focus on the arm for input.
- Based on pilot data collection, we selected a different set of resonant frequencies for each sensor package. We tuned the upper sensor package to be more sensitive to lower frequency signals, as these were more prevalent in fleshier areas.
- Inside the Skinput armband is a pair of sensor arrays, each consisting of five sensors. When the armband is wrapped around your arm, one array sits on top of your arm and the other below it, giving the sensors the widest range of useful data.

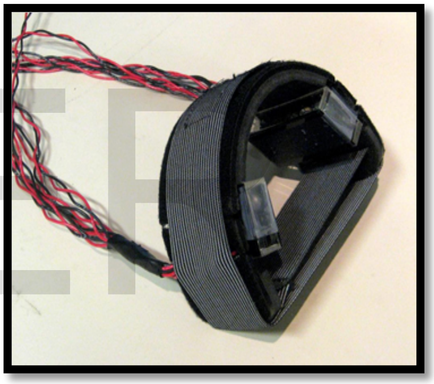

Figure 1.7 Armband Prototype

3.7 BLUETOOTH

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength radio transmissions in the ISM band from 2400–2480 MHz) from fixed and mobile devices, creating personal_area_networks (PANs) with high levels of security

Bluetooth is essentially a networking standard that works at two levels:

- It provides agreement at the **physical** level -- Bluetooth is a radio-frequency standard.
- It provides agreement at the **protocol** level, where products have to agree on when bits are sent, how many will be sent at a time, and how the parties in a conversation can be sure that the message received is the same as the message sent

4. DESIGN AND SETUP OF ARM BAND USED IN THE SKINPUT:

We employed three input locations as shown in the figure to evaluate the result of skinput.

4.1 FINGERS (FIVE LOCATIONS) SKINPUT

- Fingers with five location skinput with sensors above the joint part of hand (elbow). The armband will be placed approximately 7cm above the joint part.
- Whole arm (Five locations)skinput, with sensors lower part (below) of the elbow. The armband will be approximately 3cm aside from the elbow.
- Forearm (ten locations) skinput, with the sensors overhead of the elbow. The armband will be placed approximately 7cm above the joint part.

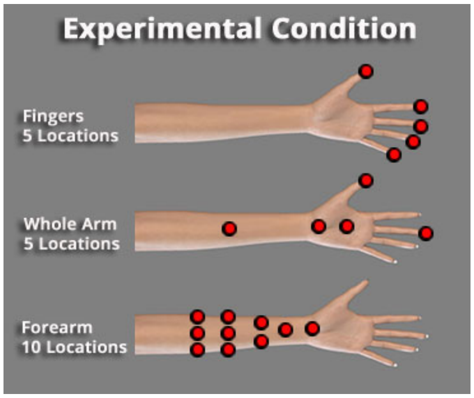

Figure 1.8 Fingers (Five Locations) Skinput

- Five Fingers Skinput Locations: The accuracy for five finger locations is high and is approximately an average rate of 87.7% is obtained.
- Whole Arm Skinput Locations: The accuracy for Whole Arm locations is relatively high and is approximately an average rate of 95.5% is obtained.

4.2 FINGER TEN LOCATION SKINPUT

The figure, it is clear that we can get a high accuracy at the six input points.

The search discloseone credible, although capricious, blueprint with very high accuracy at 6 input points. Harrison and his associate found that the tap on a fingertip, a tap on five finger point on the arm, or a tap on any one of the ten points on the forearm creates a peculiar acoustic data that machine learning programs which already programmed with experience, could learn and analyze the data. These computer programs are able to resolve the stamp of every type of finger tap by examining 186 various features of the bio acoustic input signals.

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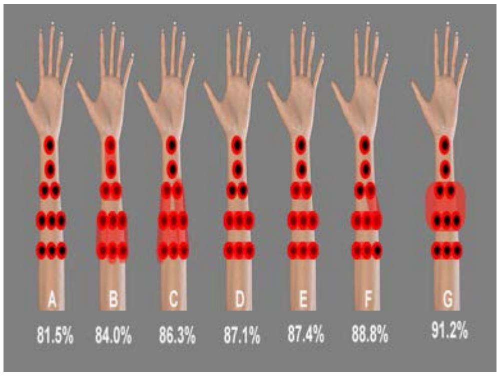

Figure 1.9 Finger Ten Location Skinput

5.IMPLEMENTATION AND EVALUATION RESULT

5.1 IMPLEMENTATION OF THE SKINPUT

Multi-touch vs. Skin-Specific Gestures In our analysis, we manually classified each user-defined gesture qualitatively using the following dimensions: input modalities, location on the body, and properties of the gesture (pressure, speed, direction, repetition, contact area). In a second step, two authors separately classified each gesture as skin-specific if it incorporated at least one input modality other than multi-touch or if the participant had explicitly mentioned a skin-specific reasoning when performing a multi-touch gesture. The remaining gestures were classified as conventional multi-touch gestures.

5.2 VARIATIONS OF STANDARD COMMANDS

The variations, participants used skin-specific gestures more frequently. The most frequently performed gesture was skin-specific for five of the ten referents.

An overview of important skin-specific gestures, which we identified for standard commands and for their variations. Some of them were the most frequent gesture performed for the respective command; some were skin-specific alternatives to the most frequent multi-touch gesture.

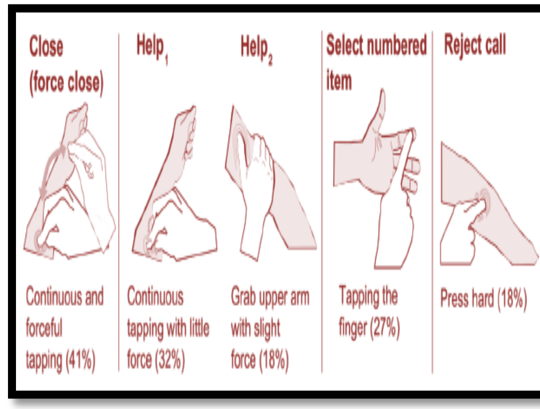

Figure 1.10 Variations Of Skin-Specific Gestures

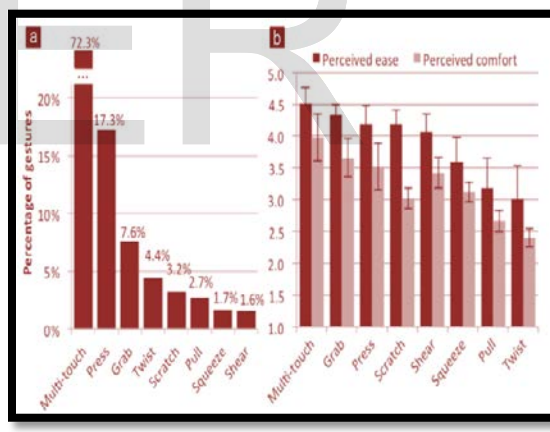

Figure 1.11 Input Modalities

The Participants used a skin-specific gesture for the majority of emotional expressions. In the semi-structured interviews, all participants stated that they could express emotions better on their skin than on a touch screen. One main reason was that this allows them to draw inspiration from typical ways of expressing emotions when touching other people. Only happiness and boredom turned out to be easier to

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express with multi-touch gestures. Here, people took inspiration from facial expressions (smiley) and bored tapping on a surface.

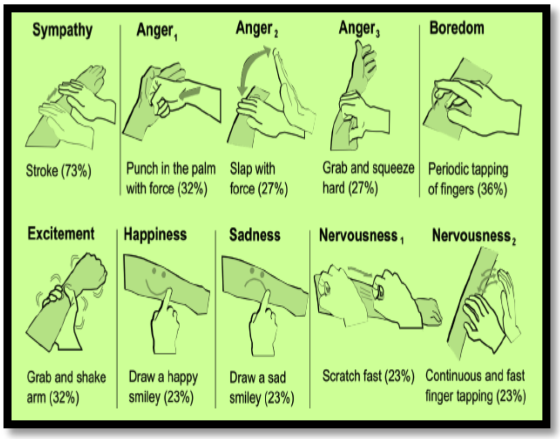

Figure 1.12 Most Frequent Skin-Specific Gestures for Emotional Expressions

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Half of all gestures were performed on the forearm. Also back of the hand and the palm were frequently used location, while the upper arm and elbow were rarely used. the mean values for perceived ease and comfort of use for each location, aggregated for all input modalities.

Input	Preferred Locations	Order	Concept
Handwriting	Palm (59%)	Frequency	Close to the hand (86% of participants)
Keyboard	Forearm (82%)	Importance	Close to the hand (64% of participants)
Numpad	Palm (45%)	Liking	Close to the hand (68% of participants)
Sketching	Palm (41%) Forearm (41%)	Privacy	Private on inner side; public on outer (all)
Touchpad	Palm (45%) Back of the hand (36%)		

Figure 1.13 Non-Gestural Input And Orders Of Task 3 And Their Most Preferred Locations.

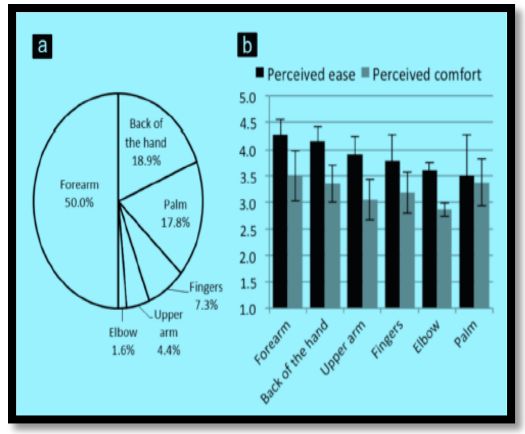

Figure 1.14 (A) Locations Of User-Defined Gestures, (B) Means And 95% Confidence Intervals Of Perceived Ease And Comfort.

5.3 ON-SKIN SENSORS

Prior work has contributed non-invasive optical techniques for sensing multi-touch gestures on skin. In contrast, we are not aware of any existing sensor that would allow for capturing the skin-specific gesture set that was identified above. This accounts for 87.5% of all skinspecific gestures performed in the study and for 19 out of the 23 gestures of the consolidated set. Three gestures comprise shearing, queuing and twisting.

5.4 COMPLEMENTARY DEVICES FOR OUTPUT

In our study setup, we have deliberately opted against providing any system output, to avoid biasing participants by a specific form or a specific location of output. In the following, we discuss implications from our findings for several promising classes of devices that can complement on-skin input by providing output to the user.

5.5 OFF-SKIN OUTPUT

All gestures we have identified can be performed in an eyes-free manner, due to proprioception and tactile feedback. Hence, our results inform most directly those application cases, in which skin is used for input only, while a complementary device provides visual, auditory or haptic off-skin output. This comprises controlling a distant mobile device, which is carried on the body or in a pocket and provides auditory or haptic output (e.g. smart phone, Music player, imaginary interface). This also comprises controlling a head-mounted display or an external display that provide visual output (e.g. public display or TV).

5.6 HANDHELD MOBILE DEVICES

For handheld devices with a touch display, such as mobile phones or tablets, the lower arm, hand and fingers can provide complementary input space. This can be used for more expressive or more personal ways of input than possible on the touch display.

6. LIMITATIONS

It was conducted indoors during summertime. Most participants were short-sleeved or could easily uncover the skin of their upper limb. No participant mentioned clothing as an issue during the study. Clothes might lower the accessibility of some locations or make them inaccessible, e.g. in cold weather conditions.

7. CONCLUSION

I have presented our approach to appropriating the human body as an input surface. We have described a novel, wearable bio-acoustic sensing array that we built into an armband in order to detect and localize finger taps on the forearm and hand. Results from our experiments have shown that our system performs very well for a series of gestures, even when the body is in motion.

Additionally, we have presented initial results demonstrating other potential uses of our approach, which we hope to further explore in future work. These include single-handed gestures, taps with different parts of the finger, and differentiating between materials and objects. We conclude with descriptions of several prototype applications that demonstrate the rich design space we believe Skinput enables.

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