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SKINPUT : HUMAN ARM AS TOUCH SCREEN

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Abstract —Skinput is a new technology which simply means skin + input. It is an input sensing technology that is created to use skin's surface as an input device .our skin is capable of producing natural and unique vibrations when tapped at different places. Bio-Acoustics sensing forms the base for the Skinput technology to pinpoint different finger-taps on the skin. When it is augmented with a Pico-projector, the device is capable of providing direct manipulation, graphical user interface on the body. It's an innovative skin based technology which allows person's to use their own hands, arms as touch screens by sensing natural mechanical vibrations that propagates in different parts of skin. For sensing body, armband is used. For the Skinput technology, it is not necessary for the skin to be invasively instrumented with sensors, tracking markers or any other things.

Keywords-Skin put, Bio-acoustics, Armband, Pico Projector, Hi-Tech, Bluetooth, Touch Screen, Human Arm

I. INTRODUCTION

We are living in the world of 21st century, in which the technologies are getting advanced day by day and the size of the mobile devices are getting very smaller and popularity of mobile devices is increasing because of portability, mobility and flexibility. Now-a-days devices which indulge significant computational power, capabilities and efficiencies can be easily carried with us on our body. But devices with smaller size have their own drawbacks like limited space for interaction which in turn can reduce the usability and functionalities. Because of the small size, small mobile devices have the drawbacks like buttons and screens cannot be created of the larger size.

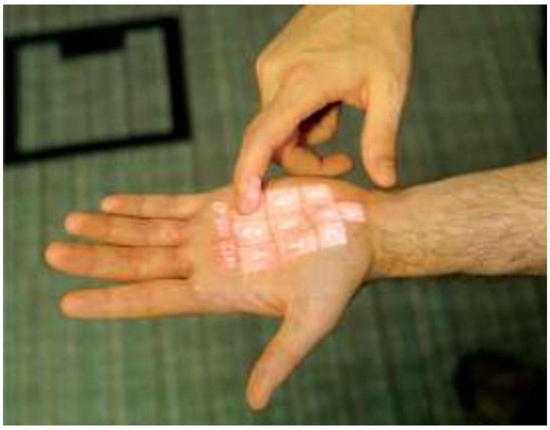

Figure 1. Skinput Technology

So instead of losing the primary benefit of small size, a novel technology is invented which solves size problem. Skinput is a technology created to use our skin which is the largest part of our body, as an input surface or canvas. Human body produces distinct mechanical vibrations when human tap on different body parts. With this distinct and unique property of the body, Skinput uses distinct locations as distinct functions of small devices like mobile phones or music players. When the individual tap on its skin, some mechanical energy transmits through their body out of which some energy is lost in air as sound waves and the rest is captured by sensor array. Armband is interfaced with micro controller and the sensor array is mounted on armband. The tapped location is found by micro controller and it processes the data. Bluetooth module is used to interface the micro controller with the mobile phone. So according to the location which is tapped, the desired task is performed. This technology provides an always natural, large, available, and portable and on-skin finger input system.

II. RELATED WORK

Mobile Input –Always Available

The main objective of the Skinput technology is to provide a means for always available mobile input system – that is an input system that doesn't requires persons to carry or pick up a device. Numerous Techniques have been proposed as a solution to this problem. Technologies which use computer vision as their base are very famous which in turn are very expensive and capable of making an error in mobile scenarios or depends on awkward instrumentation of the hands for the enhanced performance.

For always available mobile input, speech input is a logical choice, but it is limited in its precision in undetermined acoustic environment, suffers from privacy and scalability issues in shared environment and may interfere with cognitive jobs more than manual interface.

Other techniques have taken the form of wearable computing which involves a physical input device built in a form considered to be part of individual's clothing but it can be uncomfortable and clumsy to haptic sensation.

Bio-Sesnsing

Skinput technology uses maximum the natural acoustic conduction characteristics of the person's body to provide an input system and so it is related to earlier work carried out in the use of the biological signals for computer input.

Acoustic Input

Skinput technology is inspired by a system that uses acoustic transmission through input surface. Acoustics is a branch of physics that deals with the characteristics of sound. An novel input technology that allows the skin to be used as a finger input surface. A wearable armband which is non invasive and which can be easily removed was developed by the researchers to capture acoustics information.

Skinput

Skinput is a new technology that permits the skin to be used as a finger input surface, like a touch screen. In this technology the focus is mainly on our arms, although the technology can be applied elsewhere. Arms can work as attractive area as it provides large surface area for interaction, including a contiguous and flat area for projection. More precise the hands and the forearms contain a complex tacked together of bones that raises acoustics uniqueness of different locations. A wearable armband which is non invasive and which can be easily removed was developed by the researchers to capture acoustics information.

Bio-acoustics

When a skin is tapped by fingers, various unique forms of acoustic energy are generated. Some energy is radiated into the air as sound waves and not being captured by the Skinput technology. Among the acoustics energy propagated through the arm, the most ready and visible are transverse waves, created by displacement of skin from a finger impact.

Pico-Projector
Pico-Projector is dedicated as Output device that shows menu. To display the project Pico-projector is employed in camera and mobile. Pico projectors are tiny battery powered projectors, small as a mobile phone .Pico- projectors can even be embedded inside mobile phones or digital cameras .Pico-projectors are small, but they can show large displays (sometimes up to 100").

Figure 2. Pico-Projector

III. WORKING

(1) Skinput technology is an input bio-acoustic sensing technology that permits our body to be uses as a finger input surface which doesn't needs any electronics to be placed on the skin.
(2) Acoustic information is used by Skinput technology, to capture information a wearable arm band is used which is non-invasive and easily removable.
(3) To segment, analyze, distinguish and classify bioacoustics signals, Skinput sensors and processing techniques are used and studied in this section.
(4) Working of Skinput technology is based on acoustics signals through density of tissues.
(5) When the finger taps the arm skin translates through the sensors into an instruction on a menu.
(6) The graphical user interface is displayed on individual's hand or arm, wherever display is set up to be located, and from this point you can use it like a mobile phone. Arm is suitable and better because the graphical display on arm is about 200 times bigger.
(7) You can use Skinput to operate and control your mobile phone, iPod, etc, with just a single tap on the arm which acts as canvas and it looks very impressive.
(8) When the individual's skin is tapped by finger, various distinct forms of acoustics energy is created and out of which some energy is radiated into the air as the sound waves and not captured by this technology.
(9) Among the acoustic energy that is passed through the individual's arm, the most ready and visible are transverse waves that are ripples, produced by the displacement of the skin from the finger impact as shown in below figure.

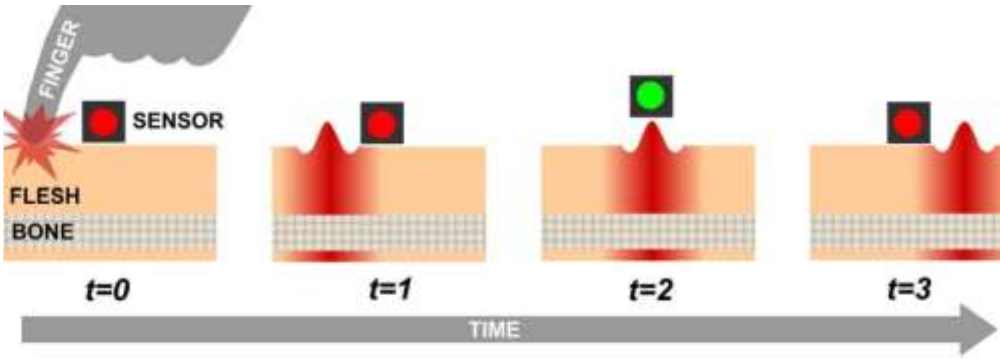

Figure 3. Transverse wave propagation

(10) When shot with a high-speed camera, transverse waves appear as ripples, which pass outward from the point of contact.
(11) The amplitude of these ripples is correlated to two things that is the tapping force and to the volume and compliance of soft tissues under the impact area.
(12) In general tapping on soft regions of the arm creates higher amplitude transverse waves than tapping on boney areas (e.g., wrist, palm, fingers), which have negligible compliance.
(13) In addition to the energy that propagates on the surface of the arm, some energy is transmitted inward, toward the skeleton as shown Figure 5.
(14) 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.

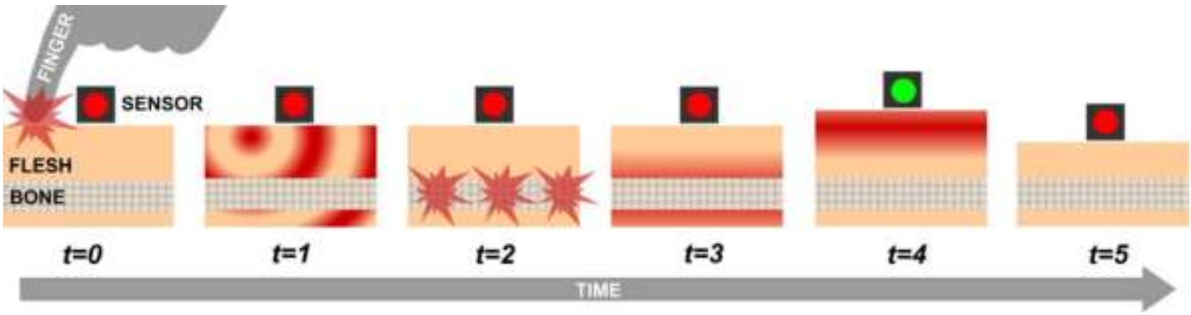

Figure 3. Longitudinal wave propagation

IV. ARMBAND PROTOTYPE

There are two different forms of waves, former known as transverse waves which moves directly on the surface of the arms and later longitudinal waves which moves in and out of the bones through soft tissues and these mechanisms can carry energies at different frequencies and over different distances. The belief says that important role is played by joints in making tapped locations acoustically unique. Ligaments hold the bones together, and joints often indulges extra biological structures such as fluid cavities which makes joints to behave as acoustic filters.

The design of novel technique, wearable sensor for bio-acoustic signal acquisition as shown in following figure depicts an analysis approach that enables our system to resolve the location of finger taps on the body.

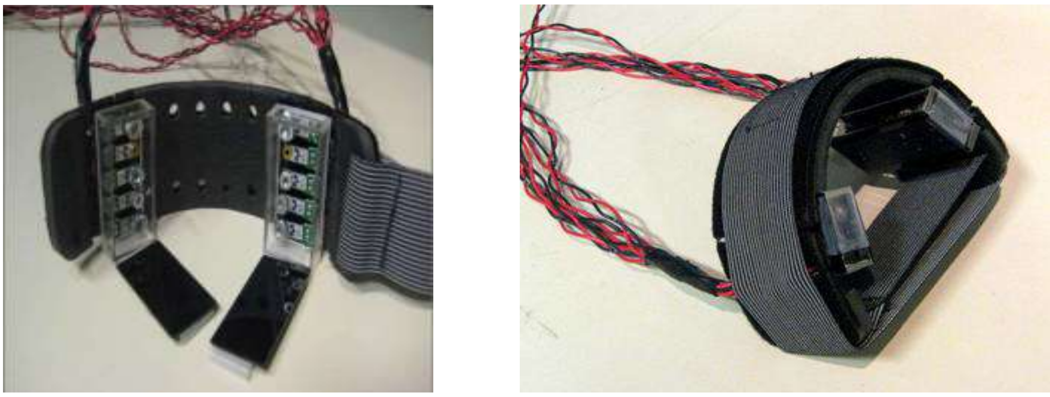

Figure 5. A wearable, bio-acoustic sensing array built into an armband and prototype armband.

Final prototype, as shown in above figure consists of two arrays of five sensing elements; indulge into an armband form factor. The upper sensor package was turned to be more sensitive to lower frequency signals, as these were more prevalent in fleshier areas. Conversely, lower sensor array was tuned to be sensitive to higher frequency signals, in order to capture signals transmitted through then denser bones.

In this prototype system, a Mackie Onyx 1200F audio interface was employed to digitally capture data from the ten sensors. This was connected via Fire wire to a conventional desktop computer, where a thin client written in C interfaced with the device using the Audio Stream Input/ Output (ASIO) protocol.

Skinput technology combines three modules which are microcontroller, bioacoustics sensors and Bluetooth. Acoustic Sensors are used to catch the vibrations produced after tapping; Microcontroller is used to processes the data and Bluetooth module to transmit the data to phone and an Android phone. As per need, consider person is wearing armband and wish to use music player of mobile and there are four different input positions on his graphical interface that is hand for playing, pausing, forward and reverse operations, then he just need to tap on his skin.

When finger tapping is done, some acoustics energy is produced. These acoustics waves are distinct in amplitude and frequency in different locations. Frequency of vibrations produced due to tapping are in range of 25Hz to 78Hz i.e. lower frequency range. Those ripples are captured by bioacoustics sensors which are mounted on armband.

This armband is connected to the micro-controller which has the Bluetooth module interface with it. With the help of Bluetooth module the controller is connected with mobile devices (android phone). So if individual taps on first location, play operation of music player gets activated in mobile. Similarly for second, third and fourth locations pause, forward and reverse operation will be executed.

Figure 6. Block Diagram

First block is acoustic sensor array, mounted on armband. Individual has to wear this armband for capturing the acoustics signal produces after tapping on hand. Here Minisense 100 vibration sensor array can be used which is sensitive to low frequency range and produces analog output after vibrations are created. Then analog output should be converted into digital and it should be deposited in microcontroller.

Support Vector Machine distinguishes the data and put into specific category which gives knowledge about, on which location the finger tapping is done. Bluetooth act as a medium between micro-controller and cell phone. So just tapping on hand, individual can control any mobile application and in our case music application is there.
If we tap on 1st location of arm, the play operation is performed in mobile. Similarly for 2nd, 3rd and 4th locations we have given pause, forward and reverse operations respectively. For interfacing cell phone with the microcontroller, an android application in the cell phone is necessary.

V. MORE THAN TOUCH

Individual's skin is somewhat distinct from off body touch surfaces, creating up a new and more unexplored interaction space or canvas. The properties of various skin-specific input modalities can be analyzed and conclude on what kinds of gestures are performed on skin, and also analyze what are input locations that can be preferred. As human skin is stretchable, it permits for extra input modalities, such as pulling, pressing and squeezing. This maximizes the input space for on-skin interactions and allows more different forms of interaction, for instance numerous different gestures.

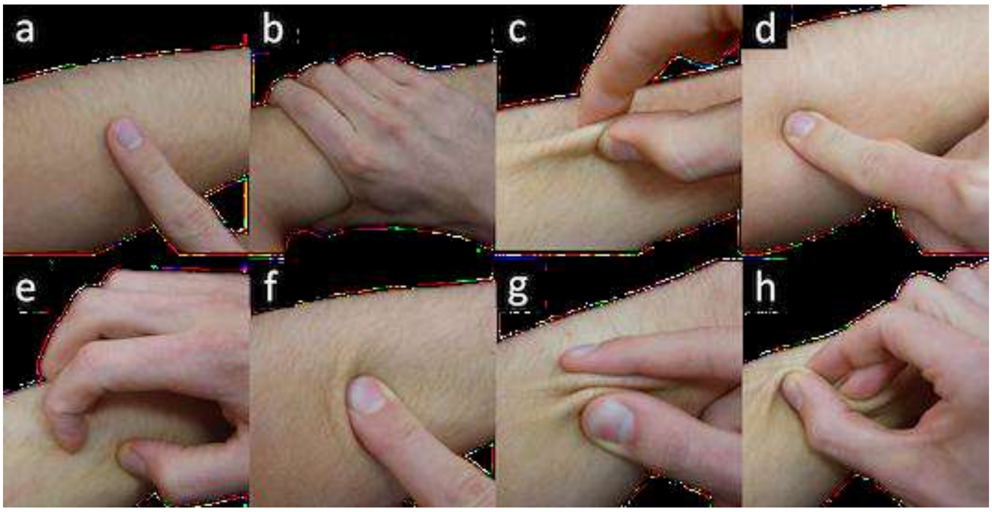

Figure 6: Input modalities: (a) touch, (b) grab, (c) pull, (d) press, (e) scratch, (f) shear, (g) squeeze and (h) twist.

The flexible nature of skin not only allows touching, but also permits for various input modalities such as pulling, shearing, squeezing, and twisting. Human skin is capable of sensing various levels of contact force, which enables pressing. Lastly, the physiological properties of the touching finger or hand further add to the expressiveness, touch can be performed with the fingernails, resulting in scratching, or the full hand can enclose another body part resulting in grabbing. The resulting set of eight modalities as shown in Figure 6. These modalities are ranging from on-surface interaction to intense skin deformations. More complex gestures, e.g. rubbing or shaking, can be performed by using these basic input modalities. Note that these modalities are defined from a user perspective and not from a technology-centered one.

VI. Applications

(1) We can play music, while walking and jogging.
(2) Playing games, Mobile, Browser system
(3) By simply tapping her or his own arm, user can send text messages.
(4) The Skinput system could display an image of a digital keyboard on a person's forearm.

VII. ADVANTAGES

(1) Not to bother about keypad.
(2) Gadget interaction is not required.
(3) For usage, visual contact is not required.
(4) Larger buttons can be created so that wrong buttons are not pressed.
(5) To play interactive games, this technology can be used.
(6) User's own arm can acts as an Instrument.
(7) This technology gives response to various hand gestures.
(8) Easy to access in absence of Mobile.
(9) In absence of mobile, it is easily accessible.
(10) Skin surface can appear much larger than it could be on device's screen.

VIII. DISADVANTAGES

(1) Armband looks easier to put on. Many persons don't like to wear this armband around their arm for the entire day just to use this technology.
(2) If it will be accessed easily, people will be more socially distracted.
(3) If the user has a tattoo located on the skin, the visibility of the projection of the buttons on the canvas can reduce.
(4) If the Body Mass Index of the user is more than 30%, accuracy of technology is reduced to 80%.
(5) Skinput works on the direct skin exposure, so you won't be able to wear full sleeves clothes when you want to use this technology.
(6) Users with visible disabilities are not able to use this technology.
(7) This technology might start up at high cost which cannot be afforded by common person.

IX. CONCLUSION

Analysis shows that the Skinput technique performs very nice and better for a series of gestures, even when the body is in motion. This technology performs while individual is walking or jogging. In future multi-sensor armband can be created wireless and includes more devices with the system. In future accuracy levels can be increased. Armband's size and its electrical complexity can be reduced.

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