DIGITAL SYNESTHESIA: USING MOBILE TECHNOLOGY TO INTERACT WITH OUR WORLD

BY

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EXECUTIVE SUMMARY

The current state of mobile interfaces is nearing a bottle-neck from two distinct points of view. On one side, the bulk of the human-device interface is resting on touch and sight with some audio and haptic cues (these cues only in the form of vibration). In addition, the industry's obsession with ever smaller devices is reaching its peak where screen size will not be big enough for comfortable multi-touch interaction. So we see a resurgence of bigger screens and bigger devices. On the other side, we have not seen a breakthrough in mobile experience for some time, with most advances in technology being slightly incremental. I believe this is not only due to the physical constraints but also because our current expected experience when using our mobile devices is not ambitious enough to demand a breakthrough in the interaction paradigm.

This thesis intends to address both the interface and the experience sides of this trend. First by understanding that what I want to be able to do with my mobile technology is to be in closer contact with the world around me instead of isolating myself in my closed virtual world. For this I will create a radically new experience based on the augmentation of our natural sensory system, either by supporting one of our existing senses and looking for ways to make it more powerful or by creating a whole new sense using electronic sensors to detect information that our bodies are not capable of sensing naturally. This will create a new paradigm of usability that we currently don't have by allowing us to interact with the world *through* our devices in new ways.

The other side of the problem addressed by this thesis will be finding a way for the mobile device to communicate this new information to our bodies in ways that don't necessarily use sight or touch. New ways of interacting with our devices can be by using our tactile sense in a much broader way, generating vibrations signals in different parts of our bodies, generating hot and cold areas in our skin, creating sound through bone-conduction or pulsing tiny amounts of electricity directly to our body.

Some work has been done in this area but never compiled under a general user experience philosophy. Some projects have looked at sensors and computation to map color to sound for color-blind people or to generate electrical signals from visual data that a blind user can detect through the tongue. But these projects have not looked at the possibility of opening up these ideas to the general public in such a way that it may enhance day to day living in more generic contexts. What I plan to do is demonstrate how valuable it will be to open up our interaction paradigm to the world and to our bodies in such a way that those same principles can be applied to many different and more specific contexts and usage scenarios.

The evaluation of this work will be done by conducting a series of activities where users will wear devices that will generate additional sensory feedback loops. These activities will be analyzed by comparing results with and without the devices and by testing users that may be familiar and un-familiar with the general task. A qualitative result will be obtained from discussion with the subjects about the wearable technology in general and a quantitative result will be obtained from the data collected during the tasks.

With this dissertation I look to understand and help map a new direction for the future of Human-Mobile Device interaction.

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ABSTRACT

The computation power that our mobile devices have gained in later years has surpassed that of the powerful computers of a few years ago . As this capacity keeps growing, the demand for better and more fulfilling mobile experiences has remained stagnant. A major reason for this is that the interaction capabilities of our devices are limited to the physical constraints of the device itself. This thesis looks to identify new and radically different mobile experiences while at the same time develop an interaction paradigm that will support the new experiences and be independent of the physical constraints of the device.

The new experience will be based on the concept of digital synesthesia or a way of using our current technologies to directly affect our sensorial systems in such a way that the brain will interpret the new input as a new sensory capability. One of the key questions of this research is precisely how capable is our brain in mapping new inputs that could be turned on and off and how will it assimilate these inputs when used for long periods of time. This thesis will also shed light on what kind of activities will find this kind of interaction valuable, by creating scenarios where users will be able to use their mobile devices as an additional sense.

Research Questions

The main questions to be addressed revolve around the ability of the brain to interpret new information represented through existing sensory stimulus and the depth of assimilation that a user will demonstrate while trying these new technologies.

The Brain and the New Stimuli Short Term

1. Can a user understand the changing data when felt through and unrelated sensory input?

2. How accurate is the interpretation of the data when experienced in this new way?

3. What differences in accuracy and efficiency are there between interpreting data through reading values on a screen and feeling the data with this new approach?

The Brain and the New Stimuli Long Term

1. Will the brain learn to ignore the new input or will the input eventually feel as natural as any of the original senses?

2. Will there be feelings of "phantom input" where the user will feel the effects of a stimuli that is not present.

Escaping the visual user interface

We know there are other senses but our understanding of visual user interfaces makes us think of the interface with these new senses in visual terms. The input signal is translated to numeric data and transmitted to the eyes.

1. Can we find the new usage paradigms for senses other than sight?

Since we don't "write" to the other senses in our current interfaces, we don't know how to "read" data that is perceived by say the skin.

2. Can this research start to uncover the particular ways in which information should be transmitted differently to the skin (or other senses) than to the eyes?

Biological and Metaphorical Approaches

I identify two major ways of approaching this research. Because I'm trying to communicate data to the body through unconventional sensory pathways, it makes sense to use those parts of the

body that would possess greater physiological characteristics to receiving specific types of input. I call this the Biological approach since it looks primarily at the body and its capabilities.

Another way of approaching my research is to identify cultural constructs that refer to the body and sensory perception. Feeling “Butterflies in the stomach” or “Chills down the spine” are concepts that are rooted already in a person’s subconscious that might prove valuable when trying out the ideas of this thesis. I call this the Metaphorical approach.

1. Is the Metaphorical approach strong enough to create a successful experience?

User Adoption

1. How comfortable are the users when using these kinds of devices?

2. How valuable is the device when used towards the completion of a task for both experienced and novice users?

Design Thinking

1. Can a pattern be observed such that we can use the findings of this thesis to create a guideline of sensory mapping?

This guideline would allow future research to understand what feedback modalities are better suited to the synesthetic translation of which new sense. So that temperature might be better for binary or yes/no/neutral situations while vibration might be better at sensations that imply different degrees of intensity.

2. Could this research pave the way for a new “Mixed-Sensory Interface” field in the user interface world?

BACKGROUND

In broad terms, humans have been using technology to enhance their physical capabilities and senses for a long time. A simple thermometer is a sensor that translates temperature information to visual output with a much greater degree of accuracy than the sense of touch could afford. A compass takes the imperceptible magnetic fields of our planet and represents them in a visual form. I'll enumerate some of the projects that I think are most significant for the path that I see on this PhD thesis.

SENSORY SUBSTITUTION

Either because a person may be lacking one of the five senses or because a different sensory input may offer other benefits like greater detail, sensory substitution has been seen in several fields. Most sensors are a translation so in a sense a substitution, temperature, wind speed, distance or the passing of time. These are all things our bodies can perceive but by using a sensor and translating the information to a coded visual form we add the ability of greater accuracy and universal understanding.

BRAINPORT[1]

Brainport is a system that captures images through a camera and translates it into electrical signals that are felt on the tongue.

EYEBORG[2]

The artist Neil Harbisson, who is completely colorblind, uses a device that captures color information through a camera on his forehead and translates it to sound he hears through bone conduction.

NEW SENSES

Another big area in this field is creating completely new senses. Mostly out of curiosity, adding a new sense to our repertoire changes the way we understand and interact with the world. If the Umwelt[3] theory shows how every creature can only understand the world through the affordances of its senses, then creating new senses should open up completely new world perspectives for humans.

THE FEELSPACE BELT [4]

The FeelSpace belt was a device with vibrators that could be worn around the waist. The vibrator closest to geographical north would constantly vibrate, giving the user a sense of direction.

MAGNET IMPLANT[5]

Dan Berg implanted a small magnet into his pinkie finger of his right hand. One of the reported effects was the ability to sense electrical flow by disruptions on the magnetic field.

Situational Awareness

Situational Awareness is the ability to extract information from our environment and integrate it with previous knowledge in order to form a coherent mental picture[6]. The military has done extensive research on Situational Awareness both learning what the limits of the brain are when forced to work in an environment with many attention cues as well as the different strategies for reducing the cognitive load while conveying information to the brain through channels other than sight or sound.

Other than many studies in how to measure Situational Awareness in various users and situations, there are some papers on actual devices being tested that use Vibrotactile Displays[7] and Tactile Navigation Cueing[8].

RESEARCH PLAN

Initially I have been freely exploring a variety of sensors and their ability to communicate with an Android device. As I learn, I have looked for user scenarios in which these sensors can be used to give the user some information that either could not be perceived or that the accuracy of our existing sense would be unable to give that level of detail. Once familiar with different sensors and technologies, a series of activities will be defined in which a user will complete a task while aided by the system.

Some of the activities may include Navigation Aids, games or sports, decision situations like driving of piloting, general user interface with household devices and remote perception of a context. Two or Three of these situations will be chosen depending on which group will help illustrate the widest breath of possibilities of the system and technology as well as a diverse sample of situations relevant to the users.

When a suitable system is developed for user testing, a first trial will be conducted with users of different backgrounds and tested in a one-time use of the technology in a specific activity. A second trial will be based on repeated use of the system to establish the effects of a continued use.

Proposed Activities

During the summer I have developed a system that will use hot and cold signals in the back of your neck in response to your location and the location of others around the Media Lab. I also developed a system that will use vibrations in your forehead to represent changes in temperature. This was made with glass blowing in mind since I need to keep a constant understanding of the different temperatures of my piece as I'm working on it, this system would allow me to do this without stopping what I'm doing with my hands.

Our mobile devices are already creating around us a system of sensory substitution. After all, a cellular signal that can't be felt by the body is transformed into either sound or vibration for us to know we have a call. But this is just the beginning and mobile synesthesia has limited itself to activities that, as discussed previously, are not allowing for a vast evolution of our experience.

The Criteria for the activities that I'm proposing is simple.

- Even if the mobile device is at the center of this activity, the activity must take place without direct manipulation of the device.

- The activity must reduce cognitive load, either by offsetting a sensory loop to another sense or by allowing for artificial monitoring of a variable and only report when significant changes occur.

- At least one of the activities must create the opportunity of detecting a variable that is currently not sensed by the body.

The initial list of activities I propose is:

Indoor Navigation

The system was made and tried for one person to be able to sense a temperature signal depending on their location around the Media Lab. I plan to extend this idea to more than one user and design activities in which participants need to find clues around the lab or find each other. A gaming scenario could be designed where the proximity to team members or opposing team member will render a different signal.

Poker Game

Using an infrared thermometer to detect the changes in temperature of a person's face can be used to detect changes in their stress level. An interesting test would be to create a feedback loop where the temperature of the other players will be translated into a frequency signal on the participant's body. This way I can determine if a new empathic awareness can be created and used, in this case, to the player's advantage.

ULTRASONIC TOUCH

I picture the ability of wearing an ultrasonic transmitter and receiver on each hand and being able to sense the time of flight of the signal between the fingers. This can be useful, for example, to detect changes in density of an object held between the user's hands, which can help make informed decisions about the state of the object. Bone density is measured this way and I'm thinking ripeness of fruits and the fill level of a container that can't be seen, like a propane gas tank.

TIMELINE

PHASE ONE (NOVEMBER - DECEMBER)

This stage is dealing with the final contexts that will be developed to prove my thesis as well as getting the proposal approved and submitted to MASCOM. By mid December I'm hoping to present my proposal.

PHASE TWO (DECEMBER 2013 – FEBRUARY 2014)

This is the development stage. Fabrication and initial testing will be made of each of the systems for the contexts chosen. Extra attention will be put on the mobility of the system and its future deployment outside the lab.

PHASE THREE (MARCH 2014)

User Testing will be done with the systems in a controlled environment.

PHASE FOUR (APRIL - JUNE 2014)

Thesis writing and defense

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BIO

SANTIAGO ELOY ALFARO

Santiago received a B. in Industrial Design from Universidad Jorge Tadeo Lozano y Bogotá, Colombia (2003), a Master in Industrial Design from the Rhode Island School of Design (2007) and a S.M. in Media Technology from MIT in 2010. During his time before MIT Santiago worked in areas as varied as Media Broadcasting, Architecture and Education. During his master at the Media Lab, he started to look into the interfaces between users and objects with an emphasis on mobile devices and video storytelling. He has also taught courses on fabrication and design.