You Do Not Miss Advice from Mentor during Presentation: Recognizing Vibrating Rhythms

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Abstract— **The haptic technology takes into consideration the human sense of touch and gives a new dimension to the way people communicate. In this work, we examined how a mentor could advise speakers to control their voice pitch and volume like speak slowly, speak fast, speak loudly and speak softly using haptic feedback during their speech. We made four vibrating rhythms and conducted a user study on different people in order to know whether they can feel the difference among four vibrating patterns or not. We used mobile's phone vibrating motor, for this purpose, which was meant to give a haptic feedback to participants. Our results show that participants were able to judge the vibrating rhythms with high accuracy.**

Keywords- Actuator, Wearable computing, Haptic feedback.

I. INTRODUCTION

Giving a speech or presentation to the audience is not easy, especially if you do not have lot of experience. People sometimes lose control of their voice and pitch; they speak fast, loudly, slowly and softly. The issue is that they do not realize it while giving a speech. It is not possible for a mentor/friend to interrupt the speaker during a presentation and advise him to control voice and pitch. Therefore, we need a system that gives the mentor the possibility to seamlessly advise the speaker during his speech.

We want to figure out how to convey advise to a speaker since he is giving a speech to the audience and it is not a good idea to interrupt him in front of all or show some body gestures which would be seen by others as well. However, rehearsals always help to make a better presentation but they do not solve this problem. Bottom line is that we need a system which can help a speaker during his speech so that he can control his voice and pitch.

Studies conducted before revealed that by using haptic vibration patterns (the so called tactons) is an an approach which can be used for communication [11]. It is not necessary to limit ourselves to understanding and perceiving single vibration patterns from or devices when there is a big possibility of understanding much more complex messages. Tactons are defined as structured tactile messages. For a wide range of distinction between them, several encoding dimensions have been studied. The research made in this area revealed that with the right combination and number of patterns, the recognition rates are not that different [11].

The way in which the information is encoded and how we distinguish the meaning of the message can prove challenging sometimes especially when we have large number of possible tactoons [12]. The limitations are given by the incapacity of distinguishing between the patterns, if they are not clear. As for parameters, it is common to use frequency, amplitude, roughness and rhythm.

Another important aspect is the spatial localization of the vibrating device. The human skin does not have the same sensibility on its entire surface to perceive information. This is due to the innervations density that varies across the average area of two square meters of skin. In order to avoid confusion of some parameters, it is necessary to consider that the skin is not able to distinguish between frequency and intensity [6]. Also, studies have shown that several areas of the body are more perceptive than others. In order to get a good perception of the pattern, the source of the vibration has to be situated close to the elbow or the spine [13]. For less sensitive parts of the body, not much research has been conducted.

In order to successfully transmit information using vibration patterns, all these aspects are needed to be taken into consideration. In this research, we want to:

- Achieve a good overall recognition rate (more than 80% of correct patterns recognition).
- Have user acceptance of the device and the idea behind.
- Figure out parameters that affect general recognition rate score
- Discover if the neck area can be an alternative for the spatial localization.

We decided on the following points regarding the number of patterns and the spatial localization. We designed four patterns using different lengths and time pauses between the vibrations (i.e., rhythm for the messages including more than one vibration). A rhythm was realized with this combination. Four messages meaning speak louder, speak quieter, speak slower, speak faster were encoded using this way. In case of an extended vocabulary, it is recommended to add at least one more variable parameter (intensity for instance). In one of the studies [7], the results showed that a combination of rhythm and intensity offers a higher recognition rate than using rhythm and roughness.

As for the location, the side part of the neck was used, since there are no studies that reveal if the neck is perceptive or not. A reduced number of patterns were designed (based

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on rhythm). The main goal behind the study is to see how perceptive this area is, how the users accept the device and if people are able to act according to the information received, when engaged in a speaking activity.

We developed a system, using a connected actuator to mobile phone via Bluetooth/Wi-Fi, which was controlled by a mentor for advising speakers if they wanted to change their voice and pitch (as shown in Figure 1).

In the next section, the related work will be discussed. Hypothesis and research question will be discussed in Section III. Experimental methodology will be discussed in Section IV. Results and analysis will be discussed in Section V. Participants' feedback will be discussed in Section VI, and conclusion and future work will be presented in the last section.

II. RELATED WORK

Integrating vibrating sensors with mobile phones are not a new research field. A lot of research has been done in this area [1]-[5]. Similarly, researchers have already designed different vibrating patterns in order to give a haptic feedback and it was proven that people can distinguish different vibrating patterns [5]-[9].

Research conducted by Feige [8], where participants were asked to keep mobile phones in their pockets, shows results far from being satisfactory to make it possible for users to distinguish different vibration patterns. That is why a prototype in a form of wristband with embedded vibromotor was built and used. Five patterns with different rhythms were designed during an iterative process, which included pre-tests on each iteration until patterns showed to be discernible. Fourteen persons aged 19 to 46 (avg: 26.2, sd: 8.4) participated in the experiment and were randomly assigned to either the experimental or the control group which were of equal size. The difference between groups was in the environment where they received tactile patterns: control group - in a neutral room environment, experimental - in a mobile street environment where they had to walk according to route randomly selected for each participant. The results show that the environment does not makes any difference in the overall recognition score (about 93% (sd: 11.5) in the control group and even 94% (sd: 16.2) in the experimental group).

Another research conducted by Lorna M. Brown and T. Kaaresoja was devoted to investigate if a regular mobile phone can be used as the source for vibrations to represent tactile patterns [7]. Nine patterns with different roughness (from smooth to rough and very rough) and intensity (low-, mid- and high-level, controlled by vibromotor frequency) were used in experiment [9]. An important fact that needs to be mentioned is that the amplitude-modulated waveforms (used to create rough nesses) could not be reproduced on the phone motor. An approximation of roughness was created by using different speeds of on-off pulses. As for positioning, participants were holding a phone in non-dominant hand.

"A series of experiments was conducted to evaluate the effectiveness with which a tactile display mounted on either the forearm or the back can be used to communicate simple instructions and commands"[6]. The results revealed that the back is more perceptive (up to 98% correct pattern recognitions, lowest - 75%), while for the forearm, the correct pattern recognition rate was only between 30% and 96% depending on specific patterns. When participants were engaged in different activities, like physical or cognitive tasks, the results of accuracy of identification were up to 92% (for back). The amount of patterns used during these experiments varied from 7 to 8 and some of the patterns were adjusted during procedures. The big difference with many other haptic experiments and with one we have conducted is in the type of vibrotactile devices and patterns used. Here, mounted tactile displays constructed from several (9 for forearm and 16 for back) vibro motors were used, so tactile patterns were encoded not with a roughness or intensity, but with a sequence of active motors. This combination made it possible to give sophisticated navigation commands with application to military forces and with a minimum amount of tactile patterns training required. Even though the solution can be considered highly scalable and effective, it is also a sophisticated and expensive one.

Figure 1: Actuator is connected to mobile phone via Bluetooth/Wi-Fi

In our research, we want to develop a system where a mentor should be able to send advice to speakers that they need to control their voice and pitch. Speakers will be wearing an actuator which would be connected to a mentor's mobile phone via Bluetooth or Wi-Fi as shown in Figure 1.

III. HYPOTHESIS AND RESEARCH QUESTION

The vibrating rhythm generated by an actuator, worn by a speaker, controlled by a mentor which is connected to the mentor's mobile device via Bluetooh/Wi-Fi advises the speaker to change his voice and pitch during a speech.

We want to prove that it is possible to determine the user's wish regarding receiving the incoming mobile calls by using some contextual information like surrounding temperature, noise and light intensity, user location like "indoors" or "outdoors", user's physical position like "sitting", "horizontal" and "vertical" and location of the mobile device like "pocket", "bag", "table" and "hand".

IV. EXPERIMENTAL SETUP

This section describes the approach we have adopted; it introduces the experimental set-ups, including the software system for testing and the gathered data in detail.

A mobile phone Huawei U8800 Pro running Android v.2.3.5 operating system was used as the source for vibrations. The device was attached to the participant's neck using an elastic band as shown in Figure 2. For data transmission, a Bluetooth Logical link control and adaptation protocol (L2CAP) was used.

Figure 2: Phone is attached to participant's neck with elastic band.

In order to solve our research question, we implemented an application for the mobile phone which generates four types of vibrating rhythms as shown in Figure 3.

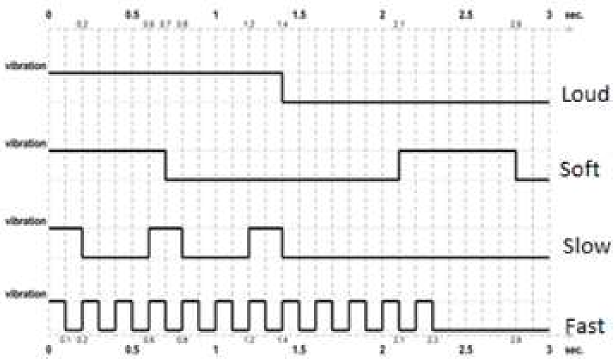

Figure 3: Different vibrating rhythms

We recruited 10 participants (7 males, 3 females), age ranged from 21 to 32 (mean: 25.2, SD: 4.11) and ranged in BM (body mass index) [10] was from 19.0 to 30.4 (mean: 22.99, SD: 3.38) because we also wanted to know whether corpulent people can feel vibrating rhythms or not.

Firstly, the purpose of the experiment was explained to participants and each participant was familiarized with the vibration patterns by holding the mobile device in his hand. After this short introduction, each participant had an unlimited amount of time to explore the four vibrating patterns in order to learn them. During training session, the device was attached to one side of the neck using the elastic band. The software user interface allowed them to select the desired pattern that was transmitted to the device as many times as he or she needed to feel it.

Later, the participants had to go through with the testing session in order to know whether they are familiar enough with the vibrating patterns. A pre-experiment was done and participants were asked to determine patterns that were sent in a random order (the default is 20 times and it can be configured). The developed software has a testing mode which shows the percentage of correct answers after completion of this part. Each participant was required to achieve a minimum of 75%; otherwise, he had to go through all processes again in order to get better trained.

Finally, participants were asked to speak about any topic for few minutes (around 7 minutes). During the speech, each participant received a total of 12 vibrating patterns (each vibrating pattern repeated 3 times). There was an interval of at least 30 seconds between two instructions. Participants were observed throughout the experiment by an observer.

V. Results and Analysis

While conducting the experiments, we were expecting two major drawbacks, which can be categorized into the following groups:

A. Confusion

When the participant recognizes the pattern, but feels unsure or unpleasant with a vibration and this affects his or her speech accordingly.

B. Interruption

When the participant's speech was interrupted for a while and then they continued.

These two are the most common reactions on vibrations and they can occur with correct pattern recognition (i.e., following the given hint), ignoring of the pattern (pattern could have been recognized but ignored or have not been recognized and ignored) or when pattern is recognized incorrectly (i.e., participant interpreted it as another pattern).

We obtained data from 10 participants (as shown in Table 1). Each participant received 12 patterns, bringing the overall total to 120 patterns; out of these, 107 patterns were interpreted correctly, i.e., 89.17% correct interpretations, taking a fact into account that 20% had two trainings, 10% had four trainings and rest 70% had three trainings before experiment.

Overall, most of the participants were able to act accordingly to a received pattern without showing any of the mentioned emotions and reactions. So, the speech was neither interrupted, nor was there any confusion or repeated speech in 80 correct interpretations, that is 74.766% of all 107 correct pattern recognitions or 66.667% of all 120 patterns being totally sent during experiment. The statistics for problems with the speech is the following: 14 speech interruptions, 11 confusions and 2 repeated speeches, all among 107 correct pattern interpretations.

TABLE I. OVERALL RECOGNITION FOR ALL PATTERNS

	Loud %	Soft %	Slow %	Fast %	Total Avg(%)
Correct interpretation/ % of correct interpretation	28/30	23/30	27/30	29/30	107/120
	93.33	76.67	90	96.67	89.17
Incorrect interpretation/ % of incorrect interpretation	0/30	4/30	1/30	0/30	5/120
	0	13.33	3.33	0	4.17
Ignored, no interpretation/ % of ignored interpretation	2/30	3/30	2/30	1/30	8/120
	6.67	10	6.67	3.33	6.66

Our results show that vibrating patterns were recognized with an accuracy of 89.17%. “Fast” pattern was recognized with an accuracy of 96.67% whereas “Soft” pattern was recognized with an accuracy of 76.67%. There were only 5 patterns out of 120 which were interpreted incorrectly, whereas 8 patterns out of 120 were ignored by participants, which means that participants were not able to feel anything.

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VI. PARTICIPANTS’ FEEDBACK

We could infer that the neck can be a good place for usage of vibrotactile device. However, we must pay a lot of attention to the social acceptance, as well as user acceptance and usability issues, because if the device and system are helpful but rejected by public it will not have any success. This is a very important aspect in wearable computing domain. This is why after each experiment we asked participants for their opinions and feedback and here is a summary of what we were able to find out:

- Sometimes the speech was interrupted because of vibration. Since the difference between the patterns was often associated with the number of vibrations, it can be possible that the participants waited until the device stopped vibrating and counted the vibrations.
- Since mobile phone was a source of vibrations and its vibromotor made noise, one participant stated that he associated the vibrated noise with the patterns instead of vibrated rhythm (haptic feedback).
- The device was considered too big for the neck area and it created a discomfort for the participants (in order to have user acceptance, the device needs to be smaller and lighter).
- Several participants mentioned that there is a chance that others could notice that you are receiving some information or hints in some way. Also, 30% of participants stated that they can probably show better results after additional training. Finally, only one (10%) participant stated that placing a vibrating device on the neck is suitable for him and does not make a big disturbance. While most of the participants wanted to take the device off as soon as possible because it felt very unpleasant and disturbing, one of the participant totally not accepted the device and stated that he “felt like a dog” because of the elastic band and big vibrating device located on the neck.

VII. CONCLUSION AND FUTURE WORK

This paper explains how to give instructions to speakers during their speeches, this paper describes the importance of the problem, discusses the methodology, results and analysis.

Currently, we are using mobile phone's vibrating motor instead of using any separate actuator (vibrating motor). Mobile phone’s vibrating motor. We generated four different vibrating rhythms by using mobile phone's vibrating motor; those rhythms were differentiated by participants with high accuracy. Results have shown that one actuator can be enough for solving this problem. This prototype is a proof of concept and our results show that one actuator can solve this problem by using the haptic feedback. Results also show that people can use this system independent of gender, BMI (body mass index) and age group.

We also got a good feedback from our participants for this proposed system because they think that this system would be helpful to those people who want to give a good presentation. Later, we will embed an actuator either in a necklace or in a tie in order to give a haptic feedback to speakers.

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