FeelTact: Rich Tactile Feedback for Mobile Applications, an Example With a Location-Based Mobile Game

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Abstract

With the ever-increasing number of applications for mobile phones, we are more and more likely to be confronted with a problem of a separation from our environment when looking at our screen. It can be easily illustrated with a mobile game that uses the real world as a platform (a location-based mobile game). Typically, the player must stop to look at the screen to get information, which then can alter the dynamics of the gameplay. One solution is to incorporate this constraint into the design of the gameplay, but there are also other options to solve this disconnect issue. The FeelTact project proposes an innovative approach that does not use the screen as the primary output device. Instead, it concentrates on maximizing rich tactile feedback, as opposed to simple vibrations. The FeelTact device is a new type of tactile bracelet that will drive the information a player receives. The first FeelTact game is an audiotactile mobile game based on an urban navigation system. The results are quite promising (higher scores and pleasure) and show that it is possible to access a new tactile dimension that has been underused in the past.

Keywords

Mobile Computing; Mobile Gaming; Location-Based Gaming; Rich Tactile Feedback; Haptic Output

Introduction

The users of mobile applications are confronted with a problem that can easily be put in a nutshell, that is, the screen screens them from the outside world. There is a clear break with the environment at the moment when our eyes get set on it. In other words, there is a separation that people have to stop and watch their phone screen. It is not always a problem, but if we are engaged in a game (especially a location-based mobile game that uses the real world as a platform), it can be greatly detrimental to the concentration. In addition, it is not the only aspect of the difficulties you meet. Indeed, this activity is, besides, not very discreet.

Generally, the screen remains the main output device. Sound is not used very much and vibrating is generally reserved to simple notifications. This is why we present an approach dealing with rich tactile feedback, which can be accompanied by sound.

Related Work and Positioning

Even though tactile feedback is not widespread among the majority of users, there is an important number of research programs on the subject: different applications, material configurations, and tactile feedback modes.

The applications of these programs often concern the augmentation of graphic tactile interfaces for mobile screens[Yatani, 2009] or non-mobile ones [Foehrenbach, 2009], and for navigation [Couture, 2006]. However, there are many other represented fields, for example: audiovisual [Kim, 2010], audio communication [Chang, 2002], Braille communication without Braille cells [Vinh Dinh, 2010], pace control [Qian, 2011], remote touch [Prattichizzo, 2010], space awareness [Ferscha, 2008], surgery[Font, 2004], virtual reality[Regenbrecht, 2005], virtual keyboards [Brewster, 2007].

Material configurations offering tactile feedback are very numerous as well: a screen[Jansen, 2010] a mobile device such as a mobile phone[Yamauchi, 2009], an entry device such as a pen, a trackball, or a graphic tablet pen [Lecolinet, 2005], a dedicated accessory [Diepenmaat, 2006], a remote control [Tahir, 2008], a joystick [Howard, 2004], a glove [Zelek, 2003], a bracelet [Lee, 2010], a belt [Van Erp, 2006], a jacket [Ombrellaro, 2008], shoes [Turchet, 2010], a chair [Réhman, 2008], a blanket [Dijk, 2010].

Tactile feedback modes are also rather varied: vibrations[Sahami, 2008], Braille cells [Tahir, 2009], piezoelectric acuators[Levesque, 2010], a solenoid [Lee, 2004], a speaker [Hashimoto, 2009], a force feedback device [Anastassova, 2010].

The FeelTact project aims, for its part, at the creation of accessible solutions for the public at large, for a material cost that will not rise above a few dozens of euros. The first FeelTact application is a mobile game based on a bracelet into which four vibrating motors are embedded. The objective is to get better scores and more pleasure with tactile feedback compared with visual feedback.

Approach: the FeelTact System

Not only does the FeelTact system enable us to add the tactile dimension to numerous contents and applications, but it also allows us to conceive directly contents and applications mainly using rich tactile feedback.

The use of touch rather than that of vision makes it possible not to have any confliction between our environment and the information received. Indeed, vision has already been globally monopolised to perceive our environment, whereas touch is much more available. Furthermore, tactile information can be received extremely discreetly. This information is then strictly personal inasmuch that I am always the only one to be able to touch what I touch, nobody else but me can feel it. Finally, tactile information can be viewed as a supplementary canal. In such cases of an important amount of information, touch reveals itself to be very efficient [Anastassova, 2010]. The first FeelTact game combines tactile and audio feedback.

The FeelTact system (see table 1) is composed at the beginning of two existing elements: a main system (for example a mobile phone), which can be connected to a network. For the case exposed in the following section, it is a smartphone with satellite navigation system, compass, and Internet connection. An accessory offering rich tactile feedback has been added, using one or several forms of communication (tactile protocols) through applications corresponding to needs generally based on software and hardware infrastructures on the server.

TABLE 1 COMPONENTS OF THE FEELTACT SYSTEM (IN ITALICS, EXISTING ELEMENTS)

Accessory (bracelet)	Tactile protocols
Main system	Mobile applications
Network	Infrastructures

Our first accessory is a bracelet that is, small, easy to build, very discreet, and doesn't have to be held in a hand. This bracelet uses a part of the body that allows four contact areas. All the testers of the system have been able to feel the four areas separately. These four contact areas are stimulated with vibration motors. With fewer areas, it allows less communication possibilities (not enough for the awaited applications) and with more areas, it doesn't allow feeling them separately.

Implementation: a Location-Based Mobile Game

A game has been conceived to illustrate our approach with the FeelTact system, that is, a mobile game based on navigation mechanisms: a GPS for localization, a compass for direction, and indications concerning direction and distance. The game functions for the time on mobile phones of the iPhone type (from the 3GS model). The aim of the game is to discover a letter from the alphabet, which has been drawn on a map (see figure 1).

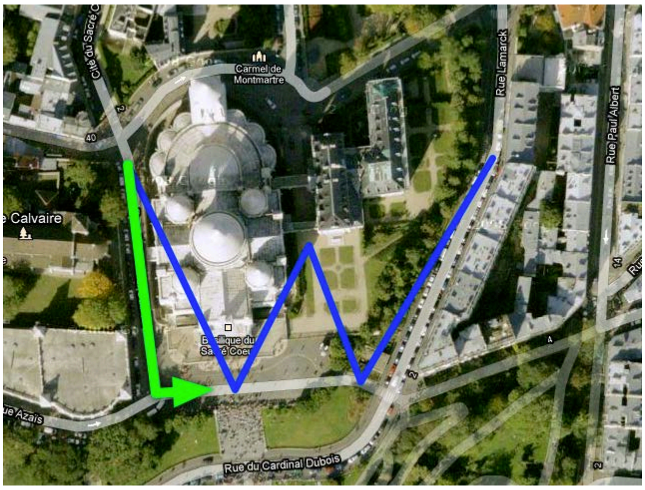

FIG. 1 EXAMPLE OF A LETTER (W) AND THE BEGINNING OF THE ROUTE TO DISCOVER IT (THE ARROW)

To achieve that, the players must be on location and go to the place which corresponds to the first spot on the map and which has been indicated to them on a map on their smartphone screen (see figure 2).

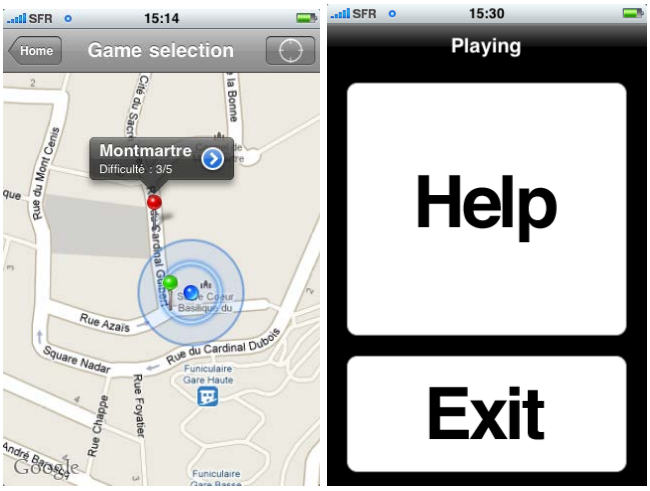

FIG. 2 SCREENSHOT OF THE SELECTION OF THE GAME (LEFT) AND SCREENSHOT OF THE GAME (RIGHT)

During the game, the players feel the direction to take (tactile feedback) and the distance to walk to get to the following spot on the map (voice synthesis), and they don't have to look at their telephone screen. The latter is only used as a virtual two-key keyboard (see figure 2): one to ask for help and one to quit the game. The Help button takes up practically all the space of the screen, so it is not necessary to look at it to activate this function. To quit the game, a confirmation is required.

Here is the tactile protocol that we use: four vibration motors are active if the direction is correct, two on the left (or right) if the player has to turn slightly to the left (or right), and one on the left (or right) if the player has to really turn left (or right). It can be understood as the following: the more precise the tactile feedback is, the more the player has to turn.

At the beginning of the game, the players are told the direction to take and the distance to walk to get to the following spot on the map. Direction is indicated under a tactile form by using the vibrating motors. The players must find the direction by moving their hand, which contributes to the fun of the game and to their implication in it. Distance is indicated by voice synthesis.

After a few moments, direction indications stop and the players must go as far as the next spot. If they feel that finally they fail to head in the right direction, they can ask for help and new indications can be given to them. If there has serious difficulties in the game detection for the players (too far from the spots or too much time), automatic help will be switched on.

When the players reach the spot, they are told about it in a tactile way and by voice synthesis. Then, the game indicates the next spot. At the moment, when the players reach the last spot, the game asks them what letter they are supposed to find. If they don't know, they can ask to see the itinerary they have taken. The score is calculated according to the time spent, the success or failure to find the letter, the number of tries, the use or not of the display of their itinerary, the number of aids they have asked for and that brought to them automatically. The score can be shared online and the players may then chose a new round of the game on the map.

The settings of the game mechanisms are mostly based on the numerous tests we made, as well on existing results concerning non-visual navigation [Magnusson, 2010] and indication of direction [Pielot, 2010].

Evaluation

The evaluation of the project was made at different levels and moments.

Before the game was developed, the hypothesis of tactile navigation has been validated in an urban environment.

To that effect, the precision of the GPS and the compass were tested. It was concluded that the scale and minimum distance between each spot had to be about the size of a block. If one spot is placed on one side of a street and the other spot just opposite, there easily may be confusion between the two. Moreover, we had to determine a diameter of about 10 meters for the circular area corresponding to a spot (when conditions are good). Finally, it could be seen that it was necessary to avoid being near very tall buildings (the precisions of these tools becoming insufficient).

Then the research of which direction to take was tested using the compass and the vibration mechanism described above. The results were quite good provided that the hand of the player was moved rather slowly.

In the course of the elaboration of the different versions of the game, the quality of its gameplay was validated. To that effect, the work was based on the pleasures identified by Alain and Frédéric Le Diberder [Le Diberder, 1998]: competition, achievement, mastery of a system, narration, spectacular aspect.

Competition: what is at stake is very clear, and it is to be number one on the leaderboard. Achievement: it corresponds to the discovery of each letter. The mastery of a system: in this case, being able to go from one spot to another with two indications (tactile and sound indication). Narration: this game doesn't include a story, so we don't take this aspect into account for the moment, even if it remains an interesting possibility. Spectacular aspect: here we have a really stunning experience, that of playing a video game while being immerged in the place where you are, which can, itself, be spectacular.

Once the game was developed, we had it tested by different complementary groups of people: students (used to playing video games), researchers (who knew what the project was about), and athletes (doing cross-country running or hiking).

Before the beginning of the game, we gave general instructions. During the game, we followed the players to observe the various sequences of the game. And after the end of the game, we talked about it with the players.

Thus, we collected information on the technical and ergonomic aspects of the game, its comprehension, the strategies of the players, and the improvements they thought were necessary (see table 2).

We had also tested a second version of the game, with visual feedback instead of tactile feedback. It allowed us to compare the common visual approach to the tactile one.

We got two main results. 1. The scores were higher with the tactile feedback. 2. The comments of the players(collected from a questionnaire) showed a higher pleasure with the tactile feedback, mainly thanks to a higher immersion in the game environment (i.e. the town).

These very positive results show that the use of rich tactile feedback makes it possible to obtain efficiently the indication of which direction to take in the context of a game of urban navigation.

TABLE 2 COLLECTED INFORMATION

Technical aspect	A problem was noted several times. The compass was disturbed by metallic elements.
Ergonomic aspect	It was necessary to remind some of the players not to move the handset too quickly.
Comprehension of the game	It seemed that there was no ambiguity concerning its aims.
Strategies	Two strategies prevailed. Either to go fast and take the risk to make mistakes or to go slowly so as not to make mistakes.
Necessary improvements	Several players were asked for clearer oral indications to identify the different moments of the game.

All this can be done without any separation from the environment. You can enjoy the setting of the places, and the aim is taken directly through your own eyes, possible dangers can be seen and avoided.

Moreover, you can remain discreet. Only the movements of your hand while trying to find the direction to take can attract somebody else's attention. An alternative consists in turning slowly around if you wish to remain really discreet.

Besides, nobody else receives the information. And finally, in this context, it can benoted that the sound feedback and tactile feedback are complementary easily.

Discussion

The evaluation of the approach proposed above has provided the opportunity to show its limits. To begin with, there are two technical limits.

Firstly, the precision of the GPS restrains us concerning the scale of the game, and the game locations, causing some deadlocks due to some shifts (it is sometimes impossible to be localized on one particular spot).

Secondly, the disturbances of the compass cause the system to send erroneous feedback. It would then be necessary to detect them and assist the player to get rid of them.

In the field of assistance to the user, we could also detect when the movements of the hand are too rapid and do automatically what we did on location when the movement is shown to the users.

Conclusion and Future Work

The FeelTact project gives applications and digital content a tactile dimension that is sufficiently rich to be able, in some scenarios, not to use the screen as the main output device. It has shown itself to be particularly pertinent to mobile gaming. There is then no separation from the environment at the moment when the access to the information is available and it is done discreetly.

Nobody else can perceive the information you get. And tactile information can be easily completed with other modes such as sound feedback.

The experiment has allowed us to validate the approach and to foresee numerous developments. New scenarios and the fundamental aspect of the project: tactile protocols is the focus of further work.

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