FeelTact: Rich Tactile Interactions and Navigation, an Example With a Mobile Game in a City

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Abstract

With the ever-increasing number of applications for mobile phones, we are more and more likely to be confronted to a problem of a separation from our environment when we look at our screen. Besides, we may seek for more discretion in the use of these applications.

This is why we propose an approach, which doesn’t use the screen as the main output device. We present rich tactile feedback via an easily manufactured and configurable mobile accessory, with a universal sound pilot.

Thanks to its Braille cells, whose use is diverted and the management of its vibrating motors, the FeelTact handset enables the user to remain connected to his or her environment, to be discreet, to receive strictly personal information (e.g. health related data) and, in some cases, to develop content and existing applications (e.g. addition of tactile feedback on music or films).

To begin with, we have implemented this approach on a mobile game based on an urban navigation system. The results are quite promising and show that we can access to a new tactile dimension, which, for its greatest part, remains to be discovered.

1. Introduction

The digitisation of our urban environment, of its structures as well as its activities, offers the opportunity of new services, as far as the distribution of information to localised individuals and the collection of local information are concerned. However, the users of mobile applications are confronted to a problem that can easily be put in a nutshell: the screen screens them from the outside world. In other words, the screen of their mobile phone, on which they can follow these applications, becomes an obstacle between the users and their environment. Therefore there is a separation: people have to stop and watch their phone screen.

At the rhythm at which this market develops, this problem gets bigger. The public have a wider and wider choice, innovations succeed one another, and the opportunities to use this kind of applications are more and more frequent, particularly in an urban context, with for example the localisation of services and the navigation that goes with it.

Despite recent progress, the screen remains the main output device. Sound is not used very much, though it is quite present as far as navigation is concerned, and vibrating is generally reserved to mere notifications.

Not to use the current approach (consisting in looking at the information) is quite an important challenge and so are the conception of these new interfaces and their acceptance by users.

This is our goal in the context of the FeelTact project, with the ambition to tackle the question, not at the level of one application, but for mobile applications in general.

This is why we will present in this article an approach dealing with rich tactile feedback (as opposed to mere notification vibrations), which can be accompanied by sound. The different options are mostly based on a mobile phone to which a handset device is added. The first we conceived allows rich tactile feedback via two Braille cells whose usage is diverted, eight external vibrating devices, and/or one internal one. The results prove themselves to be particularly interesting in some fields such as navigation. This is why we will present a first application prototype: a mobile game based on urban navigation mechanisms.

2. Context

Our team has been working in the field of sensory substitution, particularly in tactile interactions for the blind, in diverting Braille cells (each cell can control the activation of eight piezoelectric dots).

The first software we developed (Tactos) gives blind people a tactile access to the disposition of information on the screen (position of icons and active windows, recognition of simple shapes, etc.) The general principle consists in turning the cursor into a virtual little finger whose moves on the screen space are commanded by the user. When the cursor meets a black pixel, tactile stimulators are activated. Rapidly after some training, the blind people become then able to explore the screen and
have the feeling of being able to touch these shapes (Le-
nay, 2003; Sribunruangrit, 2004; Ziat, 2007).

Moreover, the digital space can be shared and different users in different places can meet in a tactile way in this virtual space. Thus, we developed the Intertact server (tactile Internet). In this context, we showed that touching somebody else was recognised as quite different from touching a simple object. At the same time, it was decided to invite non-blind people in these shared virtual spaces and more generally to develop applications for ordinary people.

In working on mixed reality (one part of the users being at home and another being on the field), our work found itself oriented toward game scenarios: collaboration (or competition) between several players (or teams). For example, a player who is at home will move his or her avatar on a map of the city. His or her partner (who actually moves in the town) commands through satellite navigation the moves of his/her own avatar on the same map. For the person in the city, the problem of a separation from the environment quickly arose. It has indeed been confirmed by some video game professionals. We then tackled the question of interactions without any output on the screen and mainly based on rich tactile feedback.

3. Separation from the Environment and Discretion

As we said before, the screen screens people from their environment. There is a clear break up with the environment at the moment your eyes get set on it. It is not always a problem, but if you are engaged in a game, it can be greatly detrimental to the concentration of the player.

It is not the only aspect of the difficulties you can meet. Indeed, this activity is, besides, not very discreet. On the one hand, the other people see that the user is looking at a screen and on the other hand, they may see what is indicated on it.

On the contrary, tactile feedback can be transmitted without any disruption, discreetly, and in a completely personal way. This is what we will develop.

4. Related Work and Positioning

Even though tactile feedback is not widespread among the majority of users, there is an important number of research programmes on the subject. The FeelTact project aims, for its part, at creating accessible solutions for the public at large, for a material cost that will not rise above a few dozens of euros.

The applications these programmes aim at often concern the augmentation of graphic tactile interfaces for mobile screens (Yatani, 2009) or non-mobile ones (Foehrenbach, 2009), and for navigation (Couture, 2006). But 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 keyboards (Brewster, 2007), virtual reality (Regenbrecth, 2005). On our side, we don’t close any doors. We have begun with a game but the options are very numerous.

Material configurations offering tactile feedback is very numerous too: 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 (Lecolinnet, 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 (Vanerp, 2006), a jacket (Ombrellaro, 2008), shoes (Turchet, 2010), a chair (Rehman, 2008), a blanket (Dijk, 2010). Here too, we remain open to any option. We can, for example, place our vibrating motors in different places on the body.

Tactile feedback modes are also rather varied: vibrations (Sahami, 2008), Braille cells (Tahir, 2009a), piezoelectric actuators (Luk, 2006; Levesque, 2010), a solenoid (Lee, 2004), a speaker (Hashimoto, 2009), a force feedback device (Roselier, 2006; Anastassova, 2010). We will see in the following section that our handset uses Braille cells and/or vibrating devices. Thus its range of possibilities is particularly wide.

Let’s add to this that our device must be mobile, therefore compact, energetically autonomous, and easily configurable with all the IT tools we commonly carry about (MP3s, mobile phones, tablets, laptops, etc.).

5. 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 or hearing makes it possible not to have any competition between our environment and the information we receive. Indeed, vision and hearing are already globally monopolised to perceive our environment, whereas touch is much more available.

Furthermore, tactile information can be received extremely discreetly. For example a vibrating device in a bracelet can be totally invisible for the people around.

And this information is then strictly personal inasmuch as 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, that is be used at the same time as
other sources of information. In some scenarios it is possible to take advantage of this supplementary aspect: we can add tactile feedback, knowing that vision and hearing are already busy. In such cases of an important amount of information, touch reveals itself to be very efficient (Burke, 2006).

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<th>FeelTact accessory</th>
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Tab. 1 – Components of the FeelTact system (in italics, existing elements).

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 mobile phone with: satellite navigation system, compass, and Internet connection.

We add to it an accessory offering rich tactile feedback, using one or several forms of communication (tactile languages) through applications corresponding to needs generally based on software and hardware infrastructures on the server.

Besides, the handset has an internal vibrating motor and eight connectors for external ones which can be placed for example in a belt or in a jacket.

The three modes can be used independently or in combination with one another. In a navigation scenario, for example, you can dedicate the external vibrating devices to direction, the Braille cells to distance and the internal vibrating device to alerts.

An important part of the volume of this prototype corresponds to power supply: three AA type batteries. The handset is rather small (it fits in your pocket) but it could be much smaller if produced industrially with the use of batteries similar to those of mobile phones. In this case it would probably be specialised handsets, perhaps without the Braille cells or without the connectors to the external vibrating devices, which would make it even smaller and also cheaper.

So that the handset is compatible with the diversity of the main systems we have considered, we have chosen to use a form of communication that goes through the audio output plug (Kuo, 2010). We connect the handset to the main system thanks to its audio connector and we have the possibility to connect earphones or mini earphones to the handset that acts as a relay station.

The handset can be configured via a simple XML file when it is connected to a computer thanks to its USB port. In this file we specify what frequency range we use and to which dots or vibrating devices they correspond.

We can then use inaudible frequencies above 20 kHz to transmit tactile information. We can also ask the handset to react to audible frequencies, for example in an augmented music scenario (that is music enriched by rich tactile feedback). It is also possible to combine these two methods.

To summarize, we can say that to create a tactile feedback from a main system, we just have to make it produce a sound of a certain frequency, therefore a sound likely to be inaudible.

The following section will present the implementation of the approach with a game scenario based on navigation mechanisms. But the application fields are numerous, for example, the follow-up of health related data, films enriched in a tactile manner, communication between the inhabitants of a town, the communication of critical information in a complex environment, etc.

6. Mobile Game in a City

We have conceived a game to illustrate our approach with the FeelTact system. It is a mobile game based on navigation mechanisms: a GPS for geolocalisation, a compass for direction, and indications concerning direction and distance. The game functions for the time being.
on mobile phones of the iPhone type (from the 3GS model) and it makes use of the GPS and the phone. The aim of the game is to discover a letter from the alphabet, which has been drawn on a map (see figure 2).

Fig. 2 – Example of a lettre (W) and the beginning of the route to discover it (the arrow).

To be able to do that, the players must be on location. They must go to the place which corresponds to the fist spot on the map and which has been indicated to them on a map on their telephone screen (see figure3). It is then that the game begins (see figure 4).

During the game, the players don’t have to look at their telephone screen. The latter is only used as a virtual two-key keyboard (see figure 3): 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.

Fig. 3 – Screenshot of the selection of the game (left) and screenshot of the game (right).

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 either by using the vibrating motor of the phone, or with the Braille cells of the handset. In the case when it is the vibrating motor, it is used continuously when the phone is oriented in the right direction. The farther away from this direction the players move, the less continuous is the vibration. When the Braille cell is used, all the dots are up when it is oriented in the right direction. The farther the players move away, the fewer are the dots in high position. Therefore, in both cases, the players must find the direction, which is not given to them directly, 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 are not heading in the right direction, they can ask for help and they are given new indications. If the game detects that the players have serious difficulties, automatic help is switched on. When the players reach the spot they are told about it in a tactile way and by sound, and the game indicates the next spot.

At the moment, when the players reach the last spot, the game asks them what letter they were 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, to the success or failure to find the letter, to the number of tries, to the use or not of the display of their itinerary, to the number of aids they have asked for and to the number of aids 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 (presented in the following section), but also on existing results concerning non-visual navigation (Magnusson, 2010) and on indication of direction (Pielot, 2010).

7. Evaluation

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

Before the game was developed we had to validate the hypothesis of tactile navigation in an urban environment.

To that effect, the precision of the GPS and of the compass were tested. We 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 de-
termine a diameter of about 10 meters for the circular area corresponding to a spot (when conditions are good). Finally, we could see that it was necessary to avoid being near very tall buildings (the precisions of these tools becoming insufficient).

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

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

Competition: what is at stake is very clear, 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, on its comprehension, on the strategies of the players, and on the improvements they thought were necessary. The technical aspect: a problem was noted several times, the compass being disturbed by metallic elements. The ergonomic aspect: it was necessary to remind some of the players not to move the handset too quickly. The comprehension of the game: it seems there was no ambiguity concerning its aims. The 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. The necessary improvements: several players asked for clearer oral indications to identify the different moments of the game.

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.

We can note that this information is obtained more rapidly with the FeelTact handset than with the vibrating motor of the telephone. Indeed, the nature of the tactile feedback is different: the Braille cells give these indications on a spatial level whereas the continuity or absence of the vibrations is perceived on the temporal level.

All this can be done without any separation from the environment. You can enjoy the setting of the places, 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. Finally, in this context, we can notice that the sound feedback and tactile feedback are complementary.

8. Discussion

The evaluation of the approach proposed above has been the opportunity to show its limits.

To begin with, there are two technical limits. First, the precision of the GPS. It restrains us concerning the scale of the game, it limits the game locations, and it causes some deadlocks due to some shifts (it is sometimes impossible to be geolocalised on one particular spot). The use of a more precise system would then be really interesting, for example the Galileo satellite positioning system. Secondly, the disturbances of the compass. They cause the system to send erroneous feedback. It would then be necessary to detect them and to 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 showing the movement to the users.

Besides, we could test other possibilities of the FeelTact handset: other uses of the Braille cells and/or an exploitation of the external vibrating motors.

As far as this first game is concerned, we could develop a version with a richer content, for example a scenario based on the history of the place to discover.

9. Conclusions and Future Work

So, we propose an approach, which 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 for mobile applications.

There is then no separation from the environment at the moment when you have access to the information. It is done discreetly. Nobody else can perceive the infor-
mation you get. And tactile information can be easily completed with other modes such as sound feedback.

We have presented in this article a handset making it possible to implement this approach. It is equipped with eight Braille cells, an internal vibrating motor and eight connectors for external vibrating motors. The connection with the main system (for example a mobile phone) is simply done through the audio output plug. An XML file, accessible via the USB file of the handset is used to configure the tactile feedback according to audible or non-audible range frequencies.

We have also presented a mobile game, which illustrates this approach in the context of an activity based on urban navigation. It consists in discovering a letter drawn on a map by moving from one spot to another.

The first phases of the experiment have allowed us to validate the approach and to foresee numerous developments. We are now going to proceed to a systematic experimental validation and develop new scenarios, mobile and non-mobile ones. We will also focus on a fundamental aspect of the project: tactile languages.

10. Acknowledgements

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11. Références


