DETI-Interact: Interaction with Large Displays in Public Spaces Using the Kinect

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Abstract. The problem of interaction with large displays in public spaces is currently of interest given the large number of displays available in such spaces (as lobbies, train stations, waiting rooms, etc.) that are only showing information with no possibility to interact with the contents. Several works have been developed in order to allow interaction with these displays using technologies such as infrared, Bluetooth, GPRS, digital compasses or touch screens. Some only intend to provide information, while others emphasize on capturing users' attention eventually leading them to some action. This paper describes DETI-Interact, a system located in the entrance hall of a University department allowing users to interact with a large display without the need to carry any electronic device since a Kinect is used to capture different user's gestures. In this work, special attention was given to another issue intrinsically linked to the presentation of information on large public displays 'How to call the user's attention?'

Keywords: Large displays, natural interfaces, attention catching.

1 Introduction

With the reduction of weight and cost of computer and television screens, we are witnessing a proliferation of large digital displays in public spaces [1], such as lobbies, train stations, waiting rooms, etc. These displays often only show information not offering the possibility to interact with the contents. At the same time, new products in the field of human-computer interaction have started emerging, allowing more natural user interfaces. Examples of such are innovative controllers, like the Wii Remote, PlayStation Move, Kinect and other less known devices, which have been widely accepted by the community [2]. Combining these controllers with large displays opens interesting new possibilities to address relevant issues in the study of interaction with large public displays, which have been tackled through the use of different technologies such as smartphones or RFIDs, implying that users would use some

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piece of hardware, precluding a more natural and general usage of this type of systems.

This paper describes a project that started by studying different possibilities of interaction with public displays using mobile phones. As a test bed, we developed a system running an application to provide useful information for students of our department deployed in the entrance hall. Despite several differences, since our system is currently limited to one display and the main focus of the research is on the interaction, it has some similarities with other public display systems, such as the E-CAMPUS project [3].

Our system, DETI-Interact, has already been through several stages. As mentioned, initially the possibility of using smartphones (Android equipped with compass, accelerometer and touchscreen) to control the display was explored, and different interaction techniques were developed and tested [4]. However, given the necessity to download an application into the user phone, the system was underused when deployed for real usage. This caused a redesign and a new version of the system was developed using a Kinect[1] to allow gesture interaction, and was installed in the entry hall of our department, providing access to potentially relevant information for those who walk in the department, such as faculty members' contacts, schedules of the courses offered at the department, as well as several promotional videos of the department activities. This idea meets the issue raised by McCarthy, "how an interactive display can be used in the background to enrich casual interactions of the people nearby, by sensing the presence of those people" [5].

This version is working and was evaluated with our students, and as part of university activities promoting science education (such as Science Week and a Summer Academy for high school students); however, the environment is error prone, since different gestures or movements may be detected (for example other people passing by) leading to involuntary interactions. Therefore, in the latest version we used tools made available by the Kinect SDK[2] (tracking of a particular user, smoothing parameters, etc.) so that the gestures produced where easy to use, but at the same time difficult to be replicated involuntary.

Since the system is deployed in a passageway, an important problem is how to get the attention of those passing showing the possibility of interaction. Otherwise potential users may not realize that the system is interactive. As Agamanolis wrote, "Half the battle in designing an interactive situated or public display is designing how the display will invite that interaction" [6]. In order to solve this problem a method capable of capturing the user's attention to DETI-Interact and to the fact that it is possible to interact with it through gestures was devised.

The system is currently being tested and preliminary results of tests indicate that it is already self-explainable and is a viable solution to provide interaction with displays in public spaces.

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[1] http://www.microsoft.com/en-us/kinectforwindows/

[2] http://go.microsoft.com/fwlink/?LinkID=247735

In what follows the architecture of DETI-Interact is presented as well as the applications available, the interaction and the attention catching methods are briefly described, and some conclusions are drawn.

2 Architecture and Available Applications

The current architecture of the application is presented in Fig.1. Regarding user interaction, the system uses a Kinect sensor to capture the gestures that are sent to the application and trigger associated actions. The information presented by DETI-Interact comes from different sources. Information related to the Department is obtained through already existing web services available at the university. The system also has a local repository of videos that can be visualized on the screen.

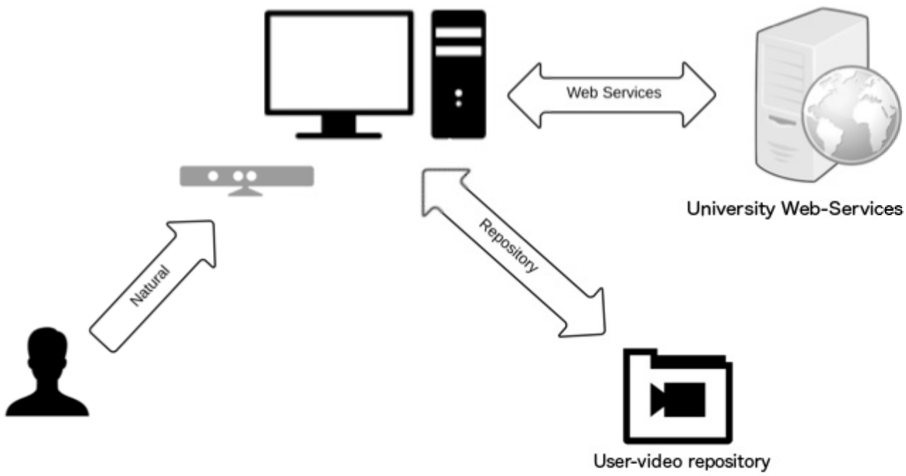

Fig. 1. General Architecture of the DETI-Interact

DETI-Interact is an extensible framework that currently encompasses multiple modules, each with its own requirements and user interface layout. As of now from a main screen (Fig. 2) four applications can be selected: a faculty member list, arranged in a vertical grid list, where users can use all three gestures developed to interact with it (described in the next section); a course schedule list (Fig. 3); a video player (Fig. 4) that allows playing videos from the local repository; and a ping pong game (Fig. 5).

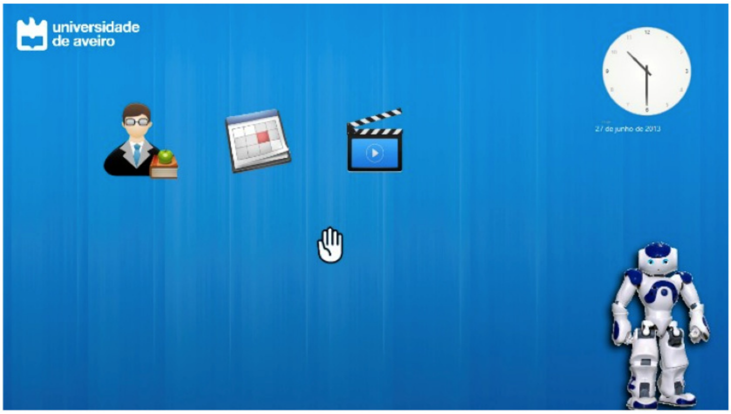

Fig. 2. DETI-Interact main screen (application/module list)

Fig. 3. Table DETI-Interact class schedule list

Fig. 4. DETI-Interact video player

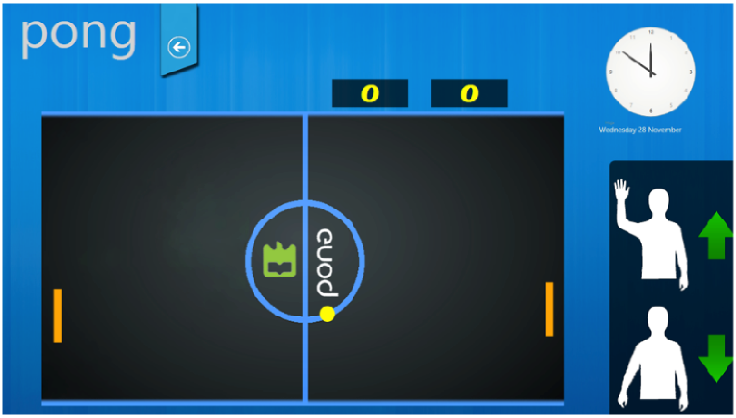

Fig. 5. Ping Pong game

3 Interaction

The first version of DETI-Interact using Microsoft Kinect had a large and complex set of gestures, thus leading to an overall difficult interaction. For instance, the "Push" gesture, which consisted in a strong and quick forward movement of the hand and arm [7], was used to select an item on the display. Although very responsive if done correctly, it could produce a high rate of false positives due to involuntary movements, made even worse by the fact that the interaction was done in a public space, with people passing by near the sensor and triggering this unwanted behavior.

Currently, the interaction is performed through a set of three different gestures:

- Hovering – holding the hand in a specific position for a short period of time activates the corresponding action on the display;
- Hand up – Allows ascendant scroll by holding the hand near the top position;
- Hand down – Allows descendant scroll by holding the hand near the bottom position;

This interaction method has been selected taking into account the recommendations from Kinect for Windows Human Interface Guidelines [8], which advise that there shouldn't be too many gestures, especially if they are very alike, and that they should be easy to learn and carry out.

The use of "Hovering" instead of "Push" was envisioned to prevent, or at least greatly diminish, the number of false positives happening during interaction. Given that the users who will be interacting need to stay in a specific position for a certain amount of time, the probability of an involuntary selection will decrease, as they will have time to notice and avoid completing the action. The efficiency of use slightly decrease, however, application robustness is more relevant than speed of use.

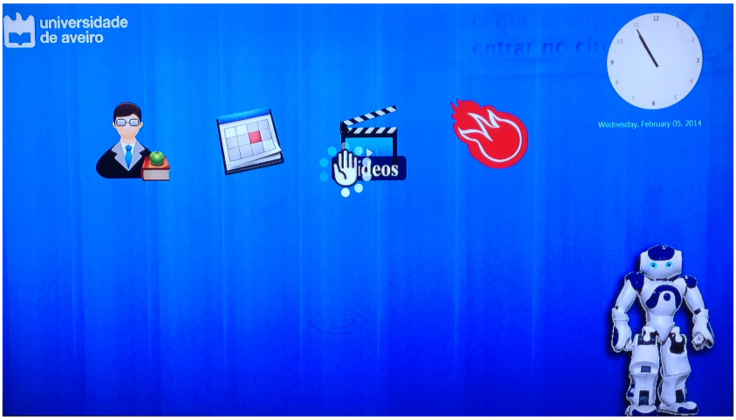

Fig. 6. Progress bar shown to give feedback concerning "Hovering"

We believe that "Hovering", besides reducing the number of interaction errors, is easier to learn, which is relevant as most users of DETI-Interact will not be much familiarized with the system, yet they need specific information at a specific moment and thus the system should be very intuitive. A progress bar is shown to give users feedback regarding how much time has elapsed since the hovering has started (Fig. 6). This seems an important advantage when compared with the "Push" gesture since in informal tests with users we noticed that most of them needed some explanation to be able to use correctly the "Push" gesture.

The quick learning curve was also one of the main reasons for selecting the "Hand up" and "Hand down" gestures, when scrolling vertically. The "grab and drag", suggested in the Microsoft Kinect for Windows SDK, was also a possibility as it is a realistic and nice performing metaphor of many day-to-day actions involving physical objects [9]. In fact, our tests with "grab and drag" were mostly positive in a user interface with content arranged horizontally. However, when the content was vertically oriented users tended to have greater difficulty and higher fatigue, mostly due to the fact that the list was long. Because the faculty member module of DETI-Interact was already arranged vertically, we opted for a vertical scrolling enabled by "Hand up" and "Hand down", thus reducing much of the fatigue felt by the users. When the interaction hand is above the user's shoulders, an upwards scroll is triggered, while below the user's waist, a downwards scroll is triggered.

4 How to Call the Users' Attention

Catching attention of users for this kind of application is a known problem [1] [10] [11]. If no attention catching method is provided, potential users may not even realize that the system is interactive.

Some other papers report the attempt to solve this problematic, like the Proxemic Peddler [6], an interesting implementation of a public advertising display, is based on a framework (the Proxemic Framework) aimed at acquiring and maintaining interest and attention from users, eventually leading them to some action, like making a purchase, by monitoring their interest and trying to lead them into a more attentive stage. The Audience Funnel [12] defines six different interaction phases, where two of them are taken into account in DETI-Interact: the "Passing by" phase and the "Direct interaction" phase. Thus, to capture users' attention during the "Passing by" phase, we have developed a module whose main focus is to attract people's attention when they pass by our system and, in a subtle way, present the gestures to the users through a 'mini-tutorial'.

As Brignull described, "social embarrassment has been identified as a key factor, especially in determining whether people will interact with a public display in front of an audience" [1]. To overcome this barrier, it was decided to use the skeleton instead of a user's real image for psychological reasons.

We have developed a method, whose main focus is to attract people's attention and to present to the user in a subtle way the gestures through a 'mini-tutorial' [13].

Fig. 7. Calling the users' attention

When users pass in front of the display, a skeleton that replicates their movements is shown ("Passing by" phase [12]) as shown in Fig. 7. It was decided to use the skeleton (making use of the potential of the Kinect) instead of a user's real image for psychological reasons [1], as the image of a person projected on a public place may cause some discomfort. In addition to the user(s) skeleton(s), a virtual ellipse similar to a target appears on the screen. When the user places their feet inside the target, the ellipse changes its color indicating the beginning of interaction. This also allows delimiting the area where the user should be in order to have better performance. According to the human interface guidelines for the Kinect [9], this device should be used in a spatial range between 40cm and 4m away from the equipment, yet we reached empirically the conclusion that for the environment of DETI-Interact, the appropriate distance is between 1,8m and 2m.

This approach also allows tracking a specific user, enabling the application to respond only to the gestures performed by the user who is inside the interaction area.

When a user is detected inside this area, a 'mini-tutorial' of the application is triggered. A virtual hand is projected over the skeleton's hand and an area indicating where the user should put his/her hand to start the application appears, effectively committing to the "Direct interaction" phase [12]. The projected virtual hand matches the general cursor of the application; therefore, the user has the perception that he/she can control any application with the right hand.

When the user puts the right hand on the indicated area, besides an illustrative message indicating that the user must wait to select the application (consistent with all the available applications of DETI-Interact), a progress bar appears elucidating the user that he/she must wait to trigger the wanted action.

5 Tests with Users

Our first test with the current version of DETI-Interact took place during the Summer Academy event (Academia de Verão) of 2013, organized by the University of Aveiro. A total of 12 students aged 16 years old, 8 males and 4 females, were able to qualitatively test DETI-Interact. They were given some objectives that needed to be fulfilled using DETI-Interact replicating real world scenarios where a user reaches the department and needs to obtain some kind of information that may be available on the entry hall display. The task were to find the email of a particular teacher, in the list of teachers, check a schedule of a particular course and open a specific video. No help was given.

Although these users are not University students, we can consider that they have a quite similar profile, since a good portion of them will probably be admitted at the University in the following year.

In order to evaluate the performance and satisfaction of the users, a direct observation was performed during testing, followed by a survey that included mainly questions about the usability of the system. The answers to these questions were given in a 5 level Likert-type scale with 1 being the worse value and 5 the best value.

As previously stated, the number of users was not significant enough to perform a statistical analysis of the data. Therefore, these tests should be seen as qualitative and not quantitative results.

Two of the most relevant issues were related to the attention calling module and the methods used for interaction. Fig. 8 and Fig. 9 show the results for these two questions.

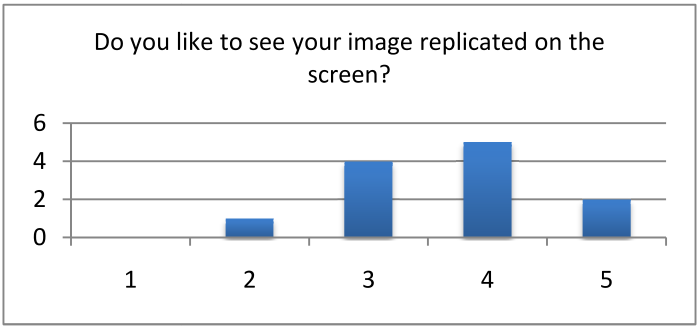

Fig. 8. Results obtained regarding the question: "Do you like to see a skeleton replicating your movements?" (1- not at all, 5- very much)

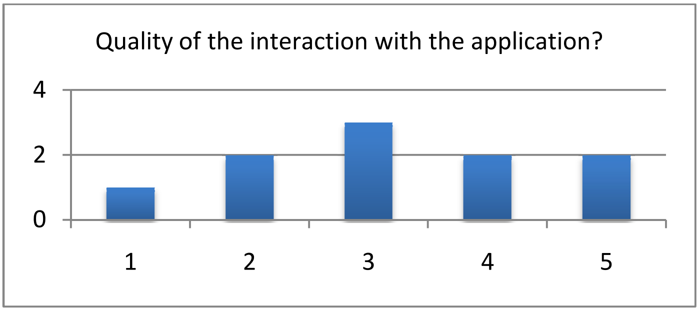

Fig. 9. Results obtained regarding the question: "The application presents a good interaction?" (1- not at all, 5- very much)

In general, results were positive both concerning the interaction and the attention catching method. Another very interesting aspect was that 11 in 12 users said that they would like to have a similar system in their own schools.

Some of the less positive results (as apparent in Fig. 9) may be due to an observed problem during the tests related to the high luminosity present in the entry hall, which led to a decrease in the accuracy of the Kinect sensor. This problem can be improved if the user is nearer the sensor.

Other less positive aspect that became evident was that smaller users had more difficulty in reaching certain areas of the screen, since they do not have a large range of upper limbs as compared to taller users.

6 Conclusions and Future Work

This paper presents DETI-Interact a system that allows interaction through gestures with a large display situated at the entrance hall of our department. This system has been used as a test bed to develop and test new interaction methods with this type of displays that should be intuitive to retrieve relevant information to people entering the department. The issue of catching the user's attention has also been studied and a method was developed that seems effective enough to entice people to interact also showing potential users where to stand and how to interact with the system.

Alongside this work and also based in DETI-Interact, the possibility of manipulating 3D objects through natural gestures using the Kinect is being studied, as well as the navigation in 3D worlds. Using this interaction method we expect a more natural interaction than currently existing approaches.

New entertainment applications are planned, such as a Pac-Man game, and a paint application where the users can freely draw using their bodies. Moreover, some improvements are under consideration for the near future, as allowing interaction using the left hand to make it easier for left-handed users, and making the interaction adaptable to the user's height.

The ability to turn users into contributors to the system, e.g. by recording and showing their activity in a timeline (as seen in [10]), either anonymously or by submission, which could then be used to automatically rank the most important contents or applications, or even provide score rankings for the Pac-Man game, is another point we consider important for a future implementation.

DETI-Interact has been evolving according to the feedback obtained from organized user tests and from informal feedback given by passersby as it has been running for some time; it is a framework that has the potential to encompass much more applications, and it will continue to be used to study other relevant issues concerning interaction with large public displays, as well as to motivate students' assignments.

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