Shamanic Interfaces for computers and gaming platforms

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Abstract. Natural user interfaces are becoming widespread as a focus of research in human-computer interaction. Gestural interaction is an important part of this field, but generally done by mimicry. This raises concerns such as the necessity of creating abstractions for non-imitable commands and the difficulty of finding gestures that are meaningful for a worldwide audience. Cultural backgrounds impart different meanings to gestures.

In this research , we explore the concept of allowing individuals to interact with computer systems using gesture from the individual's own culture, focusing on a software engineering approach to support this idea. The aim is to leverage the rich semantics of non-mimicry cultural gestures to expand gestural interaction to support abstract commands for instructions that do not have a matching gestural imitation. This approach also holds the potential to support the learning of gestural commands, by linking them to the cultural background of each user.

The proposed software engineering approach demonstrates the feasibility of planning applications with commands in mind, not specific gestures, separating concerns between gestural identification (which can include cultural background elements) and actual commands.
Keywords. natural interaction, natural interfaces, shamanic interface, human-computer interaction, gestures, gesture-based interaction, Kinect

1 Introduction

Through the years, human-computer interaction has been evolving. Recently, the concept of Natural Interaction is getting more and more trendy, as there is much to develop, study and improve in the area. New approaches to interaction are arising to render it ever more natural, and therefore simpler for the final user to learn and use.

This evolution includes the current surge in new interaction devices for natural interaction and, specifically, for gesture-based interaction. Devices such as the Leap Motion[1], which is used to track a user's finger motions [1] and Myo[2], a bracelet which identifies hand, arm and finger motions from electric activity in muscles; applications such as Flutter[3], which allows the user to control music or videos with gestures through a computer's camera and innovative approaches such as WiSee, which works on the recognition of gesture through disruption of wireless signals [2] support this idea.

These devices, along some earlier ones, such as Nintendo Wii, PlayStation Move, and Microsoft Kinect, allow the use of gestures from a part or the whole body to command computational systems. Most of this interaction is done by mimicry, which raises concerns on the scope of their use. Specifically, regarding consequences on the learning of "natural" interfaces, since many commands are not direct body motions, e.g.: "stop", "continue", "increase", etc. This means that metaphors need to be selected for these actions, in order for gestures to represent those metaphors. E.g., in Microsoft Kinect games, the "stop" command (see Figure 1) is the "guide" gesture, where the user moves the hand slightly away from the leg, as a guide would when directing someone. Consequently, these metaphors have to be learned, one by one. Metaphors, however, are based on cultural backgrounds of users, and gestures in particular can be quite distinct in meaning across nations, regions, ethnic groups, or even urban groups. Further, specific gestures can be hard or impossible to reproduce by the physically, dissociating or even excluding them from gestural natural interaction, so alternatives are necessary to allow gestural interaction to be more inclusive.

Fig. 1. Gesture to interrupt Kinect.

The world is currently under a phenomenon called globalization, making it easier to interact with people from different cultures or backgrounds, so this awareness in interaction is all the more pressing. Even earlier, the idea of including culture to improve a system's interaction has been discussed: coherent behaviour of an application according to the user's cultural background can have a great impact on improving this interaction [3].

[1] More information on: `https://www.leapmotion.com/`
[2] More information on: `https://www.thalmic.com/en/myo/`
[3] More information on: `https://flutterapp.com/`

"It's called the shamanic interface because it was designed to be comprehensible to all people on earth, regardless of technological level or cultural background" [4].

The idea of a gestural interface based on cultural background was originally proposed - under the name "shamanic interface" - by Daniel Suarez, a computer science professional and novelist, in his novels *Daemon* [5] and *Freedom*™ [4]. His idea was to leverage ritual cultural traditions - including magic rituals - as a source of somatic gestures for commanding an augmented reality system. The logic of his idea was that those traditions had at their kernel the concept of communicating with the immaterial, the virtual. Suarez utopian concept was that a single interface would be usable by all people on Earth, as the citation on this page shows. Given the contradictory meaning of gestures - including ritual gestures - across cultures, we see this concept as untenable. However, if each user could have a custom gestural interface, one in line with his or her cultural background (and/or physical limitations), Suarez' kernel concept may hold promise, even if subverting it to some extent - this was proposed recently by Morgado, suggesting that given this contradiction, either "shamanic interface" or "anti-shamanic interface" would suffice as adequate names. In this study, we present a software engineering approach that enables the interface to be customized for each culture, by enabling an application to be commanded using multiple sets of gestures [6]. Hence, the proposed approach enables the development of a gestural interface which is not something that is hermeutic, requiring initiates to learn it outside of their cultural semantics, and only accessible by some, but of an interface that is customizable for everyone, regardless of their cultural background or physical limitations.

Human-computer interaction using gestures is a trending topic nowadays and has been a research focus during the last years, but there is currently no knowledge of any gesture recognition application using the user's cultural background to overcome some of the inherent limitations of human-computer interaction by gesture imitation.

We also present a proof of concept application of the software engineering approach, to illustrate the relevance of the topic and prepare a basis for future works on the area.

2 Related Work

According to Valli [7], people naturally use gestures to communicate and use their knowledge of the environment to explore more and more of their surroundings. This is the definition of natural interaction, that, as a secondary objective, is aimed by this project: improve usability of human-computer interaction using gestures. The use of gestures for communication is an ancient habit of humans, which comes from the possibility to express an idea when there are no common spoken languages.

"The higher is the level of abstraction of the interface, the higher is the cognitive effort required for more interaction" [7].

The naturalism associated to gesture communication must be present in human-computer interaction applications: the system shall recognize gestures humans are used to do [8]. Including the idea of cultural background, gestures become even more natural to the user, as they reflect knowledge associated with himself and knowledge that does not require effort to memorize or study to learn. This reasoning also works for interaction: more familiar interfaces will have a smaller learning effort, as Valli states on:

> *"Designing things that people can learn to use easily is good, but it's even better to design things that people find themselves using without knowing how it happened. (...) Simplicity leads to an easier and more sustainable relationship with media and technology."* [7].

Natural interaction can help surpass the difficulties faced by people when interacting by turning the interaction easier and simpler. This new kind of interaction is also an advantage as it motivates individuals to concentrate only on the task to perform and not in the interface itself [9]. The desire of creating the Natural User Interface "has existed for decades. Since the last world war, professional and academic groups have been formed to enhance interaction between "man and machine" [10].

As in this research, some games *"match specific in-game actions, such as walking, with similar real world movements"* [11] and in this case, the application intends to create a meaningful abstraction for the user to use conveniently.

> *"Culture influences the interaction of the user with the computer because of the movement of the user in a cultural surrounding"* [12].

The importance of the culture background of each person to provide the best interaction possible in a system is demonstrated by this sentence. Therefore, as the system is intended to be available for the widest population possible, the differences on how people from different cultures interact is very relevant for this area. A different approach according to cultural meanings requires the system to be able to recognize culturally-accepted gestures. Only recently there has been investigation about the integration of culture into the behaviour model of virtual characters. Speed and spatial extent can also be indicators of an user's culture and that's considered an important detail to build a stronger application [13].

Rehm, Bee and Andr state that:

> *"Our cultural backgrounds largely depend how we interpret interactions with others (...) Culture is pervasive in our interactions (...)"* [14].

On Figure 2 the differences in a usual waiting posture between a German and a Japanese can be observed. These postures tend to have a cultural heritage and are therefore considered part of the cultural background of the users. These differences in some gestures and postures pose as important data for studies in the area to allow a better interaction according to each culture.

Through the use of Kinect, Microsoft showed the way to controller-free user interaction [13]. By controller-free, it is considered the use of devices not coupled

Fig. 2. Differences in postures from people with different cultural backgrounds [14].

in the body of the user or remote controls like the ones in gaming platforms. Works in the area tend to use virtual characters to represent the exact movement of the user. An example is the Online Gym project referred in [15] that intends to create online gym classes using virtual worlds.

Recent studies evidence that users tend to enjoy the interaction with the Kinect which takes to a growing interest in using the system to perform the interaction. The age range is wide, so interest is not limited to younger users, which opens up application for a vast target public [13].

3 The Shamanic Interface

3.1 Concept

The concept of this interface is the integration in software development of a gesture-identification layer, providing attribute classification (e.g amplitude) and command mapping of the cultural gesture. The resulting command is provided to applications as a specific and parameterized command, therefore independent of the actual motion of the user.

One of the main drivers for this research was enabling an implicit activity-driven interaction system, as the ones referred by Lukowicz [16]: an environment where gestures and movements are meaningful and the result is therefore obvious for the user.

As the tool is intended to be offered to a wide audience, it is important to match certain criteria and then it urges the fact that elderly people have a notorious decrease in acuity, memory and attention [11]. To support people in a wheelchair or with movement restrictions, a seated mode is allowed during the execution of the developed application.

3.2 Architecture and Gesture Recognition

The developed solution uses Microsoft Kinect for the skeletal detection and consists in an implementation of a gesture recognition system, based on Kinect

Toolbox 1.3. Its architecture, based on the concept presented earlier in this document, is expressed in Figure 3. It briefly consists of three layers: the acquisition and detection layer, the cultural mapping layer and the application layer. The data is captured and detected in the first layer, the cultural mapping layer is then used to identify the cultural gesture, analyse it, map it to the adequate command and parameterize it. The parameterized command is then sent to the application layer, for execution.

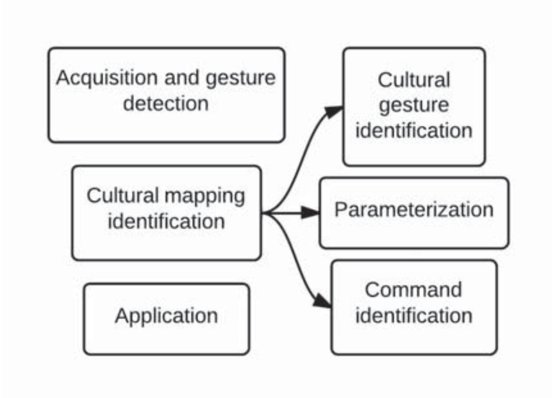

Fig. 3. General architecture of the system.

3.3 Prototype

The flow of the prototype implementation, using a Microsoft Kinect sensor and a traditional display, is presented in Figure 4. After the application is running and the Microsoft Kinect is plugged in, the user places himself or herself in front of the Microsoft Kinect capturing device, which captures each image, identifies joints, and calculates depth and the information of each joint. Body movements and gestures can then be performed, allowing the system to determine if the gesture is a known one. If the gesture is recognized, the system triggers the respective reaction, which affects the 3D scene included in the solution.

Microsoft Kinect captures a data stream, sending it through USB to the computer, allowing its visualization in real time. This data is gathered by the KinectSensor class, which allows the detection by Gesture Detector class and its descendants. The data is converted from the sensor to a two system coordinate to be used by the applications, e.g., presented to the user on the screen.

The determination of the gesture is a process based on different gesture detectors. Kinect Toolkit includes some, which are represented in Figure 5. The ones shaded are the ones which include major changes for the approach used in this demonstration. The objective of these detectors is to separate detectors

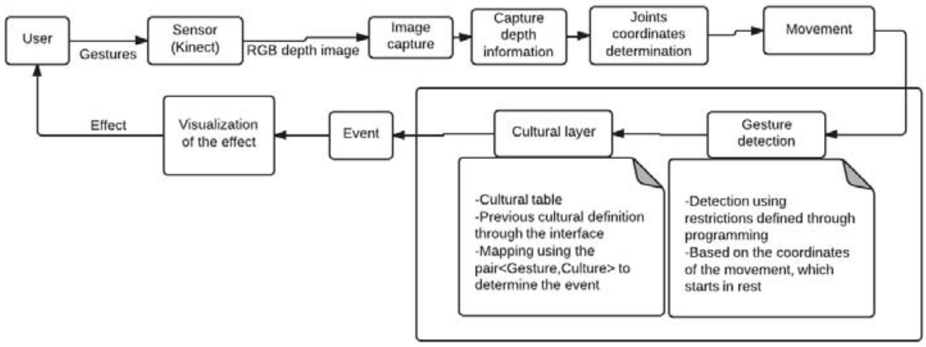

Fig. 4. Flow of the developed solution.

according to the similarity of gestures. Therefore, each detector includes various characteristics relevant for each type of gesture. The evolution of the system would require the creation of more subclasses of GestureDetector if gestures were linear. If gestures were complex, it would require the use of additional classes based on Kinect Toolkit design.

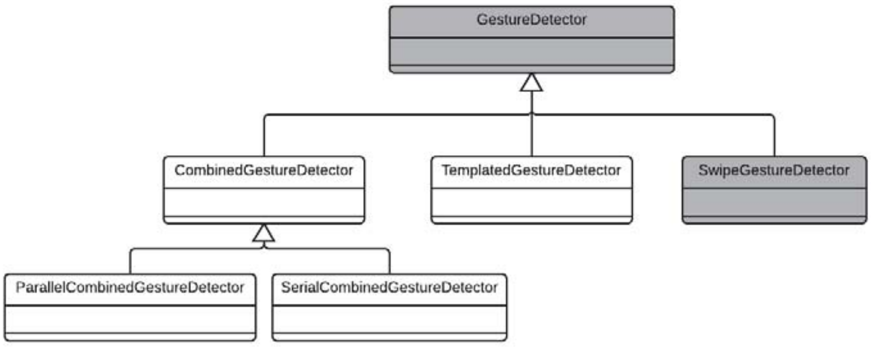

Fig. 5. Gesture Detector diagram.

After gesture detectors are registered, they are passive and waiting for the user to perform any gesture. As explained above, each detector has its own attributes, specific and adequate to the gestures they are prepared to recognize. The analysis of each movement is based on restrictions upon the points where the gesture takes part. If the gesture satisfies the conditions, it is accepted by the detector and the respective feedback is expressed. The amplitude of the movement can be taken into account producing different outputs on the system. This functionality can be considered as a filter on the movements because it depends on general conditions and available to all the detectors.

The cultural layer was introduced as a lookup table between the gesture detection and the feedback layers. Given a pair constituted by the gesture's name and a Culture, it could get the matching feedback. The simplistic scene created for demonstration purposes of the feedback was implemented using the Tao Framework [4]. This framework allowed the use of OpenGL in the project, under a .NET environment. Despite having some alternatives, this was successful as it allowed to receive keystrokes from another applications, as it is done with the developed application for the gestural interaction to affect the scene.

3.4 Culture

The importance of the cultural background of an individual to understand his interaction with a system is referred in the work from [14]. It proposes the analysis and inclusion of this variable to be taken into account in the design of interfaces.

Several questions arose in this work regarding culture integration. One of them was certainly how to include culture to check if it was measurable or deductible. As that analysis would require a heavy computation and time spent, it is required for the user to introduce its cultural background when initializing the application. This saves time and reduces (or even eliminates) analysis error regarding the cultural background of each user.

The use of culture as a computational notion is important and in this application tackles the way the user interacts with it. The configuration of different cultures can be compared to a translator change. Meaning that user's with different cultural backgrounds may expect different outcomes from each recognised gesture, depending on their history. The detailed mapping is expressed on Table 1.

Besides the use of dynamic gesture, such as the ones expressed by Table 1, there was also the definition of some predefined postures, based on previous existent work from Kinect Toolbox. The values in bold represent the ones more relevant for testing issues.

Observing the values on the lookup table, there are various relevant cases for our application: cases when a movement has the same output in each defined culture, cases when the same movement has different meanings according to a culture and cases when two different movements have the same output, each one from a different culture. It is important to emphasize that the values expressed on Table 1 are illustrative of the potencial of the developed system. This gathered data proved very useful to determine the results of the implementation.

3.5 Applications

There are several possible applications for the implemented system. The creation of a scene was purely for demonstration purposes.

[4] More information on: `http://sourceforge.net/projects/taoframework/`

Table 1. Cultural Gesture Mapping table definition. This data was used for evaluation.

Gesture	**Culture**	**Feedback**
SwipeToRight	Culture1	Right
SwipeToRight	Culture2	**Down**
SwipeToRight	Culture3	Right
SwipeToLeft	Culture1	Left
SwipeToLeft	Culture2	Left
SwipeToLeft	Culture3	Left
SwipeToTop	Culture1	Up
SwipeToTop	Culture2	Up
SwipeToTop	Culture3	Up
SwipeToDown	Culture1	Down
SwipeToDown	Culture2	Down
SwipeToDown	Culture3	Down
SwipeToFront	Culture1	PGUP
SwipeToFront	Culture2	**Right**
SwipeToFront	Culture3	PGUP
SwipeToBack	Culture1	PGDN
SwipeToBack	Culture2	**Left**
SwipeToBack	Culture3	PGDN

The actual application allows the control of other applications in foreground, using emulated keystrokes to send data to other applications or our test scenario. It is therefore dependant on the correct mapping of keys and actions. The use of software such as AutoHotKey permits customization on that matter.

As a proof of concept, this system needs future improvements to allow a better use on their targets someday. Augmented Reality applications, games and the generic control of computer and gaming platforms are some of the applications intended for this gesture recognition system.

4 Evaluation

Regarding analytical methods, a static analysis was performed. Despite gesture complexity not being high, the combination of gestures and precise detection is very important. Dynamically speaking, the performance of the system was satisfactory, because the response seems instantaneous. This was critical, as gesture recognition systems must be responsive, as users expect fast response to deem it natural. And, in this case, seemingly instantaneous feedback.

Controlled experiences and simulations were part of the experimental methods. These experiences, together with the Testing methods, include all the testing process involving the solution developed during this work.

For last, descriptive methods include all the data gathered during the Literature Review that support the importance of the system as a first step in the evolution of the concept of the shamanic interface, therefore utterly important for future developments in the area.

Following, the objective of adding different gestures and detectors is important, so it is important to understand the scope of each one of the already defined gestures and deeply test the gestures newly created. The same logic goes for postures, to understand their limits and eventual Microsoft Kinect failures related to them. This testing program required some time to allow the detection to be the more precise possible.

The following set of tests included the correct inclusion of the cultural layer in the system and the verification of a correct mapping according to defined gestures in the application.

After this setting of tests, the intuitive and obvious cultural feedback was missing. The creation of a scene to observe gestural effects on a cube was a simple solution to this problem. A more elaborated scene should be completed to allow different and more complex interactions, but that is expected to be worked in the future.

On this validation phase, tests consisted on different and obvious effects according to the culture. Therefore, we could have different gestures with similar outputs and similar gestures with different outputs, with one variable: culture. The pair gesture-culture defined the output.

4.1 Demonstration

The demonstration phase include some images on the gestures performed, along with some small videos demonstrating the use of the developed system, during this research.

In Figures 6 and 7, we can observe the different parts of the movement SwipeToRight under Culture 1, which presents a movement of the horizontal referential to the right. The complete movement is presented as a video in `http://www.youtube.com/watch?v=J56aBvF6gW0`.

On the other hand, under Culture 2, the same movement provides a different feedback, as observed in Figure 8. This situation is also expressed in a small video presented in `http://www.youtube.com/watch?v=WPOtXhvYTj0` to facilitate the understanding of the movement.

It is also important to note the importance of testing gestures that return the same feedback in different cultures, which is expressed in Figure 9 and in `http://www.youtube.com/watch?v=72ww-MSNErI`. In this case, the movement SwipeToFront in Culture 2 has the same result as SwipeToRight in Culture 1.

These tests were important to analyse the feasibility of the integration of cultural background in a gesture recognition system and also the more important features to focus, specially for future developments in the area.

After a testing phase it is important to discuss the results and trace the future of the application and specify the next steps on evaluating it. To prove the importance of the developed gesture recognition system, some more gestures culturally related shall be defined to provide substantial data for user testing. The relevance of user testing would show the acceptance of the defined gestures and also from the developed solution in some end-users. This data would also

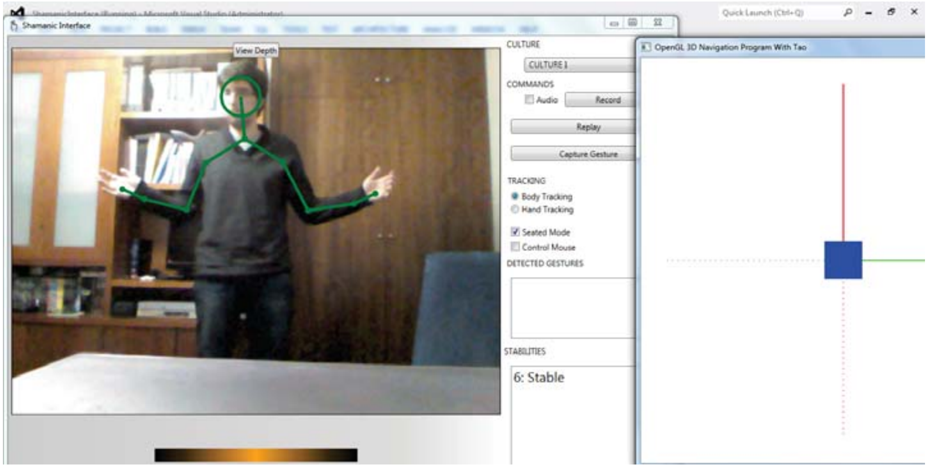

Fig. 6. Beginning of the Swipe to the Right movement.

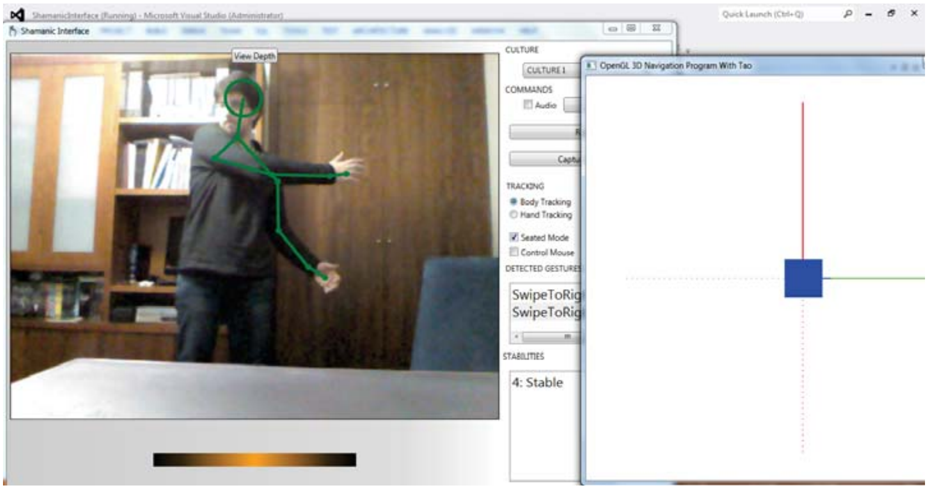

Fig. 7. The end of the Swipe to the Right movement.

be important to gather information on how to improve the system in the user point of view.

5 Conclusions

This area is greatly unexplored, leaving room for several improvements in upcoming years. During this study, a basis for future development and discussion in the area is achieved. But many possibilities of development have risen during this work.

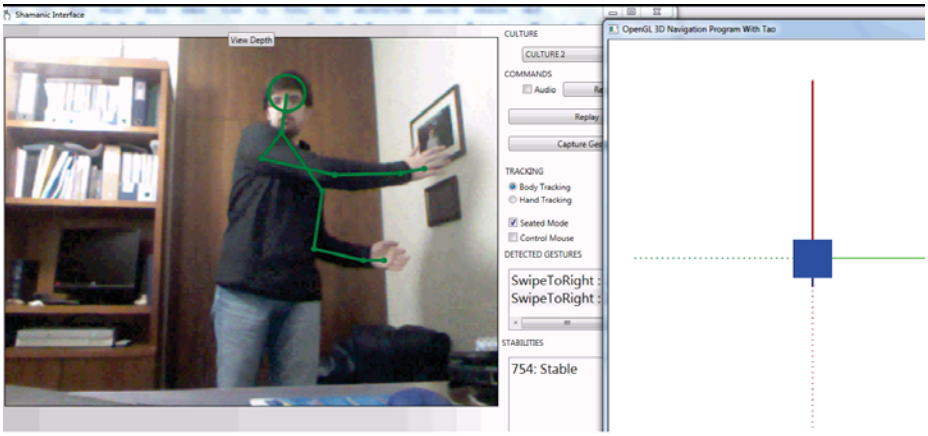

Fig. 8. Swipe to the Right under Culture 2.

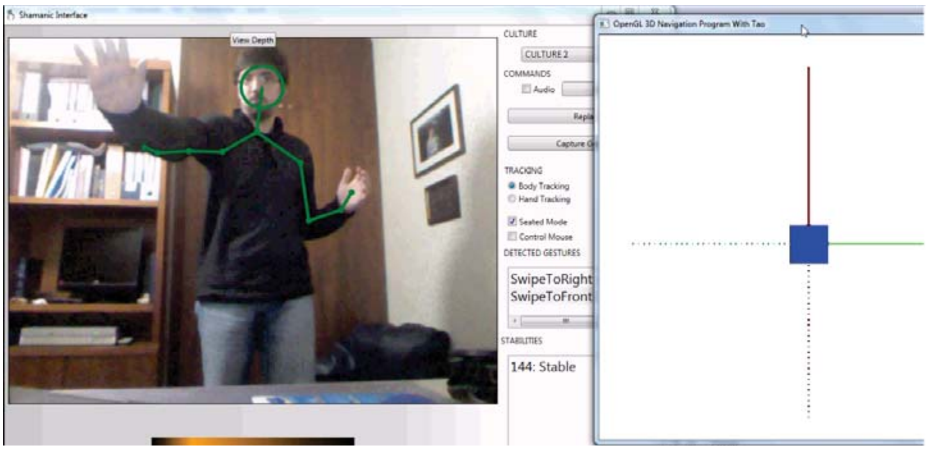

Fig. 9. Swipe to Front under Culture 2.

As explained in detail in Section 3, gestures are mapped into actions, using a lookup table, in the proof of concept, more specifically, a C# dictionary. Therefore, from a gesture and a culture combined, using the lookup table, the user gets the expected feedback. In this area, the main gesture recognition systems tend to depend heavily on gesture training to increase the number of gestures detected. On the other hand, on the developed system that feature was not planned, although it would be a major addition on an eventual future release. To recognize gestures, usually systems tend to recognize simple gestures without adding different perspectives on them. Gestures can be different one another, depending on amplitude of the movements and rhythm for example. To overcome this issue, a filter layer was created, separating movements also according to amplitude and rhythm, originating different feedbacks.

The analysis and testing of the system was continuous and always looking for logical feedbacks for the defined gestures. This work can be improved, using data from future users and through a more in-depth analysis of different cultures and habits. According to the way the mapping is achieved, the substitution of difficult to perform or impossible gestures is possible, changing the feedback of the system. Despite gestures are not culturally related at the time, the used feedbacks are simple and intuitive to illustrate the concept. After these inclusions, it is important to assess the performance of the system, for instance using a training set to train a Support Vector Machine (SVM) classifier combined with a confusion matrix in order to show the effectiveness of the classifier as well as the average precision.

The use of Microsoft Kinect for this work was a good choice and the possibility of migrating the system to Microsoft Kinect SDK 2.0 is a major advantage as it is expected that the proof of concept can combine hand and body detection at the same time with precision. On the other hand, at the moment, gesture detection using Microsoft Kinect tends to depend on firing events when the gestures are detected. Using this approach, a scalability issue may arise when the number of detectors and events is too high, but no such issues came up during development.

Gesture recognition has been shown to be very useful in Human Computer Interaction. Nevertheless, there are inherent limitations related to performing some commands, as some are difficult to perform and others are impossible to replicate. Besides, the impact of the inclusion of the cultural component to overcome the challenges of creating meaningful gestural abstractions as alternative movements is not well studied.

At first, for a better gesture interaction system, hand motion would be an interesting add-on, specially related to static gestures. At the moment, the only possibility to have hand tracking along with body tracking is to divide on phases, because 20 tracking points are not enough for a precise simultaneous hand and body tracking. With the recent launch of Kinect 2.0, there will be a new software development kit which is expected to allow a more precise detection of hand and body. It is also expected that the number of tracked points increases, which would go according to the idea intended in this work: the shamanic (or anti-shamanic) Interface would benefit from more points to track, allowing the simultaneous precise detection of hand and body motion. Along with the arise of the new version of the Kinect device, it is required the adaptation of the proof of concept to the new version of Kinect, using the new features and improving the system substantially.

Being this implementation a proof of concept, it is not really complete in terms of gesture diversity. It would be an improvement the addition of more complex gestures and a broader set of gestures, also to allow a more significant testing in the evaluation phase. Therefore, a more wider evaluation phase, including different users, preferably from different cultural backgrounds. This diversity of testers would enrich the system and provide valuable feedback to help understand if the system is evolving in the right path. Besides, suggestions of improvements on the mapped gestures and association to real cultures are the logical step of a system like this.

Through all the recent research in human-computer interaction through gestures, new devices like Myo and the new version of Kinect are being launched in the next months. After the launch it is interesting to analyse the impact of integrating any other devices with Kinect, improving the control of computers and electronic devices. As Kinect 2.0 will substitute the actual version, this could be done using Myo, but keeping in mind that one of the important points of the investigation addresses the simplification of the interaction so using coupled devices such as Myo can turn this situation more difficult. This was also one of the reasons Nintendo Wii Remote was excluded from the study, but it is expected that Myo bring certain advantages and less discomfort than the Wiimote and also more precision and diversity of movements, because it does not only depend on an accelerometer as Nintendo Wii Remote.

Actually, the use of emulated keystrokes allows a great variety of usages, allowing the user to interact with another applications, as long as they are in foreground. Even though, it is very difficult to control a variety of applications, defining interaction models could be a very interesting step, allowing similar applications to behave equally when the same keystrokes are received. This homogeneity would be very useful for a real scalable application, relating to other applications control. The possibility of adding keypress actions is also very interesting as it would allow a more precise control of applications, not being restricted to keystrokes.

Furthermore, the use of avatars to express the real movements the user pretends when he does the alternate movements could be a major benefit: it could simultaneously help people understand the uses of the application and simulate its final usage. This could be an addition on a different mode of the application. The skeletal tracking is already done using Microsoft SDK and presented to the user, so this addition would complete the information provided by sending commands to move an avatar using for example OpenSimulator or other avatar-based systems.

To conclude, this area is vast and not very explored, therefore the progression possibilities are immense and many different paths lie ahead.

5.1 Acknowledgements

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6 References

References

1. Rivera, M. L., Normoyle, A., I. Badler, N.: Project PAALM : Phalangeal Angle Approximation through the Leap Motion Controller, 497500 (2013)
2. Pu, Q., Gupta, S., Gollakota, S., Patel, S.: Whole-Home Gesture Recognition Using Wireless Signals. Washington (2013)
3. Rehm, M., Leichtenstern, K.: Gesture-based mobile training of intercultural behavior. Multimedia Systems, 18(1), 3351 (2011)
4. Suarez, D.: Freedom. London: Quercus Publishing Plc. (2010)
5. Suarez, D., Daemon (p. 632). London: Signet (2009)
6. Morgado, L.: Cultural awareness and personal customization of gestural commands using a shamanic interface. Proceedings of the 5th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion (DSAI 2013) (Vol. 00). Vigo: Elsevier B.V. (2013)
7. Valli, A.: The design of natural interaction. Multimedia Tools and Applications, 38, 295305 (2008)
8. Krahnstoever, N., Kettebekov, S., Yeasin, M., Sharma, R., St, S. A.: A Real-Time Framework for Natural Multimodal Interaction with Large Screen Displays, Proceedings of the Fourth IEEE International Conference on Multimodal Interfaces (ICMI02) (2002)
9. Yin, Y., Davis, R.: Toward Natural Interaction in the Real World : Real-time Gesture Recognition, Proceeding of the International Conference on Multimodal Interfaces and the Workshop on Machine Learning for Multimodal Interaction (ICMI-MLMI), Association for Computing Machinery (ACM) (2010)
10. Villaroman, N., Rowe, D., Swan, B.: Teaching Natural User Interaction Using OpenNI and the Microsoft Kinect Sensor. SIGITE11 (pp. 227231). New York, New York, USA: ACM Press. (2011)
11. Champy, A. S.: Elements of Motion : 3D Sensors in Intuitive Game Design. Analog Dialog, 41(4), 14 (2007)
12. Heimgrtner, R.: A Tool for Getting Cultural Differences in HCI. In K. Asai (Ed.), Human Computer Interaction: New Developments, 343368 (2006)
13. Kistler, F., Endrass, B., Damian, I., Dang, C. T., Andr, E.: Natural interaction with culturally adaptive virtual characters, Journal on Multimodal User Interfaces, 6, 3947 (2012)
14. Kistler, F., Endrass, B., Damian, I., Dang, C. T., Andr, E.: Natural interaction with culturally adaptive virtual characters, Journal on Multimodal User Interfaces, 6(1-2), 3947 (2012)
15. Cassola, F., Fonseca, B., Morgado, L., Martins, P., Paredes, H., Carvalho, F. de.: Online Gym : um ginsio virtual 3D integrando a Kinect anlise comparativa de bibliotecas de suporte. Videojogos2013 (2013)
16. Lukowicz, P., Amft, O., Roggen, D., Cheng, J.: On-Body Sensing : From Gesture-Based Input to Activity-driven Interaction, Computer, 43(10), 9296 (2010)