ATELIER – ASSISTIVE TECHNOLOGIES FOR LEARNING, INTEGRATION AND REHABILITATION

Anabela Gomes[1, 2], César Páris[1], Jorge Barbosa[1], Álvaro Santos[1], Nuno Martins[1] and Ana Rita Teixeira[3,4,5]

[1]*Engineering Institute of Polytechnic of Coimbra, Rua Pedro Nunes, Quinta da Nora, 3030-199 Coimbra, Portugal*
[2]*Centre for Informatics and Systems – University of Coimbra, P. II - Pinhal de Marrocos, 3030-290 Coimbra, Portugal*
[3]*Coimbra Education School of Polytechnic of Coimbra, Rua D. João III Solum, 3030-329 Coimbra, Portugal*
[4]*Institute of Electronics and Informatics Engineering of Aveiro – University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro – Portugal (FCT Ref:SFRH/BPD/101112/2014)*

ABSTRACT

A special needs individual is a broad term used to describe a person with a behavioural or emotional disorder, physical disability or learning disability. Many individuals with special needs are limited in verbal communication, or in many cases non-verbal, making communication and learning a challenging task. Additionally, new forms of communication based on technology aren´t designed for them, making them increasingly isolated in social and educational terms. In spite of this, and fortunately, new forms of interaction do exist and they enable these particular users to access knowledge and provide them with the ability to interact with others, undertaking otherwise impossible. In this project the technology used will not be an end in itself but only a way to "drop" the mouse/keyboard paradigm making use of affordable devices available in the market that could be adopted by people with special needs that are unable to apply the traditional forms of interaction, thus assisting people in their education, integration and rehabilitation activities.

KEYWORDS

Assistive Technologies, Games, Integration, Learning, Rehabilitation, Special Needs

1. INTRODUCTION

The success of individuals with special needs, in terms of learning, work and social integration, is very dependent on the continued support that society can give them. These individuals are usually denied access to a set of essential services for their social and professional integration, mainly due to the lack of equipment and solutions that enable them to overcome their needs whether in or outside the classroom. The basis of this work focuses on the fact that in the first instance people need to communicate in order to integrate into society. However, people with cerebral palsy who are nonverbal or whose speech is not clear to communicate effectively have severe problems. To overcome the communication problem augmentative communication devices have been created. They include tools and methods that help individuals to communicate more easily and effectively, such as, communication boards, symbol systems, programmable switches, electronic communication devices, speech synthesizers, recorded speech devices, communication enhancement software and voiced word processing. Our group has already developed an alternative communication platform (Santos et al., 2015), a pictographic system with the interface customization of the communication system, meeting the special needs of each user. In recent years there has also been a huge advance in the exploration of new and low cost equipment, allowing the acquisition of biometric data (neuronal, ECG, EDA, EMG,...) which open the way to new forms of interaction with the computer, facilitating their INTEGRATION into a society increasingly dominated by new technologies, simplifying their LEARNING and contributing towards their REHABILITATION. Also the appearance of different platforms as EyeToy (Sony's PlayStation2) and the later version of Move (Sony's PlayStation3), Kinect (Microsoft's Xbox 360) and Nintendo's Wii have allowed new forms of interaction with the user, without having to handle some kind of physical interface. Even though these platforms have been used primarily for gaming, on commercial terms, its use is not restricted for this purpose and can be used to address

accessibility issues for users with special needs. In this sense, the people involved in this project have already developed some studies (Teixeira, Tomé and Lang, 2011) and applications with Kinect (Almeida et al., 2012). However, this research also intends to study new forms of multimodal interaction for efficiency comparative purposes. The combination of these and other suitable equipment to the needs of each individual can provide them with a better integration in our society. The technology alone is not the solution. In the context of this project we intend to develop a set of software packages that allow fostering EDUCATION, REHABILITATION, LEARNING and INTEGRATION. This is a cross-sectional project covering different knowledge areas: Special Education, Multimedia, Signal Processing, Human Computer Interaction, Games and Computer Graphics.

2. PLAN AND METHODS

This section describes the plan and methods defined to accomplish the presented research project. Some points of views and possible methodologies to adopt are shown. Also briefly described are how the project will contribute to the advance of the state of the art and also the ideas that will allow achieving these goals.

2.1 Phase 1 – Study and Characterization of Cerebral Palsy Disease

Our main public are people with Cerebral Palsy (CP) due to the fact that we have already work initiated with them, working in cooperation with some local institutions in the field of children with disabilities, in particular with APCC (a Portuguese acronym for the Association of Cerebral Palsy of Coimbra) and APPACDM (a Portuguese acronym for the Association of Parents and Friends of the Mentally Disabled Citizen). Although patients with cerebral palsy may have cognitive delays, this does not directly imply that they have a deficit of intelligence, they may only have learning difficulties for sensory reasons or lack of ability to interact with the surroundings. This phase involves the analysis and classification of CP types, based on the nature of the movement disorder and the typographical distribution. It is common to use the Surveillance for Cerebral Palsy in Europe (Cans, 2000). In addition to this classification we also want to classify the level of functional severity and activity limitation among children with CP. The basis for this study can be the Gross Motor Function Classification System (Palissano et al., 1997) widely employed, however other possibilities will be explored. Thus, the first stage of this phase will be the characterization of CP in its various aspects and types. Followed by research on existing games and applications commonly used to help people with this problem. The analyses will enable us to determine software and interaction needs. This task will also require the implementation of specific prototypes in order to test some small aspects of interaction. From this we intend to prepare a report that includes: The Characterization of the CP in terms of typologies and level of functional severity; The examination and compilation of the evidence for the application of interactive computer games and applications in the interaction of people with sensorimotor disorders; The study of different types of devices and ways of interaction usually used by individuals of various diseases as well as the study and obtaining of a list of different types of requirements.

2.2 Phase 2 – Multimodal Interfaces Analysis

Human-Computer Interaction is a fast growing topic/subject which is inflowing to a multimodal stage that goes beyond the WIMP (Windows-Icons-Menus-Pointers) paradigm. Voice, gestures, force feedback and many other existing sensors can enhance human interaction with computers and allow people with disabilities to interact with them. Combining the practice of new devices and using them in multimodal interface applications will be a common action in the near future and the challenge of this work is to study, test and develop multimodal interfaces that will allow individuals with physical or cognitive disabilities to take advantage of the applications that are available. Several interaction devices and tools can be used for this purpose. Head and eye tracking systems (from lower cost cameras, such as the common webcams, to expensive systems using infrared cameras like Nintendo), Microsoft Kinect, Brain-Computer Interfaces, Physiological sensors (EMG-electromyography, EDA-electrodermal activity, or ECG-electrocardiography), could be integrated as forms of interaction in the applications we intend to develop. Therefore, we intend to develop, implement and evaluate a personalized multimodal recognition system to improve access to

assistive technology for individuals with significant speech and motor impairments as the ones with CP. It will use multiple sensors to capture vocalizations, head movements, hand and body movements filtering out involuntary gestures and sounds. These aspects will be preceded by an evaluation whether access to different interaction low-cost modalities improves the motor interaction control in the individuals, exploring and comparing the applicability of various kinematic measurements in order to propose new and feasible interaction instruments used to assess motor control activity.

2.3 Phase 3 – Integration through the Improvement of Symbolum

A person that cannot communicate often experiences great amounts of frustration, affecting his/her self-esteem, and preventing their progress in many aspects of life – learning, relationships and more. A wide variety of Augmentative and Alternative Communication (AAC) systems have been used with children who are nonverbal. In this task, we intend to improve software that we've already developed (Symbolum) allowing individuals with verbal communication problems to communicate. This application will be integrated with several different interfaces, identified in Task 2, creating a multimodal approach so that individuals can take advantage of the most effective method for a particular situation. Aiming towards the INTEGRATION of these individuals, this application should allow interaction in widely known social networks such as Facebook or Twitter. As some individuals may not have the recommended age, or may not be prepared for integration into a vast network, a private social network will also be implemented. In that network the admission will be controlled, allowing different users to share the same reality and problems while establishing contacts among themselves and their families, in a more private and controlled environment avoiding situations such as cyberbullying. Another consideration is the physical impairments that limit the use of the system by CP individuals. As portability is very important for someone who needs to use a wheelchair we considered the use of tablets as the most suitable equipment to implement in this system, due to the screen size combined with the portability advantages. This system already has a standard interface based on direct manipulation. However, several other improvements based on the above-cited explanations will be considered. In conclusion, we expect to complete an application, which will be made available in online application stores as well as the development of a private social network.

2.4 Phase 4 – Games for Posture Rehabilitation

There is clearly a need for more research regarding commercial video games in rehabilitation for people with CP. But, before we can start to plan large controlled studies we need to explore if such games are actually feasible to use in training. Computer games aren't usually thought of by health practitioners for their health benefits, but they may become a prominent part of rehabilitation programs. Using games to stimulate physical therapy for a person with cerebral palsy is our intention for this task. Therefore, we want to analyze, define and develop motion interactive games to attempt to keep the interest of the CP users and produce physical interaction enabling rehabilitation contributing to promote short-term motivation for practice and general physical training. Specific effects on motor control need to be further explored and there is also a need for reliable tests that are adequate and sensitive enough to capture changes in movement control. In the development of interactive games for rehabilitation purposes, it is a challenge to preserve the motivational and social features of games while at the same time optimizing an individualized physical training. In conclusion, we aim to achieve the following main stages: The examination and compilation of interactive applications and games for the rehabilitation of individuals with sensorimotor disorders; The creation of an application that detects if the user has bad posture (This application should be based as much as possible, in low-cost sensors (webcam, Kinect and other sensors identified in Phase2)); The creation of an interactive multimedia application on the precautions regarding posture and physical therapy exercises associated with pain zones located in the body; The creation of games where people can practice good posture while playing; The feasibility evaluation of interactive games used in physical rehabilitation in children with cerebral palsy.

2.5 Phase 5 - Games for Learning and Integration

From a popular perspective, computer games evoke fun reactions. However Gaming also has been used in educational circles since at least the 1900s. The early 2000s saw a surge in different types of educational

games, especially those designed for the younger learner. More recently different types of games approaches have also been developed to engage students in the process of learning. Kazimoglu et al. (2012) discuss Computer video games and game-like environments are strategies commonly used as a motivational tool to engage students in learning programming. Nowadays there is also a great enthusiasm concerning serious games (Eagle and Barnes, 2009). However the main idea in this task is to design, implement and test a package of instructional games that can be as engaging as action games and at the same time could bring useful learning outcomes for people with disabilities. We are particularly worried with young people suffering from these disorders. However, for the development of these types of games several sets of guidelines should be followed. BBC Accessible Games Standard (Lee, 2010) and the Game Accessibility Guidelines (Elis et al., 2012) are some examples. These guidelines are the product of experts in game design and accessibility standards. We will also focus on defining guidelines for games that will train their cognitive and learning skills. As a result of this research a report is expected, laying down the foundations for the work to be undertaken. We will start developing a series of games that will allow them to train their cognitive skills, using different interfaces. These games must have a fun element, engaging people while they are interacting with the computer. Field trials will be carried out, and the games will be evaluated taking into consideration all the relevant aspects – the way children engage, their pedagogical value and their usability and ease of use. The best game will be selected for improvement, and to add a social component allowing players to interact socially with other players.

3. CONCLUSION

The major concern of this work is researching and developing tools that allow people with special needs, especially those with communication needs, to integrate into society. Our group has already developed some systems that correspond to these objectives. However, we are now looking for solutions implying low cost equipment and new forms of interaction with the least possible maneuvering of physical interfaces. Therefore, this research intends to study, integrate and develop new forms of multimodal interaction facilitating the INTEGRATION into a society, the LEARNING and contributing towards the REHABILITATION of people with special needs. This paper describes the plan and methods defined to accomplish this idea. Some points of views and possible methodologies to adopt are presented. Also briefly described are how the project will contribute to the advance of the state of the art, the ideas that will allow the team to achieve the goals and the results expected.

REFERENCES

Almeida, B. et al, 2012. Applications for people with special needs using Kinect. *Proceedings of Portuguese Conference on Pattern Recognition*. Coimbra, Portugal.

Cans, C., 2000, Surveillance of cerebral palsy in Europe: a collaboration of cerebral palsy surveys and registers. *In Developmental Medicine & Child Neurology*, Vol. 42, pp. 816-824.

Eagle, M., and Barnes, T. 2009. Experimental evaluation of an educational game for improved learning in introductory computing. *Proceedings of the 40th ACM Technical Symposium on Computer Science Education*. Chattanooga, TN, USA, pp. 321-325.

Ellis, B. et al, 2012. Game Accessibility Guidelines. Available: http://www.gameaccessibilityguidelines.com/. [Accessed: 26- Jan-2016]

Kazimoglu, C. et al, 2012. A Serious Game for Developing Computational Thinking and Learning Introductory Computer Programming. *In Procedia-Social and Behavioral Journal*, Vol. 47.

Lee, E., 2010. BBC - Future Media Standards & Guidelines - Accessible Games Standard v1.0, Available: http://www.bbc.co.uk/guidelines/futuremedia/accessibili ty/games.shtml. [Accessed: 26- Jan-2016]

Palisano, R. et al, 1997. Development and reliability of a system to classify gross motor function in children with cerebral palsy. *In Developmental Medicine & Child Neurology*, Vol. 39, No. 4, pp. 214-223.

Santos, A. et al, 2015 Symbolum –An Alternative Communication pictographic board for people with inability to communicate verbally. *Proceedings of World Congress on Special Needs Education*. Philadelphia, U.S.A.

Teixeira, A. R., Tomé, A. M. and Lang, E. W., 2011. Unsupervised feature extraction via kernel subspace techniques. *In Neurocomputing*, Vol. 74, No. 5, pp. 820-830.