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Evaluation of semi-automatically generated accessible interfaces for educational games

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ABSTRACT

The increasing body of evidence supporting the use of videogames in educational settings (usually referred to as serious games) is pushing their deployment across different areas of the educational system. However, this increased adoption also raises serious ethical issues: videogames are one of the least accessible forms of multimedia, and if education is to embrace serious games, there is an imperative need for universal accessibility in serious games to prevent a digital divide. However, producing accessible games is expensive and effort consuming, and serious games development already fare with limited budgets. In this work we explore the potential impact of the (semi-) automatic adaptation of game interfaces as a way to facilitate accessible game development (and thus trim the cost down). We propose a game interface model optimized for point-and-click adventure games, a popular genre among serious games that we have used to perform different semi-automatic adaptations in a game. We have tested the resulting adapted game with end users with specific disability profiles. Our tests discovered that the automatic adaptations produced usable games that retained part of their attractive, although different usability issues had a negative impact on the user experience. We also discuss the origins of such limitations and propose possible remediation actions, as well as a refined interface model.

1. Introduction

Education is a Universal Human Right (United-Nations, 1948). As new technologies are brought into the classrooms, equality principles and eventually laws require that they be made accessible to all students to prevent the infringement of this right (see for example section 508 (IT Accessibility & Workforce Division (ITAW), n.d.)). This should also be the case of educational games, commonly referred to as *serious games*, which are rapidly gaining acceptance and represent a promising educational tool for the near future (Johnson, Adams, & Cummins, 2012; Johnson et al., 2013), as evidence proving positive impact on students' achievements (Papastergiou, 2009; Sadler, Romine, Stuart, & Merle-Johnson, 2013) and motivation continues to grow (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Hwang & Wu, 2012).

However, the current levels of accessibility in videogames (both educational and recreational) are still relatively low compared to those of Web-based technologies commonly used to support learning (Bierre et al., 2005; Westin, Bierre, Gramenos, & Hinn, 2011; Yuan, Folmer, & Harris, 2011), and far below acceptable standards. This aspect is especially relevant in ageing populations, like those in most western countries, where the percentage of people affected by any sort of disability is rapidly growing ((WHO), 2011). Lack of accessibility also prevents wider adoption of serious games for the education of students with special needs (Yuan et al., 2011), one of the areas where educational games have shown greater potential but which is still in an early stage (Durkin, Boyle, Hunter, & Conti-Ramsden, 2013). In this area, serious games have been effectively used to teach alcohol-affected children about fire and street safety (Coles, Strickland, Padgett, & Bellmoff, 2007), to improve visual-integrative abilities and sensory integrative functioning in children with Down syndrome (Wuang, Chiang, Su, & Wang, 2011), or to improve students' chances to getting and keeping a job (Lanyi & Brown, 2010). In order to generalize the use of serious games for special education it is indispensable to improve their level of accessibility. Besides, it is necessary to identify those types of serious games that better combine accessible design and educational value for students with special needs.

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One of the most relevant causes of the lack of accessibility in serious games is the non-trivial cost of implementing accessibility into an existing game, an effort-consuming process that may affect multiple aspects of the game. Typically this would require interventions affecting art resources, game design, difficulty adjustments, puzzles, language used, gameplay mechanics, and the different underlying game technologies (Grammenos, Savidis, & Stephanidis, 2009; Ossmann, Miesenberger, & Archambault, 2008). For this reason, game accessibility solutions are usually game-specific and therefore hard to scale and reuse across games. And that is partly why it is rare to find educational games that take accessibility into consideration.

With the goal of increasing the accessibility of serious games we advocate for providing developers with software tools that take care of as much of the process of making a game accessible as possible. We denominate the approach as "semi-automatic" because the developer will always need to deal with some tasks, but the goal is to reduce these manual adaptations to a minimum.

In this paper we discuss a first approach focused only on improving the accessibility of the game interface. Although making a game accessible requires more than providing alternative user interfaces (Grammenos et al., 2009), we consider this work a necessary first step before more ambitious approaches that deal with other aspects of the games can be considered.

The article is structured as follows: in Section 2 we describe the general approach, setup the specific scope of this work, and provide some general context about point-and-click games necessary to understand our work. In Section 3 we describe the general interface model proposed. Section 4 contains a case study where we evaluate the approach, while Section 5 discusses a potential set of improvements that may yield improved results. In Section 6 we describe some related work and finally, in Section 7, we summarize our conclusions and outline the next natural steps in this research area.

2. Approach, scope and context

In this section we briefly introduce our approach (Section 2.1.). We also discuss the actions we have taken to narrow down the scope of this work (Section 2.2.). Finally, we provide an overview of *point-and-click* games from the point of view of their interface and the accessibility barriers and opportunities they offer. This overview is important to understand the game interface model described in Section 3.

2.1. Approach

Our approach to reduce the overhead of accessible game development is to (semi-) automatically adapt the user interface, taking into account the special needs of each user profile, requiring a minimum amount of input from the game author. However, it is still necessary to make simple additions such as providing alternative synonyms for command recognition, making final tweaks and revising the adaptations made by the system. After revising and complementing the automatic adaptations, different versions of the same game are available for delivery to the end-users, each one configured with a different interface (see Fig. 1).

The application of this approach to the adaptation of serious games to different accessibility profiles is a significant challenge for different reasons: (1) The capabilities of persons with disabilities vary a lot for each individual, depending on the type and degree of disability, (2) games have some of the most complex interfaces in modern software, and (3) it is significantly more difficult to make a game accessible than a desktop or web application (Archambault, Ossmann, Gaudy, & Miesenberger, 2007).

2.2. Scope

We have taken two actions to narrow down the scope of this work. First, we have focused on classic "*point-and-click*" adventure games as the target game genre. Videogames are an heterogeneous media and it is not possible to propose a solution that covers all of them at once. We focus on this genre because it has been identified in the literature as having the higher potential for serious and educational applications due to its strong narrative underpinnings (Adams, Mayer, MacNamara, Koenig, & Wainess, 2012; Garris, Ahlers, & Driskell, 2002; M D Dickey, 2006; Michele D. Dickey, 2011).

Second, in our proposal we consider only physical disabilities, focusing on three profiles: blindness, low vision and reduced mobility. Physical disabilities are the most relevant for the purpose of this work since most of the barriers they find in videogames are related to the interface. Cognitive disabilities (another relevant area of research in accessible games (Torrente, Del Blanco, Moreno-Ger, & Fernández-

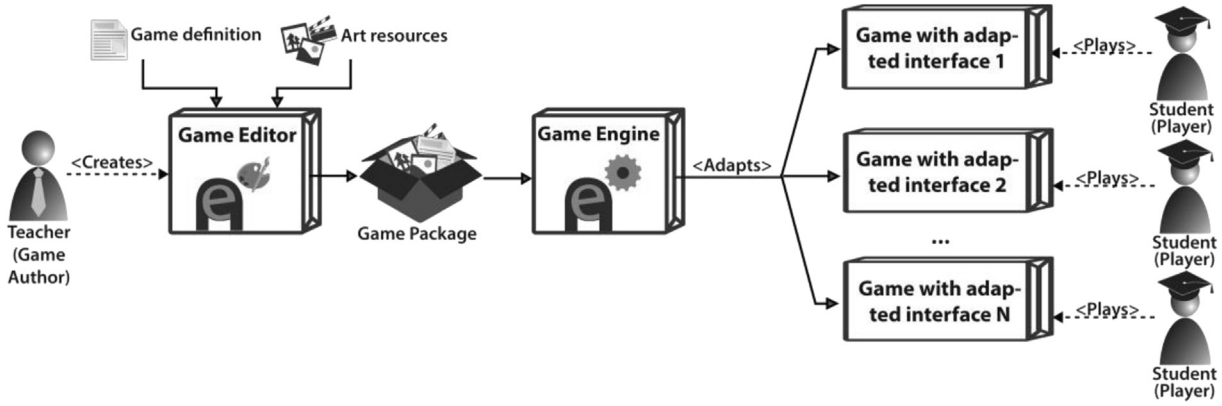

Fig. 1. General approach. Base games are written once and the different accessible variants are generated semi-automatically. The process must require minimal human intervention for cost-effectiveness and maintainability reasons.