VBGhost: a Braille-Based Educational Smartphone Game for Children

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ABSTRACT

We present VBGhost: an accessible, educational smartphone game for people who are blind or low vision. It is based on the word game Ghost, in which players take turns adding letters to a word fragment while attempting to not complete a word. VBGhost uses audio and haptic feedback to reinforce Braille concepts. Players enter letters in the game by using Braille dot patterns on a touchscreen interface. Players can raise or lower dots to create Braille characters using taps and audio feedback from the phone. When a "raised" dot is touched on the screen, the phone vibrates. In VBGhost, a player can either play against the computer or against another person. We demonstrate the potential for the development of fun, accessible and educational games.

Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation] User Interfaces-Haptic I/O. K.4.2 [Computers and Society]: Social Issues-assistive technologies for persons with disabilities.

General Terms

Human Factors; Design.

Keywords

Access technology; blind; mobile games; haptics; gestures.

1. INTRODUCTION

Over the past thirty years, computer and video games have become an important part of youth culture and also emerged as useful tools for learning [2]. Although there has been work on making computer games accessible [7], this area remains largely underdeveloped, and computer games remain largely inaccessible to people who are blind or low vision. As mobile devices become more popular, games are even more ubiquitous and can take advantage of the multi-modal output and input methods of these devices. However, because many of them rely on visual interfaces, only a small portion of these mobile games are accessible to people who are blind. It is important to ensure that blind children have access to a variety of games (both for learning and fun), just as their sighted counterparts do.

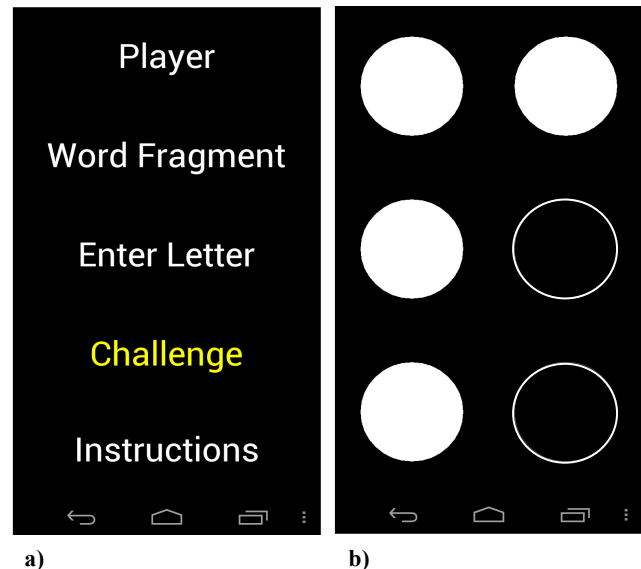One area in which smartphone games might be useful for blind

Figure 1. a) An accessible menu of VBGhost and b) the VBraille interface displaying the letter "p".

children is in learning Braille concepts. Braille literacy is decreasing at an alarming rate in the United States. A 2009 report from the National Federation of the Blind states that only ten percent of the children who are blind are learning Braille [5]. However, Braille is still relevant today: the same study reported that in a sample of 500 blind people, Braille literacy was correlated with a higher level of education, income and employment.

In this paper, we present an accessible game for smartphones based on the word game Ghost. This is a multiplayer game that is accessible to people who are low vision, blind or sighted, as it uses audio, haptic and visual feedback from the phone to convey information. Our contributions are the VBGhost game, which is available for free download through our website,[1] and the code for the game, which is available in our online repository.[2]

2. RELATED WORK

There are thousands of educational smartphone games available to sighted children [2]. Additionally, there are a few smartphone games for blind children, such as TapBeats, which allows players to replicate musical rhythms [4], and the Audio Flashlight, which allows players to navigate a virtual maze using sound cues [7].

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[1] http://vbraille.cs.washington.edu/Applications

[2] http://code.google.com/p/mobileaccessibility/

However, to the best of our knowledge, there has been no work on creating accessible games that teach Braille concepts.

There has also been work with using the touchscreen of a smartphone to input or read Braille. Both Perkinput [1] and BrailleTouch [6] use the touchscreen to input Braille letters. Our work builds upon the VBraille interface created by Jayant *et al*. [3], which divides the smartphone screen into six regions to represent the six dots in a Braille character. The phone vibrates when a "raised" dot is touched and people can double tap a region to raise or lower Braille dots.

3. DESIGN PRINCIPLES
When designing the game, we met with students and educators from the Washington State School for the Blind, and received feedback from educators and students on a prototype of the interface for reading and writing Braille on the phone. Based on this feedback, we followed three principles in designing the game. We wanted the game to be accessible, educational, and social.

Accessible: We created a game that could be operated autonomously by children who were blind or low vision. We made the game accessible by providing multiple ways of entering commands, either by using a touchscreen gesture or a keyboard press if there is a keyboard. We used high contrast menu options so that it would be accessible for those with low vision.

Educational: We created VBGhost to reinforce Braille concepts and provide a fun outlet outside of school to practice the characters. Although it cannot teach the tactile perception needed to read Braille, it can be a way to learn the dot patterns.

Social: We created a two-player setting in VBGhost to allow children to play together. The game is very interactive: children have to pay attention to each other's turn in order to excel. Furthermore, the game allows sighted peers and family members to learn Braille concepts and to identify with blind children.

4. VBRAILLE GHOST
VBGhost is based on the word game Ghost, in which each player adds a letter onto an existing word fragment. A player tries to extend the word fragment without either finishing the word or creating an invalid fragment. For example, given the word fragment "GHOS", if a player added the letter Z, she would lose, because the fragment "GHOSZ" is not the beginning of a valid word. She would also lose if she added the letter T, as GHOST is a complete word. In our application, players navigate the game with accessible menus and enter letters with the VBraille interface. We developed the game using the Android platform on the Google G1 phone.

4.1 Menu Navigation
The game is navigated via accessible menus (Figure 1), which are high-contrast with white letters on a black background. The menu options are read aloud when touched and are selected via double tapping or by pressing a button on some devices. In the start menu, players can choose to play against the phone or another player. In the main menu, the player can choose to listen to the existing word fragment, enter a letter or challenge the other player, if she believes the other player's word fragment is invalid.

4.2 VBraille Interface
Players add letters to the word fragment using the VBraille interface (Figure 1). When entering a letter, the player is presented with a blank Braille character on the screen: a black screen with the outline of six dots in white. When any dot is touched, its number (one through six) is read aloud. To "raise" a dot in the

character, the player either double taps the dot or enters the corresponding dot number on the keyboard. Dots can be removed in the same way. When a dot is raised it is filled in with white, and the phone will vibrate when that dot is touched. When satisfied with their letter, players can press the enter key or swipe with two fingers to submit it.

4.3 Gameplay
The game can be played in either single-player or two-player mode. In single-player mode, the player and the computer take turns entering a letter. The computer chooses which letter to enter next by randomly selecting from all the possible words that can be spelled from the current word fragment. In two-player mode, each player takes turns entering letters and is given the option to challenge the other player at any time. If a challenge is given, the word or word fragment is checked in the game's dictionary and a winner is announced.

5. FUTURE WORK
We have developed a number of similar word games for Android phones and are currently evaluating them in a longitudinal user study with blind children. We would like to determine how effective the games are at reinforcing Braille concepts and how useful and fun they are.

6. ACKNOWLEDGMENTS

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