HapticPong: Low Resolution Games for Visually Impaired

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Abstract
Visual impaired people can, depending on the impairment grade, detect changes on a game board by haptic or audio clues. This scanning process of the game area requires both time and cognitive load to remember the setup. This decreases the intended relaxation through games. As an alternative we propose to use a matrix of vibration motors on the human belly for haptic rendering for designing games for visual impaired people. As an example we will demonstrate a simple pong game played without visual clues.

Author Keywords
visual impaired; maker; game; pong.

Introduction
Most games rely on visual clues and are therefore hard to play by Visual impaired people. There exist ideas to enhance normal tabletop games with haptic clues as well as use audio hints. While this works well for card games, this enhancement for board games result in longer haptic scanning processes for the clues and therefore reduce the fun, as well as results in an increased cognitive load, because the scan has to be processed to an mental image of the board. Chess, which already requires an mental image for planning is played by some people just with an mental image and without a physical board at all. For more simpler, easy access games we propose to use a matrix of vibration

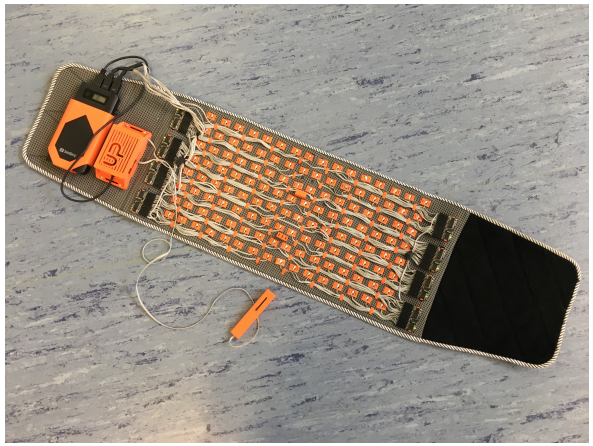

Figure 1: Playing Pong on a haptic belt. 128 vibration motors display both pad and ball position through vibration. The pad is controlled with a linear slider (below).

motors on the human belly for rendering a game. Live adjustments make it possible to even play computer games on it, limited to the low tactile skin resolution compared to the human eye. Basic examples are classic games like pong, snake or simplified Tron or Pacman games. As a test, we adapted a Pong game for a vibration belt with 8*16 vibration motors, with the pads on the 8 pixel side. The game can be either played against a perfect computer player or, using a second belt, also against another human counterpart. Ideas of the community for additional game designs on this platform can be collected while playing the game and getting a feel of it's possibilities.

Related Work

In 2007 Archambault et al. described the challenges of designing accessible games for visual impaired ([2]). With the visual main feedback method for games computer can for enlarging content depending on the grade of visual impairment, also audio feedback can be used to support gameplay. Tactile support (e.g. overlays) can be used for the gameplay, as well as other haptic devices. Since audio feedback is common available, multiple research has be done in this area: From simple instruments - Finger dance let people play melodies with a computer as instrument [4] to full audio adventure games like AudiOdyssey [3]. Haptic feedback mostly consists of few haptic or force feedback points on the human body: Morelli et al. used both audio and haptic feedback for a tennis game for the Wii [5]. In blind Hero [8] as a guitar hero version a special glove with haptic feedback is used as feedback system, additional to the audio feedback of the game. Rock vibe also used vibration feedback, here attached to the arm for a modification of the Rock Band computer game [1]. Wood et al. [7] finally used force feedback on fingertips to navigate in a 3D-world. In all these cases, haptic feedback is only used to give additional local input, not rendering the whole game board in full.

Design and Gameplay

For HaptiPong we are using the HapticToolkit Open-Source-System as basic setup [6]. While intended for navigation, we used just the haptic feedback system, controlled by an Arduino Nano clone with I2C (Fig. 1). With its 16*8 vibration motors it is already on the border of human skin resolution on the belly, and PWM allows a control of the vibration strength better than human perception. As controller a variable resistor is used to control the position the pad for each player, and the game will restart automatically when one side loses. On the available 16*8 pixel game area one column on each side is reserved for the pad. The ball is rendered with two vibration motors horizontally at each time, to make sure stuck or defect vibration motors don't break the

game play. For single player games the computer adversary will play perfect for simplification (Bouncing the ball on all three sides besides the one of the player). The reflection angle will only slightly shift (randomly) when played back by a player.

Conclusion and Future Work

An existing vibration matrix could be easily reused for displaying the pong game board. For multiplayer games a second belt and slider can be used. A LED matrix can be added for demo purposes and inclusive gameplay. Since we could reuse most code from a standard arduino pong game, just changing the rendering from a LED matrix to the vibration motor matrix, we will in future modify other basic games for this feedback system. E.g. a simplified chasing came like pong, with adversaries rendered with different pulsing speeds if catchable or not is one option.

In conclusion games played on low resolution LED matrices can be easily adapted to be displayed on a vibration motor matrix and therefore be playable blind.

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