Tangicraft: A Multimodal Interface for Minecraft

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ABSTRACT
With millions of players worldwide, Minecraft has become a rich context for playing, socializing and learning for children. However, as is the case with many video games, players must rely heavily on vision to navigate and participate in the game. We present our Work-In-Progress on Tangicraft, a multimodal interface designed to empower visually impaired children to play and collaborate around Minecraft. Our work includes two strands of prototypes. The first is a haptic sensing wearable. The second is a set of tangible blocks that communicate with the game environment using webcam-enabled codes.

Author Keywords
Accessibility; blind, children; educational technology; minecraft; video games;

INTRODUCTION
Over the past two decades, researchers have studied the educational potential of video games as contexts to engage with academic content, partake in online communities, and develop 21st century skills. In recent years, Minecraft, a virtual sandbox game has captured children's minds and sparked excitement about its use as an educational tool [4; 6]. However, as is the case with many commercial video games, playing the game relies heavily on being able to see the screen clearly. To promote the inclusion of children with visual impairments in the Minecraft playing community, we propose Tangicraft a multimodal interface.

RELATED WORK
Addressing commercial video game accessibility for individuals with VIs, researchers have augmented visual cues with auditory or tactile feedback. AudioQuake [2] is a modification to the first-person-shooter Quake where audio cues are given when visual cues are present. BlindHero [9] is haptic wearable that allows blind individuals to play Guitar Hero. Vibrations at the fingertips provide players with the necessary information needed to hit the right buttons as the song unfolds. These projects and others have demonstrated how commercial video games can be made accessible to individuals with VIs by modifying the user interface to build on auditory or tactile modalities.

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TANGICRAFT DESIGN
We sought to learn from the lived experiences of families with children with visual impairments. In particular, we wanted to understand better, how children with VIs and their families overcome challenges relating to game accessibility and educational activities. We joined an online group for parents of children with VIs and posted an online survey. The survey included multiple choice questions and open-ended questions regarding what games participants' children played, what activities they engage with as a family, and what challenges they need to overcome in said games and activities. Thirteen parents responded to our survey. The research team then extracted common themes that helped inform our design.

Some parents reported that their children could play video games independently when close to the screen. Others said that their children could not participate in gameplay unless someone around them kept them informed as to what was going on. This theme of providing verbal feedback came up in relation to video games as well as other forms play (e.g. board games).

Based on the literature and the aforementioned survey, we derived the following design goals: (1) Sensation- The interface should provide non-visual feedback regarding the Minecraft world. (2) Construction- The interface should allow users to build constructions in the Minecraft world using tangible objects. (3) Collaboration - The interface should promote collaboration between mixed ability users.

Prototyping
With the three design goals in mind, we started an iterative prototyping process. In what follows we describe two separate prototypes from our work-in-progress towards an integrated interface. At the time of this writing, we have only started user testing with visually impaired individuals. We return to this limitation in the Future Work section.

Prototype 1
To address our first design goal, we made a wearable that provides haptic feedback during gameplay (See Figure 1). The sleeve contains an Arduino Nano and a grid of nine vibration motors. Utilizing the Raspberry Jam Mod [1] we

run a Python script that polls the 3 x 3 grid of blocks before the avatar's current position. The board actuates the motors contingent on the presence of blocks.

We conducted user tests with three sighted college students who had never seen or played Minecraft before. Each test lasted 20-25 minutes. First, the participant put on blindfolds. Then the sleeve was placed over her arm. A researcher then introduced the game to the participant by handing over a Lego figure and objects made of math link cubes. It was explained that in Minecraft, the player has an avatar and that the world is made of blocks. Then the researcher moved the avatar around placing and breaking blocks while asking the participant which motors she could sense.

The tests revealed a need for better discernibility between the motors. Users had a difficulty recognizing more than two motors vibrating simultaneously.

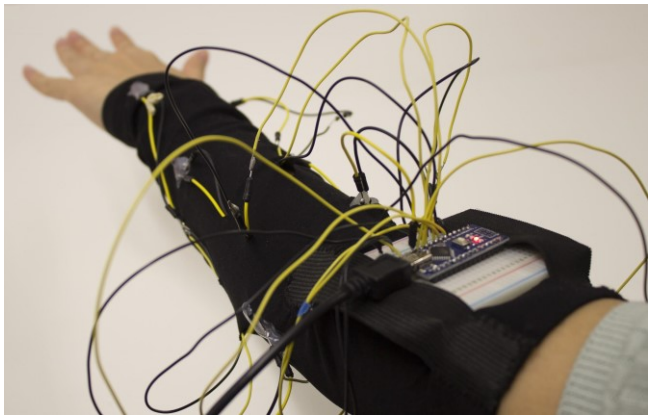

Figure 1. A wearable sleeve using an Arduino Nano and a 3x3 grid of vibration motors that sit along the forearm.

Prototype 2

To address our second and third design goals, we used laser-cut wooden blocks with TopCodes [8] on each block's sides (see Figure 2). TopCodes is a computer vision library that can be programmed to create tangible user interfaces. We created a web app that detects the TopCodes and places a corresponding object in the Minecraft world when a trigger is given. This trigger can be in the form of an Arduino button press or speech commands.

PRELIMINARY USER TEST

As we worked on recruiting families of children with VIs, we set out to test the interface with sighted children who had played Minecraft. We tested our second prototype at a science and technology event for children and their families in a Midwestern city. Fourteen participants with a mean age of 11.86 years (SD = 2.74) participated by building in creative mode either on their own or with a partner. Participants then filled a short questionnaire that included the System Usability Scale (SUS) [3]. Participants gave the interface an average score of 72.32 (SD = 13.92).

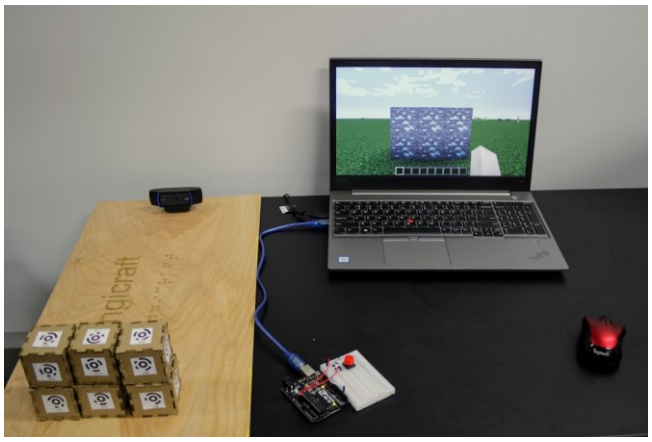

Figure 2. Blocks with TopCodes [5] are arranged into an object in front of a webcam. Upon pressing the button or speaking a command, a corresponding object is placed in the Minecraft World.

CONCLUSIONS AND FUTURE WORK

We started this work with the goal of making Minecraft accessible to children with visual impairments. We conducted an online survey and built two prototypes towards a proposed integrated interface. Future work will focus on refining the first prototype to provide feedback that is more discernable. This may include testing a force feedback interface, or testing various vibration motor configurations.

We are currently testing our second prototype with users with VIs. We plan to expand the speech model and the blocks to allow players to construct programmatically objects in the game using Python. We hope this will promote users to think programmatically and experience self-expression in the Minecraft world [7; 8].

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