AcceleSpell, a Gestural Interactive Game to Learn and Practice Finger Spelling.

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ABSTRACT
In this paper, an interactive computer game for learning and practicing continuous fingerspelling is described. The game is controlled by an instrumented glove known as AcceleGlove and a recognition algorithm based on decision trees. The Graphical User Interface is designed to allow beginners to remember the correct hand shapes and start finger spelling words sooner than traditional methods of learning.

Categories and Subject Descriptors
I.5.5 [**Computing Methodologies**]: *Interactive Systems.* J.5 [**Computer Applications**]: *Language Translation.* K.8.0**.** **[Personal Computing]** Games.

General Terms
Design, Human Factors, Standardization, Languages.

Keywords
Finger spelling, Interactive Games, Instrumented Gloves.

1. INTRODUCTION
By the end of last century, around 13 million people communicated to some extent in American Sign Language (ASL) in the United States, representing the fourth most used language in that country. It is also estimated that ninety percent of native signers were born to hearing parents who do not know sign language [1]. Since early childhood is a critical period for linguistic development, not only spoken language but also ASL acquisition [2], deaf children born to hearing parents usually evolve at a much slower pace as compared to hearing children learning spoken languages, and deaf children of deaf parents. This has been attributed to incomplete language models and lack of daily interaction using a language [3], because many times their only expose to language is at school.

The interactive game here described was designed with the idea of helping out to increase the time a deaf children is actively learning and practicing spelling, based on the fact that children are playing computer games ate arly ages. Already in 1999, 17% of children age 2 to 7 and 38% of children 8 to 13 played video games on any particular day [4].

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The current trend on video games is to incorporate as many sensorial clues as possible to give the user a complete immersive experience, effectively incrementing the time a player is engaged to a game. Instructions or clues based on English grammar, or audio, are inaccessible to deaf children, therefore, the game proposed in this paper is based on gestural interaction. Examples of ASL-based games a few: The Institute for Disabilities Research and Training (IDRT) has developed several computer games where all instructions are given in ASL via video or still images [5], but the gestural feedback from the user is absent. Georgia Tech and the Atlanta School of the Deaf [6] created an interactive game using video cameras, as a way to increase language learning through repetition of instruction signed by the game.

Although video-based systems offer an un-tethered solution, instrumented gloves have given better results recognizing hand shapes. To the best of our knowledge, there is no interactive educational software in the market that is controlled by the captured hand postures of the user, like the one described here.

2. Hardware
"Accelespell" game is based on an instrumented accelerometer-based glove called *AcceleGlove* [7] and a recognition algorithm implemented on decision trees [8]. The glove has six three-axis accelerometers strategically placed on fingers and back of the palm. Each time a PC queries the glove, it answers back with a stream of 18 bytes representing the angular position of each axis with respect to gravity vector. After calibration, the inclination range of 0 - 180 degrees is coded as a value from 0-255, i.e., the resolution is around 0.7 degrees. The glove is powered by current drawn from the USB port, and the 3.3 volts required by the accelerometers is provided by a voltage regulator built in the glove. An image of the glove with the usb cable is shown in Figure 1.

3. Recognition Algorithm.
The recognition algorithm starts by discriminating hand postures by the orientation of the palm, into any of three classes: vertical, horizontal or upside-down. The horizontal class, in turn, can be classified into horizontal flat or horizontal tilted. The vertical class is also divided into vertical-open and vertical-closed postures. As an example, "A", "I", "M", "N", "O", "S", "T", and "Y", belong to that class. Each decision tree is thoroughly described in [9].

4. AcceleSpell

The program is arranged as a tutorial with four different modules: copy single handshape, finger spell a letter, copy a fingerspelled word, and fingerspell a word. The tutorial aims to help students first, to learn the 26 hand letters of the ASL alphabet, and second, to practice fingerspelling. The first option "copy single handshape", presents a picture of a hand letter and asks the user to perform the hand shape. The program shows a different picture once the previous one has been correctly executed by the user. The second option "Fingerspell Letter", does the opposite: it sows a roman letter and asks the user to remember and execute the corresponding handshape. The third option, "Copy Fingerspelled Word", asks the user to start practicing the spelling by performing the hand shapes shown in the images. The blanks at the bottom of the screen are filled with the corresponding roman letters, so the users, preferably deaf children, correlate handshapes to roman letters, through a visual clue, as shown in figure 3.

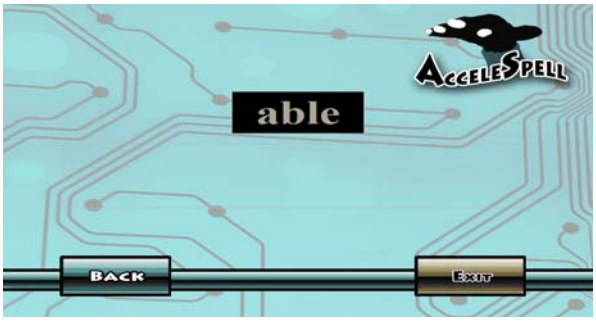

Figure 3. "Copy Fingerspelled Word" asks the user to perform the handshapes shown in the image.

In the fourth option, "Fingerspell Word", the user is presented with a word written in roman alphabet.

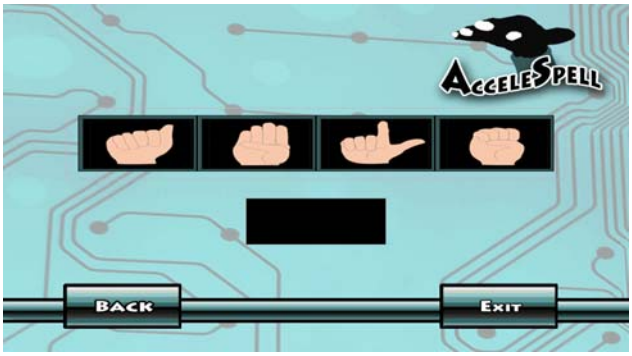

Figure 7."Fingerspell Word" asks the user to perform handshapes to spell a word in English.

As the user performs the correct letter, each blank at the bottom of the screen is filled with the corresponding picture of the handshape. A user that plays up to this level dominates the fingerspelling technique, and knows how to read English.

All the words in English are stored in a text file that can be modified to accommodate different levels of complexity, depending of the target user.

5. Conclusions and Future Work.

The interactive game described here has served as the base to develop different programs to practice and learn the corresponding hand shapes of the ASL alphabet. Since the PC is constantly querying the glove and running the recognition algorithm, the user interacts with the program without clicking with the mouse or typing the keyboard. All the interaction is performed by the user through the glove in real time. Other program that shows an animated sequence of a character spelling letters was also developed to complement the AcceleSpell, once the user is able to spell out words (execute), it is necessary to train the user to recognize continuous spelling from another person (perception). More programs are under development.

6. ACKNOWLEDGMENTS

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