Toward a more flexible, believable model of the human hand for American Sign Language synthesis

Robyn Kelley and Bill Gobber
DePaul University
School of Computer Science
Chicago, IL
rkelley5@mail.depaul.edu, wgobber@mail.depaul.edu

Introduction

American Sign Language (ASL) is the preferred language of the deaf in North America. It uses a combination of handshapes, facial expressions, and movement of the body to express words and ideas. It is linguistically different from English. Although it does share vocabulary, it is not a gestured form of English, and has a fundamental difference in sentence structure [Baker80] [Valli93]. English is a second language for most members of the deaf community, and the average reading level of Deaf adults is between the third and fourth grade level [Holt94]. Because of these differences, approaches such as closed-captioning are not effective. Using a certified ASL interpreter is the most effective means of Deaf/hearing communication, but the cost is considerable and interpreter referral agencies require at least 48 hours notice and a minimum of a two-hour block. [CAIRS11]. For these reasons, and with ASL being a visual/gestural language with no widely-accepted written form, it would be beneficial to have a personal digital translator that could accept spoken language and produce ASL as the target language. This would require having natural looking animations.

The importance of handshape in ASL

Signs in ASL are roughly the analog of words in spoken language. There are five basic linguistic parameters to signs in ASL, namely handshape, location, movement, palm orientation, and nonmanual signals [Liddell89]. Handshapes are a specific formation of the hand, and are the most discernible part of a sign [Tennant98] [Davidson06]. In fact handshapes are used as the “index” in dictionaries that facilitate the lookup of an unknown sign. Another essential part of ASL is *fingerspelling*. Based on the English alphabet, it is used for spelling proper nouns, acronyms, and technical terms and would not be possible without handshapes.

Current computer models of the human hand

To create many of the handshapes in ASL a well modeled hand is important. Because several of the handshapes need the fingers to be close together or to bend into the palm, the bone structure of the modeled hand needs to bend accurately to give a natural appearance [McDonald01]. The human hand is composed of 27 bones, including carpals, metacarpals, and phalanges [Cailliet82]. Though based off of the anatomy of the human hand, current models have been simplified, comprising of only 16 bones.

Shortcomings of current implementation

The simplification of current models stems partly from a representation consisting of a palm modeled as a single rigid body. But in actuality, the base of each finger along with the main body of the human palm is formed by four metacarpals. The metacarpal bones for the index and middle fingers are fixed, whereas the ring and pinky fingers have a small range of movement [McDonald01]. The movement of these metacarpals deforms the palm during signing, especially in handshapes where the pinky and thumb touch. Adding these bones will help the animated model mimic an actual human hand more closely. Texturing is also an important matter with the idea of creating a more natural looking hand. Faces on avatars used for signing usually have texture maps, therefore giving them a more realistic look. The modeled hand however, is not textured, giving it a plastic appearance. Texturing the modeled hand with a human skin texture will give the hands a more natural appearance.

Our approach

Creating a bone for the pinky and ring fingers adds flexibility in the palm. This will enable our model to more easily form handshapes where the thumb and pinky touch. Making the palm more deformable by adding a representation of the metacarpal bones for the ring and pinky fingers allows the palm to fold inward and releases it from being a stiff form. The addition of texture maps helps emphasize the hand's contours for better visibility in the synthesized animations.

Future Steps

Developing a natural looking animated model that is more believable and readily understood is our objective. We plan to evaluate the work through in-depth usability testing to gain user feedback.

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