3D human models play an important role in computer graphics applications from a wide range of domains, including education, entertainment, medical care simulation and military training. In many situations, we want the 3D model to have a visual appearance that matches that of a specific living person and to be able to be controlled by that person in a natural manner. Among other uses, this approach supports the notion of human surrogacy, where the virtual counterpart provides a remote presence for the human who controls the virtual character's behavior.

In this dissertation, a human modeling pipeline is proposed for the problem of creating a 3D digital model of a real person. Our solution involves reshaping a 3D human template with a 2D contour of the subject and then mapping the captured texture of that person to the generated mesh. Our method produces an initial contour of a participant by extracting the user image from a natural background. One particularly novel contribution in our approach is the manner in which we improve the initial vertex estimate. We do so through a variant of the ShortStraw corner-finding algorithm commonly used in sketch-based systems. Here, we develop IStraw with improvements to ShortStraw and then introduce adaptations of this improved version to create a corner-based contour segmentation algorithm. This algorithm provides significant improvements on contour matching over previously developed systems with low computational complexity.

The system presented here advances the state of the art in the following aspects. First, the human modeling process is triggered automatically by matching the participant's pose with an initial pose through a tracking device and software. Our system uses Microsoft Kinect and its associated SDK. Second, color image, depth data, and human tracking information from the Kinect and its SDK are used to automatically extract the contour of the participant and then generate a 3D human model with skeleton. Third, using the pose and the skeletal model, we segment the contour into eight parts and then match the contour points on each segment to a corresponding anchor set associated with a 3D human template. Finally, we map the color image of the person to the 3D model as its corresponding texture map.

The whole modeling process only take several seconds and the resulting human model looks like the real person. The geometry of the 3D model matches the contour of the real person, and the model has a photorealistic texture. Furthermore, the mesh of the human model is attached to the skeleton provided in the template, so the model can support programmed animations or be controlled by real people.

Our ultimate goal is to create a mixed reality (MR) system, in which the participants can manipulate virtual objects, and in which these virtual objects can affect the participant, e.g., by restricting their mobility. This MR system prototype design motivated the work of this dissertation, since a realistic 3D human model of the participant is an essential part of implementing this vision.

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The public is welcome to attend.