Markerless Motion Tracking

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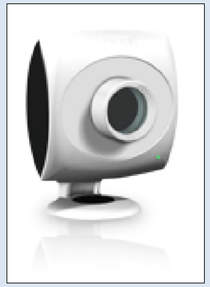
Introduction

Markerless Motion Tracking

Motion tracking for entertainment has been traditionally accomplished by using technology based on markers. The process is usually very expensive, time consuming, and restrictive. Markerless motion tracking has been attempted with multiple algorithms but is still limited in 3D motion. Therefore, there are few finger detection algorithms for motion tracking.

ZCam, a time-of-flight camera developed by 3DV Systems, utilizes infrared light to retrieve depth information besides acquiring 2D images. In June 2009, Microsoft announced Project Natal, that will incorporate the ZCam with the Xbox 360. The goal of the project is to do markerless motion tracking of the user to interact with the video game without a controller, and the slated release date is December 2010.

ZCam



ZCam Output

Objective

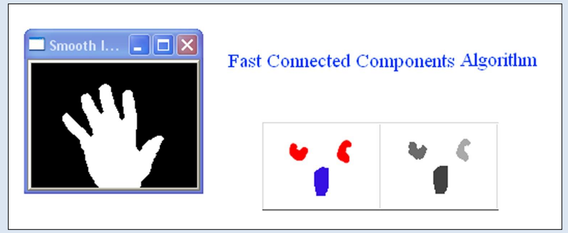
ZCam and 3D Models

To use a real human hand to drive a virtual 3D human hand model created by the computer in real time through a markerless motion tracking system with a ZCam.

Methods

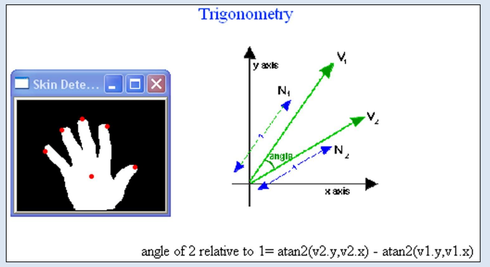
Hand Detection

The project was developed using computer vision library OpenCV for image processing and display. OpenGL was used to render 3D models. Combined with the depth output of the ZCam and the skin detection algorithm developed by Holub and Nekolny 2009, the hand was extracted.

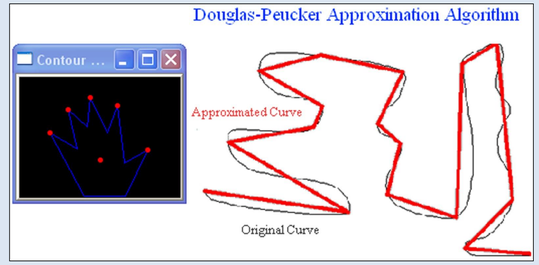


Finger Detection

To further increase the detection accuracy, a fast connected component algorithm was used to remove background noise, a curve approximation algorithm was employed to smooth the outline of finger contours, and trigonometric analysis was adopted to uniquely identify each finger. Moreover, a color calibration method was developed to increase the robustness of the skin detection algorithm under different lighting conditions.



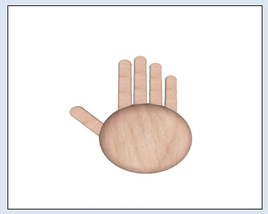
Skin & Finger Detection

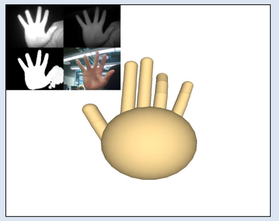


Curve Approximation

3D Hand Model

Finally, the finger motion was smoothed in a time series by using the spline fitting algorithm developed by Kalivarapu 2005. The detected motion was used to drive the 3D hand model in the computer to move in the same manner as the real hand.





Results

A markerless motion tracking algorithm was developed that allows for driving the virtual 3D hand model with a real hand. In this prototype system, only limited hand motion can be used for this motion tracking system. Generic markerless motion tracking and full 6-DOF motion tracking will be accomplished in the future.

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