Discovering Human Postures from Non-human Silhouette

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Motivation
The shadow theatre is an unique performing arts, which utilizes a shadow as an main communication tool. This can be understood easily as an extension of traditional shadow play. Key difference comes from the fact that entire human bodies are used to make interesting shapes on screen during the play, whereas puppets or human hands are only used in the traditional one. Modern technologies on projection devices facilitate larger stage area, which enables the actors to use human motions in the play. Viewers often prefer full body shadow play over the traditional one because it gives energetic and delicate feelings simultaneously and it is less trivial to conjecture original performers' postures.

Goal
Our goal is to automatically discover human postures from non-human silhouettes or shadow images. We are particularly interested in the situation where multiple actors and environments (e.g., floor, platform or props) exist similar to the true shadow theatre performances [1], [2]. The actors' posing process is therefore greatly accelerated by our system for new shapes which haven't been handled yet. The system can also be used to generate articulated sculptures imitating target shadow similar to [3].

Approach
We formulate discovering the poses as an energy minimization problem, where the energy function includes several terms reflecting not only visual similarity between the resultant shadow and the target shape but also professional actors' heuristics. The visual similarity term minimizes visual differences between two shapes in contour and area levels. The strategy terms measure how much the result follows each heuristic rules.

Heuristic Rules

Rule1: The first thing the actors do is to divide the target shape into several parts based on distinctive features on it (e.g., ears and snout for rabbit, nose and ears for elephant). An actor is usually in charge of one feature, remaining holes are then covered by free body parts of the actors or adding new ones.

Rule2: When an actor fits a feature, there are preferred body lines such as cubital-brachial, gluteal-femoral and vertebral. One of the favorite lines are selected first, fine adjustment is fulfilled later. They iterate this process until results are satisfactory.

Rule3: Only a set of fixed root orientations, which are parallel or orthogonal to the screen plane and capable of looking their shadows, are used due to several reasons. It is quite hard to remember and to pose dozens of non-parallel/orthogonal orientations during the play. The other is that looking the screen during the choreographing process and the performance is crucial to compare their shadow and the target shape themselves.

Reference


Figure 1: We recorded process of choreographing scenes with professional shadow theatre actors [1]. We found several heuristics and constraints for the process and utilized those in our algorithm.

Figure 2: We discover human postures from non-human 2D silhouette. Four postures and their resultant shadows are projected on the wall in three different views. Red line is an input silhouette, a yellow cone represents an area of point light source.

Figure 3: Optimization process of resultant shadows for three different target shapes (bunny – 1st row, air plane – 2nd row, elephant – 3rd row).