NSF Highlight Template
Research Experiences for Undergraduates
PLEASE RESPOND BY January 5, 2012

Please provide the information requested below. Suggested word limits are provided as guidance, but feel free to exceed the word limits SLIGHTLY in the interest of time, or to provide adequate background to NSF. Feel free to use this template or to provide equivalent information in the body of an e-mail. Be sure to include at least one image.

1. **Basic Info and NSF Award Number(s)**
   Your name, award number and program director

   PI: Jamie Payton, NSF Award Number: 1156822, Program Officer: Maria Zemankova

2. **What is your Suggested Title for your highlight?**

   Sketch Search: Evaluating Sketch-Based Interfaces for Human Action Recognition

3. **What is the outcome or accomplishment?**

   Cecilia Mauceri's project provides a more intuitive way for users to search for videos that contain a particular human action. Cecilia and her research team, advised by Dr. Richard Souvenir, developed and evaluated a system that provides three new sketch-based search interfaces: (1) a *freehand* sketch with motion cues (e.g., arrows), (2) an articulating human stick figure (*puppet*) with motion cues, and (3) a *keyframe* sequence of puppets, similar to a filmstrip. The system interprets the sketch, animates it, and compares the generated video to a database of existing videos.

4. **What is the impact?**

   Searching videos for particular human actions could be used to improve athletic performance or to support security and surveillance activities. Most search engines use a text-based search query; resolving such queries requires videos to be tagged with metadata, which may be incomplete or incorrect. Sketch-based search requires no metadata, and the study performed here suggests that sketching can be a fast, accurate, and intuitive approach to content-based video retrieval.

5. **What explanation/background does the lay reader need to understand the significance of this outcome?**

   Search for human actions in video is an open, challenging problem. Commercial solutions (e.g., Google Video) typically employ search methods which do not operate on the content of the video; instead, a text query is matched to metadata of the video such as the title, description, or user comments. The possibility of incomplete or incorrect metadata is a well-known limitation to this approach, and these methods often fail when the query is ambiguous (e.g., "driving" for cars versus swinging a golf club). This has led to interest in content-based video retrieval (CBVR) methods that use an example video as a search query, matching features of the example video against those in the database and returning high-scoring matches. However, finding representative videos to use for querying other videos can be difficult. More specifically, if a video strongly matching a search concept were easily obtainable, it might not be necessary to perform the query in

the first place. This motivates the need for a new kind of query specification method to search for human actions in video.

A key challenge in sketch-based search of video is matching the sketch to the video. For this problem, it is important to model the content of the video rather than the appearance, since sketches do not share appearance characteristics with real video. To do so, Dr. Richard Souvenir and his team of students in the Future Computing Lab at UNC Charlotte have created a new kind of motion descriptor that can be applied to match videos to sketches, even if the position of the human in the video does not exactly align with that of the sketch. The three new sketch-based interfaces have been integrated with this new method of searching for human actions in video, and have been evaluated through a user study that measured accuracy and speed of users' construction of sketch-based search queries and asked the users to comment on ease of use.

Cecilia's contribution to this sketch-based search project was accomplished during a 9-week period as part of a Research Experiences for Undergraduates (REU) program, funded by the National Science Foundation. Cecilia joined nine other REU students in the College of Computing and Informatics at the University of North Carolina at Charlotte in the summer to explore research in human-centered technologies that aim to solve socially relevant problems. The REU program at UNC Charlotte has a history of broadening participation of underrepresented groups in computing and excellent student outcomes, resulting in over 30 student-authored research publications and seven students going on to win prestigious national fellowships for graduate study.
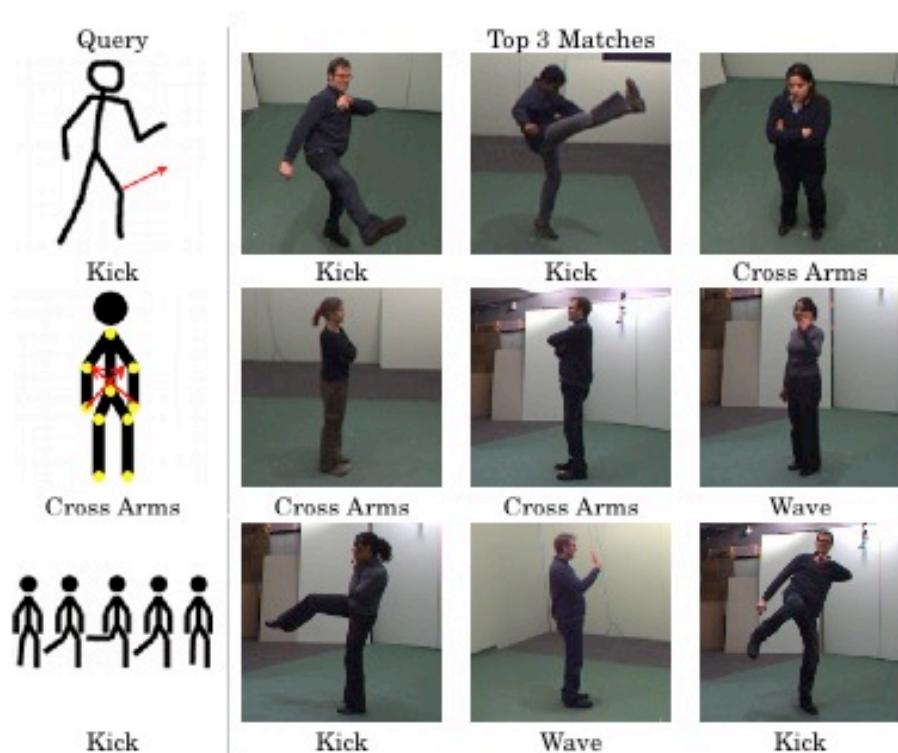
Image(s)/Caption(s)

Figure 1: Sample results from 3 queries constructed using the freeform, puppet, and keyframe sketch-based input methods to search the well-known IXMAS dataset. For each query, the input sketch and keyframes from the 3 top scoring video matches are shown.

Email address for owner of Image(s)

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