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WHAT'S NEXT

## It's Tricky, Grafting Brando's Sneer to Bogart's Shrug

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**L** OS ANGELES

IT pales in importance when compared with the cloning of Dolly the sheep or the mapping of the human genome, but researchers from the University of Southern California are trying to deconstruct the basis of what makes humans look human. And this time Hollywood directors, not just scientists, care about the results.

Once filmmakers can understand what makes people look real and unique to one another, they will be able to recreate reality with ease, inexpensively populating movies with virtual characters - rampaging Mongol hordes, clones of movie stars performing physically impossible feats - whose appearance and actions are as lifelike as a next-door neighbor.

In fact, recreating a celluloid duplicate of Humphrey Bogart or Marilyn Monroe will soon be possible, although there is little reason to fear that some cinematic Frankenstein will produce a clone of Elvis that can convince the world he never died.

"When we finally understand what makes Humphrey Bogart look like the character that he is, we won't want to see new Bogart movies," said Dr. Ulrich Neumann, director of the Integrated Media Systems Center at U.S.C. "Rather, we will want to import his unique characteristics into other virtual humans." Filmmakers would then be able to, say, create an artificial actor with Bogart's tough-guy persona and have it do whatever they need.

Dr. Neumann heads a staff of scientists and graduate students seeking to identify the essence of what makes people human. By breaking down movement and speech into a comprehensible and interlocking set of patterns, he said, programmers will eventually create software that can easily reproduce the extraordinary complexity of skin, muscle, eye and hair movements that convey emotion.

The work is still in its infancy, and visual tricks are often used to cover up technological shortcomings. For example, the virtual people that strolled across the deck in were deliberately kept small to mask their lack of sophisticated movement. More recently, the Agent Smith clones doing battle with the Neo character in looked real because they wore sunglasses.

Current motion-capture techniques are not sophisticated enough to create virtual humans that seem real because humans communicate using a variety of expressions. "A human look is much more than the movement of hundreds of points of skin on the face," Dr. Neumann said.

For example, real skin does not move smoothly; it bulges and creases in many combinations. As people converse, they move their hands in ways specific to their culture and personality, simultaneously

wrinkling facial muscles in unique patterns. When people speak, their mouths move not just to form words but also in relation to what was and will be expressed.

Even a tiny error in the representation of a virtual character can cause viewers to sense that they are looking at a contrived figure. "There is such intricacy and detail and proper timing involved in the science of human expressiveness that when something is not right we know it, but we can't explain it," Dr. Neumann said.

Researchers at the Integrated Media Systems Center have devised a number of studies to classify and quantify characteristic facial combinations. Once the movement that makes up a person's emotional state is defined, filmmakers will be able to apply an entire set of actions with one keystroke rather than arching a character's eyebrow or flaring a nostril individually.

The idea is that if the essential facial and body movements that make up Arnold Schwarzenegger can be distilled, a virtual actor can be given the same attributes.

The center has created several projects to help identify those physical traits. In one, researchers use photos to measure the distance between points on a face. By overlaying the distances found on one face onto another, the computer can create a caricature of the second person that incorporates the features of the first. For example, Michael Jackson's face could be overlaid with the essence of the filmmaker Michael Moore's, creating a Mooreish-looking Jackson.

Although testing procedures are still being defined, researchers plan to present such photos to test subjects and ask them whom the person pictured resembles. If enough subjects report that the photograph indeed looks like Mr. Moore, the researchers know that they have captured the attributes that help define a unique look.

But a face is defined by movement as well as proportion. To understand how emotions are portrayed, real people were filmed expressing feelings like happiness and surprise. Their faces were divided into nine regions, and researchers plotted the movement of three muscles within each in terms of the distance and length of time each muscle moved.

With that data, researchers were able to create a formula that described, for each expression, the movement of a combination of muscles across time. A person's emotional state could then be duplicated by manipulating the muscles of a virtual actor according to the formula. Depending on which formula was followed, the actor could have the characteristics of Bill Clinton, George Bush or anyone else whose muscle movements for a range of expressions had been plotted.

The perfected facial movements would next be combined with eye and mouth movements. The virtual eyes would need to swivel and the eyelids blink unpredictably, which can be accomplished with a technique called texture synthesis. With that, a computer can create an array of eye movements that show no discernible pattern.

Finally, the computer-generated character's entire mouth and face would need to move not just in sync with what is being said, but also in a way that reflects the words just spoken and about to be spoken. Because speech typically consists of one word following another, a virtual or real speaker must move his or her tongue from the proper place for one word to the proper place for the next.

"I don't have any illusions about figuring this all out in one year," Dr. Neumann said. But he said he was convinced that once researchers completed the mapping of the human face and emotions, commodity software would be developed that made the creation of virtual humans a simple task.

Eventually, computer animators will be able to select "Edward G. Robinson anger" from a program's drop-down menu, and create a virtual actor that can sneer in a way reminiscent of Little Caesar. "You can count on that happening," Dr. Neumann said.

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