Beyond the Table Top, Everyman, The Ultimate Commodity

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Introduction

Our aspirations are to create new ways of employing augmented reality (AR) technology in performative experiences. The project draws directly from a narrative that has a conceptual aspect that uses the technology as an integral part of the story. Gopal Baratham's *The Ultimate Commodity*[1] forms the basis of the narrative and is adapted in the experimental theatre play, to become, Everyman, The *Ultimate Commodity.*[2] The AR technology we employed in bringing this story into production served as the ideal vehicle with which to explore, recreate, and represent the unique themes of original text and the adapted stage play.

The ultimate commodity — the story

"The Ultimate Commodity" imagines a future in which a scientist has created a formula which causes all those who ingest it to physically change so as to become universal organ donors. In this imagined future, the government has taken the liberty of adding this formula to the city's drinking water (thus fulfilling the country's destiny where the claim that "Our people have become our only resource. . . has become literally true").[1] However, it turns out that one side-effect of the formula is that it also causes the distinguishing characteristics of population to disappear, so that every one begins to appear morphologically similar to each other.

Against this backdrop our theatre project focuses on a small part of the larger story; on the identity crisis which occurs when a father confuses his daughter with his wife. And as it turns out, AR proves to be ideally suited to the telling of this story due to the potential for having the father played by a live actor, while the other two characters are played by pre-filmed three dimensional reproductions of actors, superimposed into the scene with the live actor. The simultaneous staging of "real" characters with "simulated" or "morphed" characters also resonates with the theme of identity construction which is a prevalent theme in Baratham's original text.

Implementing "morphed" characters on stage

We began by considering several methods for employing "morphed" characters on a live stage. As technically the theatre play is about making the actors look alike each other, the system we use has to be able to replace one actor's head with another's, and, let the audience see several identical faces on the stage simultaneously. Our implementation uses a hybrid vision — inertial sensor approach, as described below.

Hybrid vision — inertial sensor tracking method — the sensor fusion approach

This method uses cameras and sensors to track the position and orientation of the actor, and then superimposes a 3D model of a head onto the actor in rear screen projection. Generally this method requires beacons and/or sensors to be attached to the actor so that he or she can be tracked. In a broader technical sense, this technique of combining and extracting useful information from several similar or different sensors is called "sensor fusion".[3] This is especially common with camera and inertial sensor, where they could compliment each other in terms of performance under various ambient conditions.

The lack of luminosity of the lights in the theatre is a big challenge for vision tracking systems. We thought that using bright luminous colors as beacons would improve the tracking performance greatly. Therefore we let the actors wear special light-emitting diode (LED) headsets which are designed for tracking purposes; the two cameras hang above the theatre stage track the color of

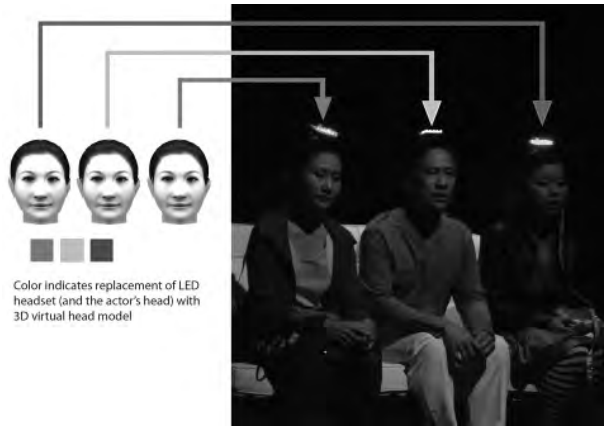

Figure 1: The actors' heads are replaced by 3D head models, according to the color of the LED headsets the actors are wearing.

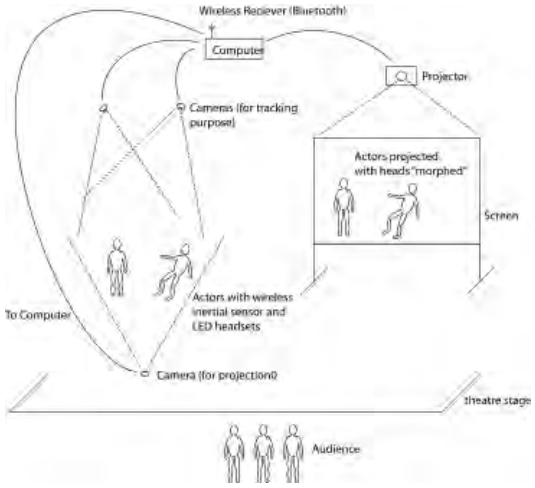

Figure 2: Setup of augmented reality system for theatre. The audience sees the juxtaposition of real and augmented spaces.

the LEDs. The orientation data from the inertial sensor is transmitted to the host computer via Bluetooth. In this way, the actors had complete mobility, while their entire head could be replaced with a three dimensional head of the creative director's choosing (Figure 1). The system set up is shown in Figure 2.

The array of light-emitting diodes (LEDs) could be tracked much more easily in a darkened theatre (it is also worth noting that in the place of distinct markers we employed different color LED displays for the tracking and superimposition of up to six several different heads over the actors, depending on the color of the LED display).

The tracking of LEDs only provides the spatial information (the x, y, z location of the head in the theatre space). It is also necessary to acquire the orientation of pitch and tilt of the head as well. To accomplish this, a wireless motion sensor, comprised accelerometers, gyroscopes and digital compasses and Bluetooth transmitters, was embedded underneath the LEDs. The hybrid LEDs and sensor technique allow for the full six degree of freedom information of the head to be known. The tracking camera at the front of the stage was utilized to capture the action and then projected in the staging.

Modeling and animation (lip-synching) of 3D head

The 3D model of the actor's head was constructed from a 3D model of a generic head. Six different views of the actor's face (each made-up with 15 small markers) were then captured by 6 pre-calibrated cameras. The 2D points on the captured images — and 3D points on the generic model corresponding with those markers on the actor's face — were selected manually. After that, the 3D generic model was morphed iteratively until the distance between the selected 2D points on captured images and 2D projections of selected 3D points on the generic models was minimized on all 6 different views.

Pre-recorded voice tracks were then embedded in the live video stream (synchronized with the script and action) and a lip-sync technique was used to animate the 3D head's lip movement. Each model was constructed with a sequence of "visemes" that are interpolated (morphed) to synchronize with the voice track. This makes the model "talk" in real time and in sync with the other actors on stage.

Acknowledgement

The original story *The Ultimate Commodity* was written by the late Dr. Gopal Baratham, a Singapore writer and surgeon. The authors would like to thank Diego Diaz, Clara Boz for their contributions in the performance *The Ultimate Commodity* v1.0 which took place at the Esplanade theatre in Singapore in 2006.[4] The author would also like to thank the actors, actresses and crew of the *Everyman — The Ultimate Commodity* v2.0 performance which took place in the Fringe Festival in Toronto, 2007: Gerald Chew, Sara Yang, Debra Teng. Gerald provided significant contributions in dramatic direction. The play was produced but the Interaction and Entertainment Research Centre with creative direction by the author, and written by the second author.

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1 *Ultimate Commodity*, Gopal Baratham's *Figments of Experience.*

2 *Everyman, The Ultimate Commodity*, Daniel Jernigan Also see acknowledgements in section 4.0.

3 Azuma R., Lee J.W., Jiang B., Park J., You S. and Neumann U. 1999. "Tracking in unprepared environments for augmented reality systems." In *Computers & Graphics* 23(6), pp. 787–793.

4 http://www.esplanade.com/SOPApp/espsop/portal_proxy?uri=WZmthm_iwUHoh-8e!1ovCUG39YnDZFI2HLKlZ8pDah_,CgiDY@49ihaXM,zs=CsmROgsJFM