Research Statement

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Overview:

As the primary sensory system for humans, eyes and gaze are as fascinating as they are important. My research interests stem from the use of gaze in social interaction and virtual agents, as well as exploring what the eyes can tell us about cognitive activity.

My Ph.D. dissertation, entitled "Generation of Emotionally Expressive Gaze Shifts in Virtual Embodied Characters" focuses on the development of gaze models, including eye movement, head movement, and torso movement, for virtual embodied characters, as well as how gaze behaviors are related to the affective state of the character. State of the art virtual embodied characters are deficient in emotional expressivity when compared to animated characters in feature films. Characters in animated feature films can come alive, enthrall audiences and critics, and even win Oscar awards. Virtual embodied agents currently cannot. For virtual environments, whether for entertainment or pedagogical purposes, to have lasting impact, the virtual characters that populate those environments must be seen as having the "illusion of life" by the user.

Looking forward from my Ph.D., I am also interested in training and teaching through virtual environments and serious games. While working in the Center for Advanced Research in Technology for Education (CARTE) group at ISI, I developed an interest in how virtual training environments could be used to demonstrably improve the ability of individuals to perform real-world tasks. My dissertation work on generating and evaluating emotionally expressive gaze for virtual characters, as well as my post-dissertation work on the Institute for Creative Technologies' virtual human toolkit, have prepared me to do research in this field

Dissertation Research:

For my Ph.D. dissertation, I developed a model of gaze and how gaze behaviors express emotion, using a basis of recorded data from head, torso, and eye movements of actors performing gaze shifts. This data was used because gaze consists of more than just eye movement, and differences in the head and torso were necessary in order to display emotion. However, eye movement was modeled separately from head and torso movement.

The head and torso movement were modeled using a construct I developed called the Gaze Warping Transformation (GWT), which transfers movement manner between two gaze shifts. The GWT was found by collecting two gaze shifts directed at a specific target, one displaying an emotional behavior while the other was emotionally neutral, and finding a set of parameters which would transform the animation curves representing the non-emotional gaze shift into those curves representing the emotional gaze shift. Then, in order to generate new emotionally expressive gaze shifts, the GWT is applied to a new emotionally neutral gaze shift to add emotional content to the movement. Finally, a

procedural model of eye movement, based on the neuroscience literature is used to layer realistic eye behavior onto the gaze shift generated using the GWT. This eye model implements saccadic movement, the vestibulo-ocular reflex, and determines how head movement is related to eye movement.

In order to determine the mapping between specific gaze behaviors and specific emotional states, I generated GWTs for individual and combined gaze behaviors, and I collected data on the emotional content of the resulting animations online in order to determine whether or not emotion attributed to combined gaze behaviors could be predicted based on the emotion attributed to individual gaze behaviors. The end result was a mapping between gaze behaviors and the emotional state attributed to gaze shifts performing those behaviors, a set of transformations for procedurally generating gaze shifts displaying these behaviors, and an evaluation demonstrating the correctness of both the mapping and the gaze transformations.

Research Agenda:

I strongly feel that the development of virtual humans, virtual training environments, and serious games requires a multidisciplinary approach. I am particularly interested in how current research in Neuroscience and Psychology that deals with how people learn can influence the future development of serious games and training technologies.

In order to learn more about applicable research in these fields, I am working as a Postdoctoral Research Fellow in Cognitive Neuroscience, jointly between the Institute for Creative Technologies VRPsych lab, and the Army Research Lab – Neuroscience. I am working on the development of the Virtual Reality Cognitive Performance Assessment Test (VRCPAT), a situated virtual environment that is intended to be used to assess, evaluate, and eventually rehabilitate cognitive function lost due to traumatic brain injury.