

Jeremiah: the face of computer vision

Increasing Public Engagement with Science

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Abstract

This poster presents a humanoid computer interface (Jeremiah) that is capable of extracting moving objects from a video stream and responding by directing the gaze of an animated head towards them. It further responds through change of expression reflecting the emotional state of the system as a response to stimuli. As such, the system exhibits similar behavior to a child. The system was originally designed as a robust visual tracking system capable of performing accurately and consistently within a real world visual surveillance arena[1][2]. As such, it provides a system capable of operating reliably in any environment both indoor and outdoor. Originally designed as a public interface to promote computer vision and the public engagement with science (exhibited in British Science Museum, fig 6), Jeremiah provides the first step to a new form of intuitive computer interface.

Introduction

Jeremiah is based around two basic subsystems, a graphics system which constitutes the head and a vision system which allows him to see. There is also a simple emotion engine that responds to visual stimuli via expressions or emotions. We are currently developing a new model called Saul (see figure 5) who is a full body model providing more lifelike appearance, motion and the ability to speak.

Jeremiah's head is based upon the GeoFace (DECface) articulated bone model with prescripted expressions for key emotions. Linear Interpolation provides transitions between these expressions. To increase the realism he contains a simple Newtonian model of motion with random elements of movement such as blinking and ambient motion.

The underlying visual surveillance system allows static background scenes to be learnt dynamically, providing the ability to detect moving foreground objects. Jeremiah's attention is randomly distributed between these objects weighted by their size and motion. Co-ordinates of objects within the field of view are sent to the head model for animation. Figure 1 shows two image frames taken from Jeremiah after processing. Fig 1a shows the segmentation with foreground objects denoted as black and shadows as grey. Figure 1c shows the objects detected with the object of interest (largest) denoted with a blue cross.

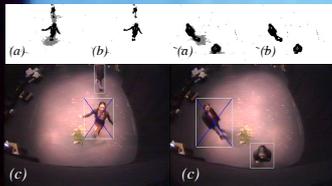


Figure 1- What Jeremiah Sees

Jeremiah's emotional state is determined from simple parameters extracted from objects of interest within the visual field. These simple rules coupled with the chaotic nature of his visual stimuli provide lifelike responses to human activity. Jeremiah likes visual stimulus - high rates of movement make him happy. Jeremiah likes company - lack of stimulus makes him sad. Jeremiah doesn't like surprise - high rates of change in the size of objects make him surprised. Jeremiah doesn't like to be ignored - if objects exist but don't move then he assumes they are ignoring him and hence gets angry. If Jeremiah experiences too much of any particular stimulus he will get bored with it and reduce its influence on himself.



Figure 2- The Emotional faces of Jeremiah

Jeremiah in Operation

Jeremiah was originally designed to work on a single desktop computer where the act of waving at Jeremiah would stimulate a smile. During either a large-scale installation or performance, Jeremiah works on the same principle and a typical set up can be seen in figure 3. This figure demonstrates how a camera mounted above the projected head provides a wide field of view for Jeremiah (up to 180°). The projector mounted above either the performance space or audience, projects the head onto a black canvas. Within a few seconds Jeremiah is capable of learning a background sufficiently accurately to identify moving objects. The system constantly updates so subtle changes in scene structure or lighting are accommodated by the model and do not lead to failure.

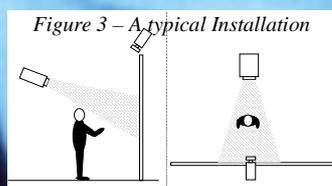


Figure 3 - A typical Installation

If an object such as a chair is placed in his field of view then he will see the object. However, if the chair remains static, eventually he becomes bored of the chair and will incorporate it into his model of the world. If the chair is then removed, he does not become confused by the change in scene structure as he remembers what it looked like before the chair was present. Therefore, any object which enters Jeremiah's field of view can be seen by him. From all visible objects a specific object of interest is randomly selected



Figure 5- Saul, Jeremiah's replacement

weighted by its size and motion i.e. large fast objects are more likely to attract Jeremiah's attention. Once an object of interest has been selected the eyes of Jeremiah look in that direction. Depending upon the physical difference between the orientation of the head and eyes the head may follow to turn and face the object. Given multiple objects of interest this results in Jeremiah sharing his attention between objects. The simple emotions gained from this visual stimulus are reflected by the current facial expression of Jeremiah i.e. the more happy he is, the more he will smile. Figure 2 shows the basic expression of Jeremiah (default, angry, happy, sad and surprised). All this results in an artificial system that exhibits similar behaviour to that of a child.

Figure 4 shows Jeremiah being used as part of a live performance 'Blue Bloodshot Flowers'. Here he is one of the performers opposite a live performer who interacts with him. As he has both random elements and reacts directly to visual stimulus he never behaves in the same way twice so the performer is forced to interact with him to try and get the desired responses. Once the performance is over the audience is encouraged to interact with Jeremiah. However, he can see the audience throughout the performance. Normally the performer is the most interesting object for Jeremiah to watch but should the performer remain inactive Jeremiah will respond to audience presence.



Figure 4- Publicity Image

Jeremiah was born from a security system

Jeremiah's visual system is actually based upon a system developed for visual surveillance[1][2], a system which is designed to watch people and vehicles performing their every day tasks. Jeremiah has literally 'been born of this technology' and is the emotional face or the automated security guard who watches patiently for something to happen. Imagine now if we gave that system feelings. Boredom when nothing is happening, anger when people leave and he can't, sadness, joy and surprise when finally the event happens that he has been waiting for. This is Jeremiah, but his emotions and interest in the world and people make him more like a child than a computer system. Jeremiah was recently demonstrated at the British Science Museum where both children and parents interacted with Jeremiah with delight. He provides an interactive exhibit which demonstrates the applications of computer vision in a fun and intuitive way. Future work includes the construction of a full body interactive virtual human Saul (see figure 5). We will extend the system with visual biometrics to allow the system to recognise people and address them personally. We are also investigating the possible use of such systems for digital storytelling and hope to work further with the science museum to this end.



Figure 6- Children Playing with Jeremiah at the British Science Museum

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