Exploring Humanistic Intelligence Through Physiologically Mediated Reality

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Abstract

We present a way of making the wearing of a lifelong electrocardiographic health monitor fun for a user. The health monitor is coupled with a reality mediator device to create a Physiologically Mediated Reality. Physiologically Mediated Reality is Mediated Reality which alters a user's audiovisual perception of the world based upon their own electrocardiographic waveform. This creates an interesting audiovisual experience for the user, playing upon the poetic narrative of combining cardiocentric metaphors pervasive in everyday life (the heart as a symbol of love and centrality, e.g. "get to the heart of the matter") with the ubiquitous occularcentric metaphors such as "see the world from my point of view". This audiovisual experience is further enhanced by combining music which alters the visual perception and also heightens the user's emotional response to their experience, and in doing so, further affects their heart(beat).

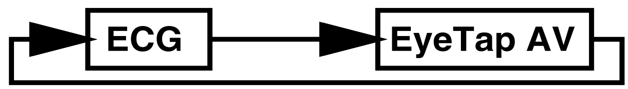

Figure 1: Signal flow paths in Physiologically Mediated Audiovisual (AV) Reality

Figure 2: Screenshot of computationally altered live video in which the the environment appears to swirl and pulse to the beat of the wearer's heart.

1 Ambulatory Physiologically Mediated Reality

In the same way that the bars of a simple spectrum analyzer rise and fall along with along with the beat (or, more accurately, the frequency spectrum of the music), we have developed a Physiologically Mediated Reality in which a video stream of what the user sees is altered in time with their own heartbeat. Of interest is the synthesis of cardiocentric and occularcentric metaphors common to society. Since the heart is often linked with emotional response (we are often said that we "feel" with our hearts), the emotional experience of a physiologically mediated reality was coupled with an auditory mediated reality, where music was used to create a heightened emotional response to the experience (see figure 1).

Through the use of EyeTap (a device which allows the eye of a wearer to function both as a camera and as a display) [5], the field of view of the wearer is altered in time with both the music and wearer's heartbeat (see figure 2). We combined our EyeTap system with common wearable personal sound systems. Our EyeTap eyeglasses based implementation currently allows the video to "saturate" between beats (i.e. video frames are superimposed on top of one another), and then clear to a fresh video frame on either a heart beat or a musical beat. Musical bass beats were detected by analyzing the spectrum analyzer output from software music player. The real time video saturation effect was achieved by applying the X–windows GXand and GXor functions to the updated video. It was found that this system created the impression of visual reality cardiographically and musically pulsating along with the beat of the heart, allowing the music to be experienced both visually and aurally. The physiological control system allowed the user's emotional response to further affect the system, and this, in turn, further affected their experience and emotional response, thus creating a closed loop feedback system.

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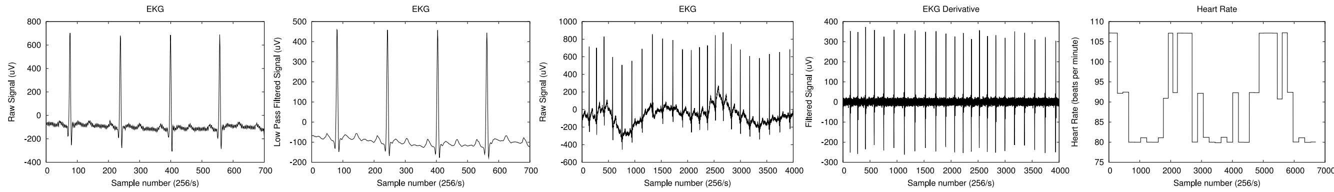

(a) (b) (c) (d) (e)

Figure 3: ECG (a) Raw ECG, (b) Low Pass Filtered ECG, (c) ECG showing baseline drift, (d) High pass filtered ECG to eliminate baseline drift, (e) measured heart rate

2 Analyzing the ECG

In order to measure physiological response, the Procomp+ [1] device was used. The Procomp+ is a ambulatory psycho–physiological data acquisition system. Ambulatory ECG is known [3], The Procomp+ is capable of working with a variety of inputs, including electrocardiographic inputs (ECG) [2] An ECG signal is created when the cells of the heart *depolarize*. The depolarization of the myocardial cells (heart muscle) causes them to contract. Depolarization creates an electrical potential and this is what is measured by the ECG electrodes. The most distinct characteristic of the ECG, the sharp spike, is called the QRS complex, representing the propagation of depolarization through the heart to the Purkinje fibres.

Figure 3(a) is the raw data collected from the Procomp+ and it was noted that the data appeared noisy and that high frequency noise was present, removed by low pass filtering, as shown in figure 3(b). The initial undershoot (Q wave), the large overshoot (R wave) and the following undershoot (S wave) can be seen. A very simple, and direct method of detecting heart rate is to measure the time between occurrences of the QRS complex by detecting to R wave peak by thresholding. Figure 3(c) shows the phenomenon of *baseline drift* common in ECGs. Here, the QRS complex appears as though it has some DC offset associated with it. Thus, the absolute magnitudes of the data vary up and down when baseline drift is present. This would make it difficult to reliably determine where to place a threshold. A high pass filter was applied to the data and figure 3(d) shows that the high pass filter eliminated baseline drift.

Figure 3(e) shows the results of using the filtered data to measure the heartrate of subject J.F.. The subject's heart rate was noted to vary between 79-107 beats per minute. This variation was correlated to respiration. On inspiration (inhaling), the heart rate increased, and on exhaling, the heart rate decreased, demonstrating that the Physiologically Mediated Reality can be a breath–taking experience.

3 Conclusion

We have presented a Physiologically Mediated Reality in which the user's perception of their environment is altered according to their heartbeat. Additionally, music is used to heighten the emotional response and further affect both the visual perception, and the user's heartbeat, in essence allowing the user to see with their heart. Thus what was created was a feedback loop between the computer and the human, which is at the heart of Humanistic Intelligence [4]. Such a device could further be used to make health monitoring a fun activity, perhaps to encourage usage by children. The presence of the video capture device facilitates archival of video for lifelong video capture which accompanies the lifelong ECG capture. This could then be used to detect conditions which may have caused an abnormal arrythmia, aiding medical diagnosis.

Acknowledgements

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