Extracting Emotion From Movement: Representing Interactions as Glyphs

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ABSTRACT

We present a preliminary exploration of information visualization techniques for extracting social and emotive aspects of movement. Our glyph-based technique visualizes particular characteristics of a motion path or interaction sequence between two characters. In this paper we detail our efforts of creating glyphs that extract and expose underlying emotive and social aspects of the collocated physical interplay between a human and a robot.

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General terms: Human factors.
Keywords: Emotion, motion, behaviour, glyph, visualization.

INTRODUCTION

Movement is an important part of social interaction. Research shows that movement and emotion are closely tied together and in fact, the word emotion is derived from the Latin *ex* (out) and *motio* (motion). Indeed, powerful emotions can be achieved even with only a few physical degrees of freedom (DOFs). Animators use simple movement with great effect to create characters with a wide range of expression [3]. For example, Wall-E, a popular *Pixar* character, displays a significant range of emotion with a few DOFs. Keepon [1], a social dancing robot capable of eliciting strong emotional responses, has just 4 DOFs.

When people watch objects interacting, such as leaves blowing in the wind, they often translate the interaction into emotional terms, and can even relate at times to the "characters". Heider and Simmel found that, as fixed non-social geometric shapes moved around a screen, observers created detailed emotional stories to explain the interaction [2].

An important aspect of our exploration into the social aspects of movement relates to robotics. In a future where robots are part of our everyday life, it will be important for them to interact in a way that is socially acceptable. It will be useful to have tools to understand, evaluate and compare the social aspects of robot actions. That is, a designer of computerized moving entities, be it animated characters or robots, would be concerned with a programmed behaviour that incites an undesired emotion. For example, consider a hospital robot that is perceived as scary or a guard robot that is perceived as having comical traits. A common method of evaluating the emotion of an interaction is to experience or observe the interaction itself. But what if one wishes to review a multitude of prolonged interactions? As well, how does one compare different interactions? If lengthy and involved interaction sessions could be transformed and displayed as static glyphs (images), such that particular emotional or social qualities are emphasized, comparing and evaluating them would be greatly simplified

In this text we present our efforts at designing new information visualization techniques, based on static glyphs, to explore the underlying social and emotive undertones of movement and interaction. Specifically, we visualize the social interaction between two characters, explain our design method and approach, and present preliminary results.

VISUALIZING EMOTION

For the purposes of this study, we have limited our scope to full-length social interactions between two characters. We aim to present the data in such a way to aid in interpreting underlying emotional characteristics. Further, we limit our visualization techniques to static glyphs.

To populate the visualizations, the data we use is from interactive sessions (30s – 1min) recorded using the *PuppetMaster* [3] interactive animation tool, which creates emotion laden interaction sessions. This data consists of two-dimensional character location and orientation.

To import the data into our glyphs, we start with a saved behaviour and convert the needed data into an XML file. This file is imported into our visualization generator.

Design and Preliminary Evaluation

Our initial system resulted in two kinds of glyphs, a spatial trace of the interaction session (see for example Figures 1 and 3) and an inter-character distance over time graph (see for example Figures 2 and 4). The motivation behind the trace graph is that it allows an immediate sense of the types of movement present during the interaction and portrays the entire session in a fixed-size static glyph. The distance over time graph emphasizes how close the characters were to each other, the velocity that they were moving, as well as how they approached or fled from each other.
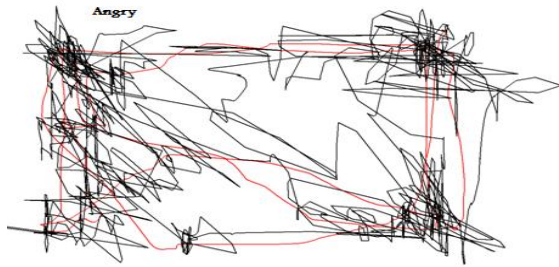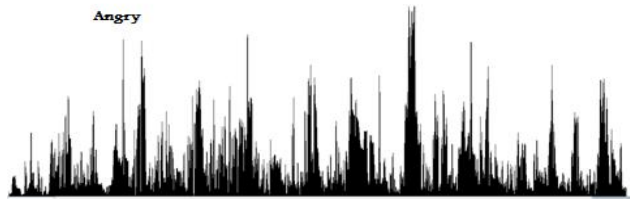
Figure 1: *Angry*: Trace Routes

Figure 2: *Angry:* Distance-time graph.

Figure 3: *Playful*: Trace Routes

Figure 4: *Playful:* Distance-time graph.

In order to explore the benefits and drawbacks of our initial prototype, as well as to inform ourselves on future direction, we conducted a targeted design critique session consisting of an HCI expert and an information visualization expert. The session consisted of a videotaped, semi-structured experimental protocol, in which the experts were shown the unlabeled visualizations and asked to describe the interaction. They were also asked to critique the design.

This process was very beneficial, and we present a few highlights. First, both experts suggested that there should be a temporal aspect to the trace glyph. It was also decided that the essence of the distance time glyph could remain unchanged, but it could display more information if relative direction of the interacting characters was added. These changes were effective in increasing the understanding of a single visualisation. The prototype was updated to reflect these suggestions, and we present the new results (with a different interaction being visualized) in Figure 3 and 4.

Lessons Learned
The preliminary study we performed demonstrated that we are pursuing a potentially promising direction. Without being told what the glyphs were, our participants were able to give many of the describing characteristics of the presented behaviours. Words such as "aggressive" for the "angry" behaviour were used to describe the interaction, as well as "fun" for the "playful" behaviour. Also, there was much discussion which stated that a temporal aspect in the trace glyph would help to make it more comprehendible.

Some of the comments exposed potential drawbacks, such as how do we distinguish between an angry robot, and one which needs to speed up to climb a ramp? This is a question which will need to be addressed in the future.

FUTURE WORK
We see the preliminary visualization tools presented here as a first step toward enabling more rigorous analysis and evaluation of the social components of human-robot interactions. Our planned future steps are:
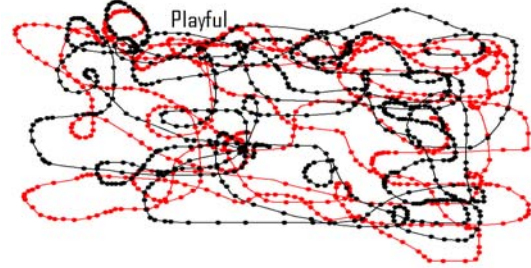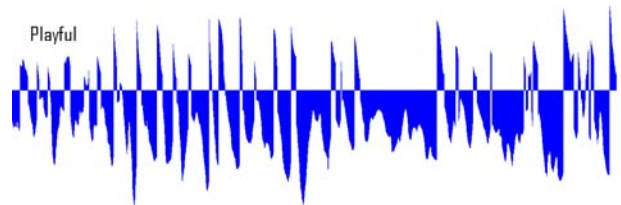
Streamline the glyphs – what sorts of information characteristics and transformations can be used to emphasise particular classes and types of emotions?

How should extremely long interactive sessions be filtered and displayed to best preserve the behaviour while reducing information overload?

Present data egocentrically from particular character viewpoints instead of globally. Implement a visualization in which the reactive character is stationary and the acting character is presented relatively to it.

Furthermore, we are planning to design an interactive version that enables people to actively interact with, explore and edit the data presented in our visualization in real time. We are also hoping to perform more in-depth user studies to find out how components of movement are relate to the conveyed emotion and behaviour, and use this information to create better visualizations. One potential long term outcome of this direction is the creation of a database of behaviours, which robots or designers of robots could use to find patterns of behaviour to use or avoid when deciding on a course of action, or reviewing a previous engagement.

CONCLUSION
We are developing techniques that visualize the behaviour and emphasise underlying emotion of interaction between two characters. Our preliminary design and its evaluation points to the potential promise of our approach, and we intend to continue to explore and improve these visualization techniques and to fit them to more realistic human-robot interactive data.

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