AN OBJECTIVE UNOBTRUSIVE MODEL-BASED TRACKER OF FACIAL EXPRESSIONS OF NEGATIVE AND POSITIVE EMOTIONS IN SPACE FLIGHT

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INTRODUCTION

During space flight astronauts must maintain high-level performance while experiencing potentially lethal environmental risks and psychosocial stressors (e.g., isolation, confinement, high workload). Negative emotions can jeopardize individual and team performance in space. There is a need for an objective means to unobtrusively detect changes in astronaut emotions in space. This study is developing and validating an optical computer recognition (OCR) algorithm based on a single-camera input as an objective, unobtrusive, computational model-based tracker[1] that reliably detects facial expressions of positive and negative emotions.

METHODS

Positive (i.e., happiness) and negative emotions (i.e., sadness, anger, disgust), and the absence of emotion (i.e., neutral facial expressions) were induced experimentally using standardized sets of photographs that have been shown to evoke markedly different emotions [2]; standardized video clips [3]; and role-play tasks (e.g., describe something that made you feel angry). The Facial Expression Coding System (FACES)[4] was used by trained personnel to score (blinded to emotion-induction condition) videotaped recordings of emotional facial expressions in N=31 subjects (16 females). Facial videos were also scored by the OCR model-based tracker algorithm [1]. These frame-by-frame scores were then used to calculate the duration of emotional expression and which emotion was predominantly expressed. Videos were compared between human scorers and the OCR model-based tracker algorithm using epochs, which were defined as the emotion predominantly expressed in the face for a period of time ranging from a few seconds to a number of minutes.

RESULTS

The experiment yielded 30 hours of facial video from the 31 subjects. There were 989 epochs of discrete emotional expressions (total 5.29h) as judged by human scorers. These were comprised of the following emotional expressions: happiness (1.95h), sadness (1.58h), anger (1.30h), disgust (0.32h), surprise (0.15h). There were 24 hours of neutral facial expressions. At the first-pass (uncorrected) analysis, the model-based OCR tracker correctly categorized 34% of the epochs of negative emotions (anger 46%, sadness 25%, disgust 29%), and 20% of happiness epochs. It correctly identified 29% of neutral expressions, but missed 13% of happiness epochs and 29% of negative emotions (anger 20%, sadness 40%, disgust 11%). The predominant tracker error was over-scoring anger. Analyses of OCR misclassifications revealed that low facial feature contrast and difficulties tracking head movement produced the classification errors. Both of these deficiencies are correctable with algorithm modifications.

CONCLUSION

The results suggest that a computational model-based tracker of the human face that can detect facial expressions of positive and negative emotions is feasible when people are interacting in situations involving other people and events, and it has the potential to perform at the level of human observers of facial expressions if head tracking and feature contrasts are optimized for a single-camera system. Continued correction of the OCR algorithm programming for facial expressions to enhance its facial tracking capability (e.g., of the face partially out of view), its contrast detection capability (e.g., using infrared), and its quality-control features (e.g., avoidance of false positives and false negatives) will be necessary to make it optimally useful in spaceflight, and for a wide range of Earth-based operations.

REFERENCES


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