Studying Facial Expressions Using Manifold Learning and Support Vector Machines

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Autism is a pervasive developmental disorder that impairs social interaction and communication. There are facial expressivity difficulties in autism, which may reflect emotional deficits in social interaction. Smiling is especially important as an index of positive emotion and for its role in regulating social interactions. The current standard for facial measurement, the Facial Action Coding System (FACS), is manual and labor intensive. We used manifold learning and support vector machine (SVM) classifiers/regression to automate the detection and measurement of smile strength (AU 12 in FACS) and eye constriction (AU 6 in FACS) on a continuous intensity scale from absent to maximal. SVMs are a set of supervised learning methods used for classification and regression. In this work, the facial data are modeled using the Active Appearance Model (AAM). Because of the large dimensionality of the appearance data (more than 10,000 pixels and facial landmarks), a manifold learning technique (i.e., Laplacian Eigenmap), which is a nonlinear approach for dimensionality reduction, was utilized to represent the appearance data in a lower dimensional space. Twelve features in the manifold space were used for training separate SVM classifiers and regressors for smile intensity (AU 12) and eye constriction (AU 6). This method was applied to the facial video clips of social interaction of two separate mother-infant (about 4000 video frames for each subject.) Thirteen percent of the frames were randomly selected for training the SVMs. AU 12 and AU 6 were accurately classified on a 6-point scale from absent to maximal at one of the five FACS (trace to maximum) intensity levels. Table 1 shows the accuracy of this technique for classification of the AU 12 and AU 6 into six levels. The mean performance of the system in classifying AU 12 and AU 6 were 76.6% and 75.7%, respectively. The correlation between the actual smile intensity (eye constriction) and predicted smile intensity (eye constriction) are shown in Table 2. The mean value of correlation between the predicted smile intensity and the actual smile intensity and also the correlation between the predicted eye constriction and the actual eye constriction were 0.936 and .921, respectively. This automated technique replicated laborious human coding of facial expressions intensity and will be utilized in investigating the expressivity of children with autism and infants at risk for autism. We will expand this technique to detect negative emotions and predict their intensities.

Table 1. Classification of AU 12 (a) and AU 6 (b) into six Levels.

	Dyad A	Dyad B
Mother	79.2%	73.1%
Baby	69.3%	84.6%

(a)

	Dyad A	Dyad B
Mother	74.7%	76.3%
Baby	67%	84.7%

(b)

Table2. Correlation between the actual AU 12 and predicted AU 12 (a) and also correlation between the actual AU 6 and the predicted AU 6.

	Dyad A	Dyad B
Mother	.95	.928
Baby	.918	.951

(a)

	Dyad A	Dyad B
Mother	.906	.921
Baby	.918	.94

(b)