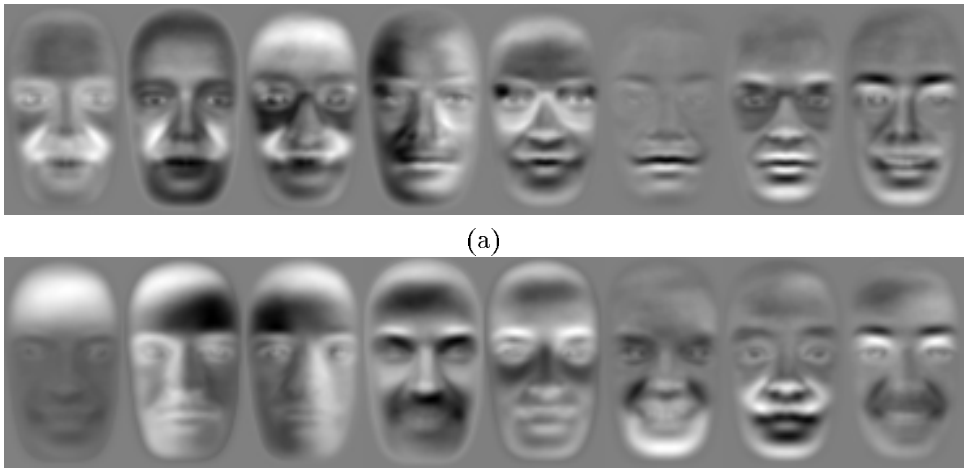

(a)

(b)

Figure 6: "Dual" Eigenfaces: (a) Intrapersonal, (b) Extrapersonal

have shown that this intrapersonal eigenspace alone is sufficient for a simplified *maximum likelihood* measure of similarity (see Section 4.4).

Note that since these classes are not linearly separable (they are both *zero-mean*), simple linear discriminant techniques (*e.g.,* using hyperplanes) can not be used with any degree of reliability. The proper decision surface is inherently nonlinear (hyperquadratic under the Gaussian assumption) and is best defined in terms of the *a posteriori* probabilities — *i.e.,* by the equality $P(\Omega_I|\Delta) = P(\Omega_E|\Delta)$. Fortunately, the optimal discriminant surface is automatically implemented when invoking a MAP classification rule.

Having computed the two sets of training Δ's, we computed their likelihood estimates $P(\Delta|\Omega_I)$ and $P(\Delta|\Omega_E)$ using the susbspace method [13, 14] described in Section 3.1. We used principal subspace dimensions of $M_I = 10$ and $M_E = 30$ for Ω_I and Ω_E, respectively. These density estimates were then used with a default setting of equal priors, $P(\Omega_I) = P(\Omega_E)$, to evaluate the *a posteriori* intrapersonal probability $P(\Omega_I|\Delta)$. This similarity was computed for each probe-gallery pair and used to rank the best matches accordingly. This probabilistic ranking yielded an improved rank-1 recognition rate of 89.5%. Furthermore, out of the 608 extrapersonal warps performed in this recognition experiment, only 2% (11) were misclassified as being intrapersonal — *i.e.,* with $P(\Omega_I|\Delta) > P(\Omega_E|\Delta)$.

4.4 The 1996 FERET Competition

This Bayesian approach to recognition has produced a significant improvement over the accuracy obtained with a standard eigenface nearest-neighbor matching rule. The probabilistic similarity measure was used in the September 1996 FERET competition (with subspace dimensionalities of $M_I = M_E = 125$) and was found to be the top-performing system by a typical margin of 10-20% over the other competing algorithms [34]. Figure 7 shows the results of this test on a gallery of $\approx$1200 individuals. Note that rank-1 recognition rate is $\approx$95% and significantly higher than the other competitors. In fact, the next best system is our own implementation of standard eigenfaces. Figure 8 highlights the performance difference between standard eigenfaces and the Bayesian method from a smaller test set of 800+ individuals. Note the 10% gain in performance afforded by the new Bayesian similarity measure which has effectively *halved* the error rate of eigenface matching.

As suggested in Section 3, a simplified similarity measure using only the *intrapersonal* eigenfaces can be used to obtain the *maximum likelihood* (ML) similarity measure as defined in Eq. 3 and used instead of the *maximum a posteriori* (MAP) measure in Eq. 2. Although this simplified ML measure was not officially