

# Matching Images of Never-Before-Seen Individuals in Large Law Enforcement Databases

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**Abstract.** A method is developed for extraction of robust human facial features that can be used on never-before-seen individuals in homeland security tasks such as human tracking or matching photos of dead against missing individuals (e.g. recent Asian tsunami aftermath).

One of the central goals of face-processing research is to identify informative high-order facial features that can effectively characterize and distinguish human faces independent of variations of viewing conditions, such as, for example, viewing angle, illumination, or facial expression. Such features constitute hidden factors – they are variables that are present in face images, but hidden in the spatial patterns of pixels across the image and require computational extraction. Due to lack of knowledge of such features, classical face recognition deals only with known individuals. In most cases, a separate classifier will be developed for each known individual to discriminate it from other known individuals. These classifiers will be less likely to come up with good generalization with small number of training samples. Our approach is to search for invariants by concurrently exposing SINBAD cell to different images of the same individual, thus forcing it to discover some higher-order variable that does not change across different images of the same individuals.

Lately face recognition for real-world applications focuses on no human intervention during all phases; training (learning), recognition, insertion of new face classes (individuals). Scalable approaches not requiring constant overhead of extra training with addition of new individuals have recently been particularly demanded for applications such as in criminology and homeland security. Another consequential demand is compression of the visual input. Robust facial features that are valid for never-before-seen individuals make all these possible. Once they are learnt, no more training is needed, recognition becomes much easier, and adding a new class only requires feature values to be stored, which will also accomplish good compression.

For example, after the recent tsunami in Asia, we learnt that an application was needed in Sri Lanka to match photos of dead bodies with photos provided by relatives of lost people. Offender tracking is just another possibility as a homeland security

application; for example, suppose we have collected photos of persons who committed crimes or behaved suspiciously, the task might be to match these photos with photos of passengers taken at times of boarding airplanes. We hope that our approach will be very useful in these types of tracking applications (see Fig. 1). Face-matching can also help in duplicate record elimination (e.g., the confidence in merging/purging distinct records can also be based on face-matching as well as matching records based on name, address, date of birth, race, sex, and so on...).



**Fig. 1.** Two exemplary images from our simulation database. Only robust high-level features make it possible to compare two face images.

One of the major advantages of our research is that we have a working test-bed to experiment with (FINDER – the Florida Integrated Network for Data Exchange and Retrieval). FINDER has been a highly successful project in the state of Florida that has addressed effectively the security and privacy issues that relate to information sharing between over 120 law enforcement agencies. It is operated as a partnership between the University of Central Florida and the law-enforcement agencies in Florida sharing data – referred to as the Law Enforcement Data Sharing Consortium. Detailed information about the organization of the data sharing consortium and the FINDER software is available at <http://finder.ucf.edu>.

We have already demonstrated the usefulness of SINBAD approach in a variety of fields, including metabolomics, natural images, and face recognition. After we have obtained top face recognition accuracies, we moved towards this much more difficult problem of matching faces of unknown individuals. We obtained very high accuracy in this task as well. We are ready to deploy our method in a real-world application: FINDER.