

# Chapter 28

## Face Match for Family Reunification: Real-World Face Image Retrieval

**Eugene Borovikov**

*U.S. National Library of Medicine, USA*

**Szilard Vajda**

*Central Washington University, USA*

**Michael Gill**

*U.S. National Library of Medicine, USA*

### ABSTRACT

*Despite the many advances in face recognition technology, practical face detection and matching for unconstrained images remain challenging. A real-world Face Image Retrieval (FIR) system is described in this paper. It is based on optimally weighted image descriptor ensemble utilized in single-image-per-person (SIPP) approach that works with large unconstrained digital photo collections. The described visual search can be deployed in many applications, e.g. person location in post-disaster scenarios, helping families reunite quicker. It provides efficient means for face detection, matching and annotation, working with images of variable quality, requiring no time-consuming training, yet showing commercial performance levels.*

### INTRODUCTION

The Content Based Image Retrieval (CBIR) technology has seen significant advances recently resulting in many useful web-scale image search techniques (Dharani & Aroquiaraj, 2013). Several web search engines (e.g. [bing.com/images](http://bing.com/images), [images.google.com](http://images.google.com), [yandex.com/images](http://yandex.com/images)) employ those techniques to provide visual search capabilities. The face recognition (FR) technology has also seen a considerable progress during the last decade, in several cases approaching human-level accuracy in face detection and verification tasks (Naruniec, 2010; Tan, Chen, Zhou, & Zhang, 2006; Zhang & Zhang, 2010), especially in well-controlled environments such as studios.

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Modern web-based FR solutions (e.g. in [facebook.com](https://www.facebook.com) or [plus.google.com](https://plus.google.com)) may work well with limited face datasets (e.g. user circles, family albums) that tend to contain tagged pictures of the same few individuals (e.g. family and friends) with multiple photos per person, which allows for user-specific recognition model training. Our experience did not provide us with an abundance of publicly available single image per person (SIPP) face image retrieval systems that can work effectively using no training with millions of unconstrained face images, presenting many challenges for such systems in practice, e.g. disaster recovery:

- No constraints on gallery or query pictures, as in Figure 1;
- Often suboptimal quality images for query and gallery;
- Dataset size: web-scale collections with many near-duplicates<sup>1</sup>;
- Large inconsistency in query and gallery face appearance.

Many of those challenges are being addressed by modern FR systems thanks to the emergence of labeled datasets with constrained-free images (Beveridge et al., 2013; Huang, Ramesh, Berg, & Learned-Miller, 2007; Kemelmacher-Shlizerman, Seitz, Miller, & Brossard, 2016) utilized for various competitions. Development of such challenging datasets presents a great opportunity to assess capabilities of the existing systems on the real-world data, and then improve them or develop some new capabilities, ultimately approaching a human-level visual matching accuracy.

Typical FR systems would approach the face recognition problem in one of the two formulations (Zhou et al., 2014): verification (answering if photos depict the same person) or identification (suggest the person ID by visual similarity to the query image). Such systems usually require some sort of model training, using multiple photos per individual. They would typically work with a set of visual features extracted from images by learning a measure of visual similarity, modeling human visual perception of faces. While modern automatic face classification and verification methods can work fairly well on good quality (fairly well lit, sharp, 80×80 pixels or better) face images, their performance degrades quite rapidly as the image quality drops (e.g. due to blurring, scaling, re-compression, etc.) causing significant degeneration of the visual attributes (Scheirer, Kumar, Iyer, Belhumeur, & Boult, 2013) they rely on.

We approach our face matching task as a face image retrieval (FIR) problem: given a query image, we aim at returning visually similar faces from a dynamically changing photo gallery, thus effectively reducing the search space from several thousands to about 20 likely candidates conveniently displayed on a single page. Our open-set approach practically out-rules person-specific training and uses the accuracy evaluation methods (e.g. top-N hit rate) that are typical of CBIR, rather than those typical of FR,

*Figure 1. Unconstrained images may be challenging to modern face recognition systems*



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