Introduction to the Special Section on Real-World Face Recognition

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1 Introduction

In recent years, there has been an emerging demand for robust face recognition algorithms that are able to deal with real-world face images. This is largely due to two factors. First, consumers have shown an increasing desire to annotate or tag their digital photos to facilitate organization, access, and online sharing of their personal albums. Industrial responses to this consumer desire can be exemplifed by successful commercial face recognition systems included in applications and web sites such as Google Picasa, Windows Live Photo Gallery, Apple iPhoto, face.com, PolarRose, etc. Second, the growing applications in public security also call for robust face recognition technologies that can identify individuals from surveillance cameras in uncontrolled situations.

In consumer digital imaging, face recognition must contend with uncontrolled lighting, large pose variations, a range of facial expressions, make-up, changes in facial hair, eyewear, weight gain, aging, and partial occlusions. Similarly, in scenarios such as visual surveillance, videos are often acquired in uncontrolled situations or from moving cameras. These factors have been the focus of face recognition research for decades, but they are still not well resolved.

In addition to these market forces, face recognition also represents an ongoing set of key scientific challenges. How can we match or exceed the performance of humans on face on many real-world face recognition tasks (e.g., recognition of people known to the human viewer)? How can we learn a good model of a face from a small number of examples? How can we achieve the level of robustness exhibited by human face recognition? These questions and new applications for the technology promise to keep this area active for the forseeable future.

Standard face recognition systems often start with a set of labeled *gallery faces*. When a new *probe image* is provided, it is matched against the gallery faces to be recognized as a known face or rejected. In a well-controlled setting, face images can be carefully captured for both gallery and probe faces. In a moderately controlled setting, we may have quality control over either the gallery faces or the probe faces, but not both. In an uncontrolled setting, we lose control of both.

Face recognition in well-controlled settings has been extensively studied and is relatively mature. Earlier face recognition methods often directly appled pattern recognition and machine learning techniques on informative face features and are only effective when the probe and gallery images are frontal. More recently, to achieve higher recognition performance, many works have started to consider more precise geometric, shape, lighting, and reflectance models of faces. Notwithstanding the successes of these techniques, there remains much room for improvement of face recognition in real-world scenarios since, overall, much less attention has been paid to these less controlled settings.

Two general misconceptions are that face recognition is a solved problem and, on the other hand, that the uncontrolled scenarios are too difficult to address in practice. Neither is true in our opinion. A primary purpose of this special section is to deliver the following message to the community: Although significant progress has been made in the last few decades, there remain plenty of challenges and opportunities ahead.

In the consumer digital imaging domain, practical face annotation systems are emerging based on existing face recognition technologies. This brings human factors in the assistanted annotation system since good user interface (UI) and user experience (UX) design are essential in order to compensate for possible failures of the face recognition algorithm. Last but not least, in many of these applications

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there may be rich additional contextual information and meta-data that one can leverage to improve face recognition. A multidisciplinary exploration may be required to deliver real working systems.

2 Review Process

The motivations for organizing this special section were to better address the challenges of face recognition in real-world scenarios, to promote systematic research and evaluation of promising methods and systems, to provide a snapshot of where we are in this domain, and to stimulate discussion about future directions. We solicited original contributions of research on all aspects of real-world face recognition, including:

- the design of robust face similarity features and metrics,
- robust face clustering and sorting algorithms,
- novel user interaction models and face recognition algorithms for face tagging,
- novel applications of web face recognition,
- novel computational paradigms for face recognition,
- challenges in large scale face recognition tasks, e.g., on the Internet,
- face recognition with contextual information,
- face recognition benchmarks and evaluation methodology for moderately controlled or uncontrolled envi-ronments, and
- video face recognition.

We received 42 original submissions, four of which were rejected without review; the other 38 papers entered the normal review process. Each paper was reviewed by three reviewers who are experts in their respective topics. More than 100 expert reviewers have been involved in the review process.

The papers were equally distributed among the guest editors. A final decision for each paper was made by at least two guest editors assigned to it. To avoid conflict of interest, no guest editor submitted any papers to this special section.

3 The Papers

Six papers were accepted through the rigorous review process, for an overall acceptance rate of 14.3 percent. The accepted papers can be placed into three categories: face recognition in real-world watch-list visual surveillance systems, 3D modeling for pose variant face recognition, and design of robust face similarity features and metrics for face recognition in consumer photos. In the following, we briefly summarize the papers in each category.

In "Toward Development of a Face Recognition System for Watch-List Surveillance," Kamgar-Parsi et al. examine the problem of designing a face recognition system for a watch-list visual surveillance system where a small set of people needs to be identified from a large number of people passing through surveillance cameras. Their approach is to use view morphing to automatically generate borderline faces to define the face space of a person, and then to train classifiers based on the borderline faces from each person in the watch-list. The method attacks a real-world face recognition problem with an interesting and solid approach.

3D face recognition has been regarded as a natural solution to pose variation. In "Using Facial Symmetry to Handle Pose Variations in Real-World 3D Face Recognition," Passalis et al. propose using facial symmetry to handle pose variation in 3D face recognition, while in "Unconstrained Pose Invariant Face Recognition Using 3D Generic Elastic Models," Prabhu et al. propose a generic 3D elastic model for pose invariant face recognition. Both are plausible approaches for using 3D information to assist in face recognition under large pose variations. While historically 3D face recognition has been criticized for lack of real-world 3D sensory cameras, this issue may be resolved in the future with inexpensive 3D sensors as evidenced by the PrimeSense sensor used in the Xbox Kinect from Microsoft.

The other three accepted papers all deal with face recognition in photos and images in the wild. In "Describable Visual Attributes for Face Verification and Image Search," Kumar et al. present a face verification algorithm based on a representation that uses a set of describable attributes. Their classifier achieves very good results on two publicly available benchmarks, namely Labeled Faces in the Wild (LFW) and the Public Figures (PubFig) data set. Since their method was first published at ICCV '09, there has been a lot of work using attribute-based representations for various visual recognition problems beyond face recognition.

In "Effective Unconstrained Face Recognition by Combining Multiple Descriptors and Learned Background Statistics," Wolf et al. propose an approach for face verification in the wild that combines multiple descriptors with learned statistics from background context. Its face verification accuracy ranked first on the LFW benchmark. In "Scalable Face Image Retrieval with Identity-Based Quantization and Multireference Reranking," Wu et al. present a scalable face image retrieval system using identity-based quantization to build a visual representation and multiple references for reranking. It builds a good foundation to tackle the problem of searching for face images over the internet image corpus.

The face recognition research community has built a variety of solid benchmarks to evaluate different algorithms. It is vital for researchers to leverage these databases to conduct solid and convincing experimental validation and compare with the state-of-the-art. Yet there also comes a time when performance on a benchmark reaches ceiling performance or methods become overengineered for nuances of a data set, and modest performance gains may be indicative of overfitting.

Alternatively, some new works or operational scenarios may push the envelope in directions that are not well represented with existing benchmarks; in such cases, authors may need to develop alternative benchmarks and justify this need in subsequent publications. Interestingly, real-world face recognition methods that achieve state-of-the-art performance on data sets like LFW may actually perform worse on constrained, frontal data sets like FERET. We should not be surprised by this, and we should embrace methods for where they are effective.

4 CONCLUSION

Through the editorial process of this special section, it has been our observation that the joint efforts of the whole face recognition research community have made many applications of real-world face recognition achievable, but there are still many challenges to address and opportunities to explore.

Claims that face recognition is a solved problem are overly bold and optimistic. On the contrary, claims that face recognition in real-world scenarios is next to impossible are simply too pessimistic, given the success of the aforementioned commercial face recognition systems. We hope this special section on Real-World Face Recognition will serve as a reference point toward an objective evaluation of the community's progress on face recognition research.

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Guest Editors

Gang Hua was enrolled in the Special Class for the Gifted Young of Xian Jiaotong University (XJTU) in 1994 and received the BS degree in automatic control engineering from XJTU in 1999. He received the MS degree in control science and engineering in 2002 from XJTU, and the PhD degree from the Department of Electrical and Computer Engineering at Northwestern University in 2006. He is currently a research staff member at the IBM Research T.J. Watson Center. Before that, he was a senior researcher at Nokia Research Center, Hollywood, from 2009 to 2010, and a scientist at Microsoft Live Labs Research from 2006 to 2009. He is an associate editor of the *IEEE Transactions on Image Processing* and *IAPR Journal of Machine Vision and Applications* and a guest editor of the *IEEE Transactions on Pattern Analysis and Machine Intelligence* and the *International Journal on Computer Vision*. He is an area chair of the IEEE International Conference on Computer Vision, 2011, an area chair of ACM Multimedia 2011, and a Workshops and Proceedings Chair of the IEEE Conference on Face and Gesture Recognition 2011. He is the author of more than 50 peer reviewed publications in prestigious international journals and conferences. As of August 2011, he holds three US patents and has 17 more patents pending. He is a senior member of the IEEE and a member of the ACM.

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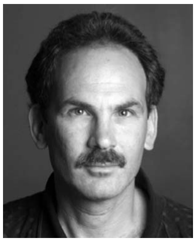

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