→ O' Toole

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Person Identification from Video with Multiple Biometric Cues: Benchmarks for Human and Machine Performance

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13. ABSTRACT *(Maximum 200 Words)*

We have compiled a database of images and videos that includes images and videos of approximately 300 human participants. Duplicate sets of images and videos taken from 1 week to 6 months after the first set are available for approximately 200 of these people. The images include 9 standard "mug shot poses". The videos include head rotations, dynamic facial expressions, facial speech clips, and 3 whole-body gait clips. Experiments have been completed comparing the effects of several types of facial motion on face recognition, the effects of face familiarity on recognition from video clips taken at a distance, and on the effects of attention on recognition of moving faces. The results of these studies provide insight into the way motion can facilitate or interfere with the encoding of the invariant face and body features that support recognition.

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Final Report

Person Identification from Video with Multiple Biometric Cues:
Benchmarks for Human and Machine Performance

PI : Alice J. O'Toole, The University of Texas at Dallas

Objectives

The objectives of the proposed work are divided into two parts. First, we have developed a database of person images and videos designed to provide comprehensive and controlled tests of the automatic systems developed in the human identification at a distance DARPA initiative. Second, we have made use of this database to assess human identification performance under a variety of training and testing conditions. This assessment has served as a baseline for evaluating the performance of computational algorithms in the DARPA initiative under the Face Recognition Vendor Test conducted this year at the National Institutes of Standards and Technology.

Approach & Methods

Part 1. We compiled a database consisting of a series of close-range, surveillance-range, and gait videos of a set of male and female individuals of several races. The close-range videos capture dynamic information about the face across a range of emotional expressions. A subset of these videos include speech-generated lip-movements. The surveillance-range videos include dynamic information about individuals who are either actively or passively involved in a conversation. Gait videos are taken of subjects walking and include information about the face, posture, and gait of the individual.

Part 2. Three series of experiments have been performed. The first series of experiments provides baseline data for human recognition with different presentation types. These experiments test recognition when learning and testing presentation types match. The second series of experiments provide data for human recognition when learning and testing data presentation types do not match. We have tested recognition transfer conditions that are encountered commonly and unavoidably in the situations targeted in this DARPA initiative. The third series of experiments addresses questions about the nature of familiarity in person recognition. Previous psychophysical results indicate that people are far more accurate at generalizing recognition across presentation conditions when they are familiar with the person to be identified than when the person is unfamiliar to them. Using the various categories of close range and gait videos, we have varied the learning and testing conditions to determine which combinations of learning stimuli facilitate familiarity, and thus, accurate generalization of identification to novel presentation types.

Status

We have compiled a database of images and videos that includes images and videos of approximately 300 human participants. Duplicate sets of images and videos taken from 1 week to 6 months after the first set are available for approximately 200 of these people. The images include 9 standard "mug shot poses". The videos include head rotations, dynamic facial

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expressions, facial speech clips, and 3 whole-body gait clips. Experiments have been completed comparing the effects of several types of facial motion on face recognition, the effects of face familiarity on recognition from video clips taken at a distance, and on the effects of attention on recognition of moving faces. The results of these studies provide insight into the way motion can facilitate or interfere with the encoding of the invariant face and body features that support recognition.

Accomplishments, Publications, and Presentations

The accomplishments of the project are reported below in the form of the DARPA quarterly reports that span the final year of this grant. In these reports, we list publications and conference presentations, as required for the Publication (section 6) and Interaction (section 7) sections of the AFOSR final report.

Quarterly Report – January 15, 2002
Human Identification at a Distance Project

Progress Summary[1]

- The first two experiments on the effects of facial movement on recognition have produced preliminary results (see submitted abstract reference below). We continue to collect additional data on these experiments in order to increase the power of the designs.
  - Snow, S. M., Lannen, G. M., O'Toole, A. J. & Abdi, H. Memory for moving faces: Effects of rigid and non-rigid facial motion, (abstract submitted for presentation to The Annual Vision Science Society Meeting).

- The second set of research involved a review and synthesis of the psychological literature on recognition of moving faces (see recently submitted abstract reference and accepted paper reference).
  - O'Toole, A. J., Roark, D. Abdi, H. Recognizing moving faces: A Psychological and Neural Framework. (abstract submitted for presentation to The Annual Vision Science Society Meeting).
  - O'Toole, A. J., Roark, D. Abdi, H. Recognizing moving faces: A Psychological and Neural Framework (manuscript accepted with revisions) *Trends in Cognitive Sciences.*
  -
- Two additional experimental projects are in the planning and preparation stage. An investigation of the interaction between color and motion information in recognition memory is ready for data collection. A second experiment examining the role of familiarity in the use of motion information for identification is nearly ready for data collection.
- The database was continually expanded so that it now includes 250 data collections comprised of 148 persons with duplicate sessions on 102 of these.

Recent Progress

From October 15, 2001 to January 15, 2002, we have accomplished the following:

Work Performed.

[1] Date of input February 11, 2002

Subject filming. We have added to the database on a continuous basis over this time. We now have 250 full sets of the protocol still and video shots. This includes 148 people with duplicate sessions on 102 people. Editing of these videos proceeded in parallel with the data collection effort and is, at present, nearly up to date.

Database development. We have been working on the problem of converting our UTD-developed MS Access database to the recently finalized DARPA XML database..

Psychophysical Experiments. We now have preliminary data on two experiments. Abstracted versions of these have been forwarded previously to the PM. The abstract from one of these has been submitted formally to a conference for presentation, (The 2nd Annual Meeting of the Vision Science Society). A paper in which we review the psychological data on human memory for moving faces has been prepared, submitted, and accepted with minor revisions to the journal *Trends in Cognitive Sciences*, O'Toole, A. J. Roark, D. & Abdi, H. (accepted with revisions). Recognition of moving faces: A Psychological and Neural Framework. We are currently beginning data collection for three additional experiments aimed at assessing the effects of different kinds of movement on recognition memory for faces.

Progress Summary

- The database now contains 148 persons with duplicate sessions on 102 people. We will proceed, this quarter, to collect additional videos in a systematic fashion and edit/log these as we go.
- The first two experiments have produced preliminary results (see submitted abstract references below). We continue to collect additional data on these experiments in order to increase the power of the designs enough to test for statistical significance.
- Three additional experimental projects are planned. An investigation of the interaction between color and motion information in recognition memory is ready for data collection. A second experiment examining the role of familiarity in the use of motion information for identification is nearly ready for data collection. An investigation of the role of expression perception on memory for the identity of the person is also planned.
- O'Toole, A. J., Roark, D. Abdi, H. Recognizing moving faces: A Psychological and Neural Framework. (abstract submitted for presentation to The Annual Vision Science Society Meeting).
- Snow, S. M., Lannen, G. M., O'Toole, A. J. & Abdi, H. Memory for moving faces: Effects of rigid and non-rigid facial motion, (abstract submitted for presentation to The Annual Vision Science Society Meeting).
- O'Toole, A. J., Roark, D. Abdi, H. Recognizing moving faces: A Psychological and Neural Framework (manuscript accepted with revisions) Trends in Cognitive Sciences. Monthly Report – March 15, 2002

Quarterly Report – April 15, 2002
Human Identification at a Distance Project

Recent Progress

From January 15, 2001 to April 15, 2002, we have accomplished the following:

Work Performed.

Database development. We have completed six of the eight required files for the XML coded database and are working on the remaining two, which will involve more complex conversions of the data. We hope to produce tools that will automatize this been working on the problem of converting our UTD-developed MS Access database to the recently finalized DARPA XML database.

Psychophysical Experiments. Data collection has begun on five new experiments. Two of these are extensions of work described previously. The first involves the effects of head motion on recognition memory for faces. A second extension of our previous findings is to compare the effects of four kinds of motion on recognition memory accuracy. We are comparing the effects of head rotations, facial speech, and expression in a single experimental paradigm. Additional experiments have begun on: 1.) the effects of familiarization of moving faces on recognition accuracy; 2.) the effects of facial expression and motion on recognition accuracy; and the 3.) combined effects of color and motion on recognition. We anticipate the completion of data collection on these experiments by the end of May, 2002.

- *Subject filming*. We have added to the database on a continuous basis over this time.

Progress Summary

- All five experiments described above are in progress and will be complete by May, 2002..
- XML code for six of eight required database files is complete and will be forwarded to the database managers within 1 week of this writing. Conversion code for the 7th file is nearly complete.
- We now have 161 subjects in the database, including full sets of static and video images for each. Duplicate sessions exist for 106 of these individuals, triplicates exist for 3 individuals and quadruplicates for 1 individual.

Quarterly Report – July 15, 2002
Human Identification at a Distance Project

Recent Progress

From April 16, 2001 to July 15, 2002, we have accomplished the following:

Work Performed.

Database development. We have completed six of the eight required files for the XML coded database and are working on the remaining two, which will involve more complex conversions of the data.

Psychophysical Experiments. Data collection has been completed on the following experiments. We have completed a comparison of head movements including faces; speech, expression and head rotation. We have extended the previous work on head rotation to test the transfer to a single static image and are currently in the process of writing a paper on the findings. Several additional experiments are underway to: a.) assess the effects of attention load on face recognition, by varying the predictability of facial expressions on a trial by trial basis; b.) assess the effects of color and motion on recognition of static and moving stimuli; c.) further compare the effects of head movements when transferring to single frontal images; and d.) assess the effects of familiarity on learning moving versus static presentations of faces. We anticipate the completion of data collection on these experiments by the end of August, 2002.

- *Subject filming.* We have added to the database on a continuous basis over this time.

Progress Summary

- The first two experiments described have been completed and paper preparation is in progress.
- XML code for six of eight required database files is complete and have been forwarded to the database managers.
- We now have 210 subjects in the database, including full sets of static and video images for each. Duplicate sessions exist for 143 of these individuals, triplicates exist for 9 individuals and quadruplicates for 3 individual.
- We have just published a review of the literature on memory for moving faces.
  - O'Toole, A. J., Roark, D., and Abdi, H. *Trends in Cognitive Sciences, 6*, 261-266.

Quarterly Report – October 15, 2002
Human Identification at a Distance Project

Recent Progress

From July 16, 2002 to October 15, 2002, we have accomplished the following:

Work Performed.

Database development. XML coding of the database is nearly complete. The recent changes in the dtd files from the Hbase developers delayed the final conversion.

Psychophysical Experiments. Data collection has been completed on the following experiments. We have completed a comparison of head movements including facial speech, expression, and head rotation. We have extended the previous work on head rotation to test the transfer to a single static inage. A final follow-up experiment is underway. Data collection is nearly complete in several additional experiments to: a.) assess the effects of attention load on face recognition, by varying the predictability of facial expressions on a trial by trial basis; b.) further compare the effects of head movements when transferring to single frontal images; and c.) assess the effects of familiarity on learning moving versus static presentations of faces. This third experiment has produced interesting findings indicating that familiarity with the face may be necessary for motion to have a beneficial effect on memory. We are also currently looking at the effects of color and motion on recognition of static and moving stimuli. We anticipate the completion of data collection on these experiments by the end of November 2002.

- *Subject filming.* We have added to the database on a continuous basis over this time, although we have slowed down this collection temporarily to be able to proceed with the testing of subjects in memory experiments.

Progress Summary

- Paper preparation has begun for all of the experiments in which data collection is complete..
- XML code conversion of the database files is nearly complete.
- We now have 250 subjects in the database, including full sets of static and video images for each. Duplicate sessions exist for 180 of these individuals, triplicates exist for 9 individuals and quadruplicates for 3 individual.
  - We have just submitted an extended review paper of the literature on memory for moving faces to the journal Behavior and Cognitive Neuroscience Reviews. This is a much more highly detailed version of the O'Toole, Roark, and Abdi, (2002). *Trends in Cognitive Sciences, 6*, 261-266. The paper also includes a section on the development of recognition of moving faces.

Quarterly Report – January 15, 2003
Human Identification at a Distance Project

Recent Progress

From October 16, 2002 to January 15, 2003, we have accomplished the following:

Work Performed.

Database development. XML coding of the database is complete and has been accepted bby the Hbase developers.

Psychophysical Experiments. Data collection has continued on the following experiments. 1) The experiment assessing the effects of attention load on face recognition, by varying the predictability of facial expressions on a trial by trial basis is about 2/3 complete. We have included full counterbalances on the gender and race of the subjects, both of which appear to be affecting performance. 2.) The experiment assessing the effects of familiarity on learning moving versus static presentations of faces is nearly complete. Early indications are that motion will aid in recognition and that there may be an interaction between familiarity and motion such that motion becomes relatively more important as the faces become more familiar. 3.) We are also currently looking at the effects of color and motion on recognition of static and moving stimuli. 4.) An experiment using synthetic versions of faces is being carried out to look at short term perceptual high level adaptation effects. We anticipate the completion of data collection on these experiments by the end of February, 2003.

- *Subject filming*. We have added to the database on a continuous basis over this time, although we have slowed down this collection temporarily to be able to proceed with the testing of subjects in memory experiments.

Progress Summary

- Paper preparation has begun for all of the experiments in which data collection is complete..
- XML code conversion of the database files is complete and submitted.
- We now have over 300 subjects in the database, including full sets of static and video images for each. Duplicate sessions exist for over 200 of these individuals, triplicates exist for 9 individuals and quadruplicates for 3 individual.
- We are preparing a manuscript for the IEEE Transactions on Pattern Analysis and Machine Vision on the database, which will be made publicly available when this paper is published.
  - An extended review paper of the literature on memory for moving faces has been accepted to the journal *Behavior and Cognitive Neuroscience Reviews*. This is a much more highly detailed version of the O'Toole, Roark, and Abdi, (2002). *Trends in Cognitive Sciences, 6*, 261-266. The paper also includes a section on the development of recognition of moving faces. We anticipate publication early this year.

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