FABIS-Mobile Facial Recognition Software

Experimentation Report

April 2017

Homeland Security
Science and Technology

NUSTL
NATIONAL URBAN SECURITY
TECHNOLOGY LABORATORY

OpEx-T-R-10

The *FABIS-Mobile Facial Recognition Software Experimentation Report* was prepared by the National Urban Security Technology Laboratory, U.S. Department of Homeland Security, Science and Technology Directorate.

The views and opinions of authors expressed herein do not necessarily reflect those of the U.S. government.

Reference herein to any specific commercial products, processes, or services by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. government.

The information and statements contained herein shall not be used for the purposes of advertising, nor to imply the endorsement or recommendation of the U.S. government.

With respect to documentation contained herein, neither the U.S. government nor any of its employees make any warranty, express or implied, including but not limited to the warranties of merchantability and fitness for a particular purpose. Further, neither the U.S. government nor any of its employees assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed; nor do they represent that its use would not infringe privately owned rights.

The cover photo and images included herein were provided by the National Urban Security Technology Laboratory, unless otherwise noted.

FOREWORD

The U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) Urban Operational Experimentation (OpEx)—hosted by the National Urban Security Technology Laboratory (NUSTL)—provides first responders with the opportunity to experiment with new and emerging technologies in realistic, urban settings. This event combines demonstrations of leading-edge technologies with application-based field assessments throughout the New York City metropolitan area.

NUSTL hosts the S&T Urban OpEx with participation from a broad range of federal, state, local, academic and private sector partners. NUSTL's Urban OpEx Program presents an important opportunity for DHS to gain a greater understanding of the operational needs and requirements of local first responders, while enabling first responder agencies to assess new technologies.

Capability gaps and potential technologies will be reviewed with New York City first responder agencies to ensure the S&T Urban OpEx best addresses local responders' needs, interests and priorities, and benefits the homeland security enterprise as a whole. Participating first responders will train on, and experiment with, technologies they have identified as possible solutions to meet priority capability gaps. Participants will also be in the unique position to influence the development of new technologies and provide recommendations for future DHS S&T investments through their field technology assessments.

For more information on the S&T Urban OpEx Program or to view published S&T Urban OpEx reports, visit www.dhs.gov/science-and-technology/frg-publications.

POINTS OF CONTACT

National Urban Security Technology Laboratory

U.S. Department of Homeland Security

Science and Technology Directorate

201 Varick Street

New York, NY 10014

E-mail: NUSTL@hq.dhs.gov

Website: https://www.dhs.gov/science-and-technology/frg-publications

Author:

John Kada, NUSTL Experimentation Director

EXECUTIVE SUMMARY

FABIS-Mobile facial recognition software, developed by Ideal Innovations, Incorporated (I³), underwent operational experimentation on January 24, 2017, at the National Urban Security and Technology Laboratory (NUSTL). FABIS-Mobile is designed to enable users to rapidly identify individuals appearing in video and still camera images. It is available as a smart phone application that performs facial recognition analysis on images collected with the smartphone's built-in camera. It also is available as software for laptop or desktop computers that can analyze images obtained from sources such as a surveillance camera network. The faces of individuals captured in video or still imagery are compared against a database of facial images of people who security or law enforcement agencies seek to identify.

Fourteen evaluators from various law enforcement and security organizations participated in this event. The evaluators were given a presentation on the features and capabilities of FABIS-Mobile by an I³ representative and then experimented with it on both smartphone and laptop computer platforms. The experimentation session allowed evaluators to use FABIS-Mobile in operationally relevant ways so they could provide feedback on its features, capabilities and suitability for use by law enforcement and security organizations. Smartphone experimentation involved acquiring video and still images of volunteer camera subjects, and attempting to determine which of them were on a smartphone-based "watch list" of over 175,000 individuals. Laptop experimentation involved identifying individuals in images the evaluators selected from news websites, Google searches and other sources, and comparing the selected images against a laptop-based database incorporating several million facial images. Feedback was obtained from the evaluators via a questionnaire they completed after the hands-on experimentation session, and by recording their remarks during the hands-on experimentation session and during an interactive debrief session with the I³ representative held after the hand-on experimentation session was completed.

Evaluator opinions of FABIS-Mobile were generally quite positive. They considered FABIS-Mobile's user interface to be easy to use and believed it could potentially improve their organization's ability to perform its law enforcement and security functions. The majority of evaluators indicated FABIS-Mobile was an improvement over similar technologies they were familiar with, and they believed it could be readily integrated into their organization's operations. They generally liked the speed and accuracy of facial recognition analysis and that FABIS-Mobile provided this capability on a mobile platform. The evaluators identified a number of specific uses for FABIS-Mobile by law enforcement and security organizations, such as identifying people in street encounters or in surveillance camera imagery of crime scenes as well as screening people seeking access to secure areas. Suggestions for improvement included eliminating the need to save video imagery before performing facial recognition analysis and integrating FABIS-Mobile with body cameras for use in undercover operations.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

On January 24, 2017, FABIS-Mobile facial recognition software, developed by Ideal Innovations, Incorporated (I³), was evaluated during the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) Urban Operational Experimentation (OpEx) event, hosted by the National Urban Security Technology Laboratory (NUSTL). This event brought together urban first responders and product developers to experiment with emerging technologies in operational conditions. Subject matter experts from the New York City Fire Department (FDNY), New York City Emergency Management (NYCEM), New York City Police Department (NYPD) and Port Authority of New York and New Jersey (PANYNJ) supported the Urban OpEx, selected the technologies and worked with NUSTL scientists to plan the experimentation scenarios and arrange test venues. Responders from these agencies and members of the First Responder Resource Group (FRRG) experimented with the technologies and provided feedback and observations. Table 1-1 lists the technologies that were included in this event.

Urban first responders from the FDNY, NYCEM, NYPD, PANYNJ and FRRG as well as Metropolitan Transit Authority (MTA) and Federal Protective Service (FPS) were canvassed for input on capability gaps that could be solved with technological solutions and technology areas of interest.

NUSTL then combined input from subject matter experts at these agencies and conducted a thorough technology selection process to establish three topic areas (Table 1-1) for the Urban OpEx.

Table 1-1 Urban OpEx Technology Focus Areas

Topic Area	Description
Incident Management Systems	Emergency Data Exchange Language (EDXL) compliant incident management software, for large and cross-jurisdictional emergency management, that allows for data to readily be received and shared with other EDXL compliant software.
Communications and Tracking in Subterranean Environments	Technology solutions that enhance a first responder's ability to communicate voice, data and location information from an incident area that is GPS denied and impedes RF signals (e.g., tunnels and underground subway systems) to other colleagues and incident commanders who may or may not also be in such environments.
Video Content Analysis and Video Analytics	Mobile and deployable technology solutions that aid law enforcement in threat detection including but not limited to: anomaly detection (e.g., left behind bags), behavior threat detection (e.g., crimes in progress, people in need of assistance) and facial recognition.

1.1 PURPOSE

The FABIS-Mobile operational experiment was designed to provide evaluators from law enforcement and security organizations with an opportunity to learn about FABIS-Mobile, experiment with it in a hands-on fashion, and provide feedback about its use for law enforcement and security applications. The aim of eliciting evaluator feedback was to provide I³ with information helpful in optimizing FABIS-Mobile for use by law enforcement and security personnel and to provide S&T program managers with a better understanding of law enforcement and security organization needs in order to guide future S&T investments in this technology area.

1.2 OBJECTIVE

This experimentation was designed to allow responders to experience the use of FABIS-Mobile in operational settings, and to offer feedback and suggestions to the technology developer that could enhance the product capabilities for first responder operations.

Figure 1-1 FABIS-Mobile Smartphone User Interface

1.3 RESPONDER CAPABILITY NEED

Law enforcement and security agencies advising NUSTL on technologies to include in Urban OpEx indicated that they considered facial recognition software to be a technology that could potentially significantly enhance their ability to quickly identify people of interest in a range of contexts, e.g., individuals who pose a security threat, wanted criminals, or subjects of Amber Alerts. These views were echoed in the DHS Biometrics Strategic Framework for 2015-2025[i], which identifies facial recognition software as a technology that can potentially enhance law enforcement and security functions by speeding identity verification processes while maintaining or increasing security.

1.4 PRODUCT DESCRIPTION

FABIS-Mobile facial recognition software is intended to enable users to perform real-time identification of individuals appearing in still or video camera images. It is available as an Android smartphone application that can analyze still and video images collected with the smartphone's camera. FABIS-Mobile is also available in a version that runs natively on the Windows, OS X and Linux operating systems on laptops with as little as 16 GB of RAM to analyze images obtained from sources such as a surveillance camera network. According to I[3], FABIS-Mobile's facial matching algorithm performs more effectively than industry standard algorithms when analyzing images collected under non-ideal conditions, such as partially occluded facial images or oblique camera angles. Facial features of camera subjects are compared against those on a user-defined "watch list" database of individuals whom a security or law enforcement organization wishes to identify, e.g., terrorists, wanted criminals or missing people. Video and still images acquired with a smartphone can be compared against a watch list representing several million faces stored internally in the smartphone's memory. Smartphone users operating in the field may optionally connect to an organization's back-end servers to update the internally stored smartphone watch list or run facial identification searches against back-end server watch lists representing tens of millions of faces.

---

[i] DHS Biometrics Strategic Framework 2015-2025, June 9, 2015. Prepared by the IBSV Biometrics Sub-Team, DHS Joint Requirements Council.

2.0 EXPERIMENTATION DESIGN

2.1 EVENT DESIGN

A detailed description of the experimentation design can be found in the FABIS-Mobile Experimentation Plan[ii]. The experimentation scenario was developed with input from law enforcement officers, security organization personnel, the technology developer and NUSTL's experimentation directors.

The experimentation was intended to provide a group of first responder evaluators an opportunity to learn about the features and capabilities of FABIS-Mobile. Additionally, the evaluators used the software on both smartphone and laptop computer platforms in order to assess the potential for rapidly identifying persons of interest to law enforcement and security organizations.

2.2 SUMMARY OF THE OPERATIONAL EXPERIMENTATION

On January 24, 2017, a group of evaluators, comprised of law enforcement and security personnel from the NYPD, PANYNJ, MTA and the Seattle Police Department convened at NUSTL in New York City, to participate in an operational experimentation with FABIS-Mobile.

Activities began in a conference room with a presentation by the NUSTL Experimentation Director about the Urban OpEx program and the purpose of the operational experiment. Additional opening remarks were provided by the NUSTL Director and a safety briefing was provided by the Safety, Health and Environmental Management System Coordinator. A representative from I³ then provided information about the features and capabilities of FABIS-Mobile.

A total of 14 evaluators then separated into groups, and took turns using FABIS-Mobile on three smartphones and a single laptop computer. The hands-on experimentation continued until each evaluator had an opportunity to use FABIS-Mobile on both platforms. The I³ representative was available to answer questions and provide technical assistance as needed during the hands-on experimentation.

2.2.1 SMARTPHONE PLATFORM EXPERIMENTATION

In this experimentation session, evaluators were given the task of using FABIS-Mobile-equipped Android smartphones to identify which members of a group of volunteer camera subjects were on a watch list stored on the smartphones for experimentation purposes. Approximately 20 NUSTL staff members served as volunteer camera subjects for this activity. The Test and Evaluation Division and Administrative Division corridors and work areas at NUSTL served as the venue for the smartphone experimentation session. Evaluators captured video and still images of camera subjects in various situations as might occur in the field, e.g., they captured images at various distances from the camera subjects, at various facial viewing angles, and collected images that included a mix of watch list and non-watch list camera subjects. The camera subjects varied their appearance during the experimentation session by donning eyeglasses, sunglasses and hats. Evaluators were also free to experiment with changing

---

[ii] Urban Operational Experimentation Plan FABIS-Mobile. January 2017. OpEx T-PL-12, NUSTL.

software settings, i.e., facial match score threshold, number of facial matches returned and maximum number of faces analyzed, to explore how such changes affected the ability of the software to identify camera subjects as members of the experimental watch list.

The watch list used for this experiment was created from two sources. It was prepopulated by I[3] with facial images of approximately 175,000 wanted individuals as identified by the Federal Bureau of Investigation, Immigration and Customs Enforcement and Bureau of Alcohol, Tobacco, Firearms and Explosives. Half of the NUSTL camera subjects participating in the experimentation session were then added to the experimental watch list, while the other half were not. This provided opportunities for all four possible identification results vis-à-vis the watch list, i.e., true and false positive, and true and false negative identifications.

Figure 2-1 Evaluator experimenting
with the smartphone application

2.2.2 LAPTOP/TABLET PLATFORM EXPERIMENTATION

Laptop experimentation took place concurrently with the smartphone experimentation using a version of FABIS-Mobile running on a laptop computer provided by I[3]. Here, evaluators explored the ability of the software to identify well-known individuals in digital images they selected from various online sources, e.g., Google searches, news and social media web sites using, a web browser integrated with the facial recognition software. Evaluators explored the ability of the software to correctly identify individuals in varying poses, viewing angles and image resolutions, checking the images they selected against a database stored in the laptop's memory that represented 42 million facial images.

2.3 DATA COLLECTION

Feedback from the evaluators was obtained in several ways. During the hands-on experimentation session, NUSTL data collectors recorded evaluator comments and concerns when using FABIS-Mobile on the smartphones and laptop computers. After experimenting with FABIS-Mobile, the evaluators completed a questionnaire eliciting their opinions of FABIS-Mobile's features and suitability for use by law enforcement and security organizations. Finally, following the experimentation, the evaluators returned to the conference room for a debrief session led by the Experimentation Director, in which first responders provided comments to, and asked questions of, the I[3] representative.

2.4 OPERATIONAL SCENARIO DEBRIEF

Following the experimentation, the evaluators returned to the conference room for a debrief session led by the Experimentation Director, to gain a better understanding of the suitability of the technologies, deficiencies, efficiencies and possible improvements. Additionally, first responders provided comments to, and asked questions of, the I^3 representative. The discussion included the following questions:

- What applications would you consider using FABIS-Mobile for?

- What did you find to be the most useful feature of FABIS-Mobile?

- What did you find to be the least useful feature of FABIS-Mobile?

- Are the costs of ownership (training needs, maintenance, etc.) likely to be greater than the benefit of such a technology?

- How can the technology be further improved?

The point of this discussion was to engage the users in a conversation that led to feedback that might not be gained from the survey. Notes were taken and incorporated into this report.

3.0 RESULTS

3.1 QUESTIONNAIRE FEEDBACK

The first part of the questionnaire the evaluators completed asked them to respond to a series of statements about FABIS-Mobile's features and suitability for use by law enforcement and security organizations. A breakdown of these responses is provided in Table 3-1. All evaluators indicated that FABIS-Mobile was easy to use and understand. Most evaluators believed facial recognition technology could potentially enhance their organizations' ability to perform law enforcement and security operations. A majority of the evaluators who expressed an opinion indicated FABIS-Mobile was an improvement over similar technologies with which they were familiar. They also tended to believe FABIS-Mobile could be easily integrated into their organization's operations, but here opinions were less strongly positive and more varied than on the previous points, with two evaluators indicating they thought integration could not be easily achieved. Finally, most evaluators indicated FABIS-Mobile was a product they would recommend their organizations acquire. In total, more than eighty percent of the responses expressing an opinion were positive about FABIS-Mobile's features and suitability for use in law enforcement and security organizations, while only five percent expressed a negative view.

Table 3-1 Summary of FABIS-Mobile Questionnaire Responses

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Unable to Determine
The user interface was intuitive and easy to both understand and engage with.	8	6	0	0	0	0
This technology is an improvement on similar technologies that I am familiar with.	2	4	4	0	0	4
The technology can potentially improve my organization's ability to perform its security/law enforcement operations.	7	4	2	0	0	1
This technology could be easily integrated into my organization's operations.	1	6	2	1	1	3
I would recommend that my organization acquire this technology.	5	5	0	1	0	3
Number of responses	23	25	8	2	1	11

The second part of the questionnaire elicited responses to a series of questions about FABIS-Mobile, and provided space for evaluators to provide comments on any other points not covered in the questionnaire that they wished to discuss. These questions, and a summary of responses, are presented below.

- What applications would you consider using FABIS-Mobile for?
  - Evaluators indicated FABIS-Mobile could help law enforcement and security personnel identify individuals who have outstanding arrest warrants, who are wanted for questioning with regard to crimes or who are known terrorists. They also

suggested FABIS-Mobile could be used to retrospectively identify individuals of interest in surveillance camera imagery of a crime scene. Additionally, the evaluators indicated FABIS-Mobile could be used as a tool to screen people seeking access to high-profile events or to secure facilities.

- What did you find to be the most useful feature of FABIS-Mobile?

  o Evaluators cited FABIS-Mobile's ease of use and the rapid speed at which it provided identification results, and that it worked on a mobile platform. They also cited the accuracy of facial recognition analysis, and that the smartphone watch lists could be quickly updated in the field utilizing the smartphone's internet connectivity.

- What did you find to be the least useful feature of FABIS-Mobile?

  o Evaluators mentioned video imagery had to be saved to memory prior to searching for facial matches. They also mentioned that, when collecting images of a group of people, it was sometimes unclear which individuals in a group image the software was attempting to identify. One evaluator indicated that during hands-on experimentation there were too may failures to identify camera subjects on the experimentation watch list. Some evaluators indicated FABIS-Mobile's optional capability to connect to an external server might not be useful in practice due to organizational requirements for secure communications between digital devices.

- Describe whether the costs of ownership (training needs, maintenance, etc.) are likely to be greater than the benefit of such a technology.

  o Most evaluators indicated they needed more information to provide a meaningful reply. Several evaluators suggested a pilot study involving actual field use of FABIS-Mobile would be necessary to assess its cost effectiveness.

- How can the technology be further improved?

  o Suggestions for improvement included making it possible to analyze video imagery in real-time rather than after storing it in memory; making it clearer which individuals in images containing several people the software was attempting to identify; more clearly correlating camera subjects with watch list matches in group images; providing a reverse forensic search capability, i.e., the ability to bring up facial images of individuals requested by the user; allowing users to add search qualifiers (not specified) when performing facial recognition analyses and finally, that FABIS-Mobile should provide ancillary data such as known associates or identifying marks (e.g., scars).

- Additional comments: Two evaluators used this section to ask questions that were not discussed on the day of the Urban OpEx event. These questions were forwarded to an I3 representative for response.

  o Can FABIS-Mobile be integrated with standard commercially available video management or physical security management system software?[iii] The I3 representative responded that I3 would need to work with vendors providing

---

[iii] Video management system software collects video from a security camera network, provides a live view to system users and records it to a storage device where it can be later accessed. Physical security information management software integrates multiple existing disparate security devices and information systems into a single, comprehensive user interface.

components of a system to discuss the methods available to extract facial images from the system for facial recognition analysis.

- o Another evaluator expressed concerns about data security when using smartphones running FABIS-Mobile to connect to an external server. The I³ representative responded that there is commercial off-the-shelf software available to encrypt smartphones and the data in transit. The I³ representative further stated I³ would be open to putting the necessary encryption software into place if a customer requests it.

3.2 DATA COLLECTOR NOTES

Evaluator comments recorded by NUSTL data collectors during the hands-on experimentation and debrief sessions largely reiterated the questionnaire feedback; however, a few additional points were raised. During the debrief session, several evaluators indicated that analyzing video data in real-time from a body camera would be a useful capability, especially for undercover operations. The I³ representative responded this might not be feasible when running FABIS-Mobile from a mobile platform such as a smartphone due to processing power limitations, but I³ was working with other companies to determine whether these limitations could be overcome. An evaluator suggested extending the range over which facial recognition analysis could be accomplished would be desirable.

3.3 CONCLUSION

Overall evaluator opinions of FABIS-Mobile were generally quite positive. They considered FABIS-Mobile's user interface to be easy to use and believed it could potentially improve their organization's ability to perform its law enforcement and security functions. The majority of evaluators indicated FABIS-Mobile was an improvement over similar technologies they were familiar with, and they believed it could be readily integrated into their organization's operations. They generally liked the speed and accuracy of facial recognition analysis and that FABIS-Mobile provided this capability on a mobile platform. The evaluators identified a number of specific uses for FABIS-Mobile by law enforcement and security organizations, such as identifying people in street encounters or in surveillance camera imagery of crime scenes as well as screening people seeking access to secure areas. Suggestions for improvement included eliminating the need to save video imagery before performing facial recognition analysis and integrating FABIS-Mobile with body cameras for use in undercover operations.