Portable Biometrics Workstation: Session Interface

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Executive Summary

The portable biometric workstation is being developed as a means of creating a database of biometric information. The workstation will consist of nine (9) digital cameras that will capture a set of face photographs from different angles. Two (2) different fingerprint scanners will be used to collect digital fingerprints. Irises will be digitally recorded using an iris scanner. Each step (photographs, fingerprinting, and iris scanning) will be accomplished twice for the database in a single session. Six (6) months after the first data capture a second data capture will occur. This will create a database of biometrics taken at two points in time from the same person. The goal is to collect 10,000 sets of data. An operator will use the session interface to direct subjects through the workstation. The interface must clearly indicate what task is being accomplished as well as any specific requirements of the individual tasks.

In order to collect 10,000 complete sets of biometrics, we estimate using the workstation at least 25,000 times. In order to minimize the time, both for operators and the biometric subjects, it is critical that the usability of the workstation be maximized.

To test the usability of the session interface an interactive prototype was created. Participants were asked to play the role of the operator while developers played the roles of the assistant and the user (the person having biometric data collected). All the biometric data "collected" in the prototype was fake data. This was explained to the participants prior to the scenarios. There were three (3) scenarios; in the first scenario everything was normal and in working condition, in the second scenario two of the scanners were offline due to errors, and in the third scenario everything appeared normal but there were three scanning errors during the walkthrough. The scenarios were presented in the same order for all participants. After each scenario the participants were given a brief six-item questionnaire with space to provide feedback about the interface.

There were eight (8) participants, five (5) males and three (3) females. All were NIST employees at the time of the experiment.

The overall average time per scenario was 208 seconds. For the 1st and 3rd scenarios (with all tasks available) the average time was 239 seconds. The face photos took an average 28 seconds, fingerprints averaged 37 seconds per set (LH/RH and thumbs), and iris scans averaged 17 seconds. NOTE: These numbers do not take into consideration the actual "true" equipment timing. These numbers are based on 1.6 second simulated scan/display times.

There were few errors committed during the testing. Most of the errors that did occur were based around incorrect prompting. There were fewer errors committed as the session progressed, even though scenarios two and three had various sensor and image errors.

The collection times (photos, fingerprints, iris scans) stayed fairly constant across participants/scenarios, which implies that the timesavings between the scenarios are mostly due to an increased understanding of the procedure and tasks.

Almost all of the participants rated the interface and its components as easy to use. Even those who found it difficult in the first scenario rated it easier to use in the subsequent scenarios. Observations of operator behavior suggest that the assistant may be an unnecessary role.

Introduction

Full Product Description

The portable biometric workstation is being developed as a means of creating a database of biometric information. The workstation will consist of nine (9) digital cameras that will capture a set of face photographs from different angles. Two (2) different fingerprint scanners will be used to collect digital fingerprints. Irises will be digitally recorded using an iris scanner. Each step (photographs, fingerprinting, and iris scanning) will be accomplished twice for the database in a single session. There is also an operator workstation, which will guide the flow through the biometric workstation and make sure the biometric data is properly captured. The operator workstation is also referred to as the session interface.

Nine Olympus Camedia C-5050 digital cameras were setup to capture the face photographs. One LS2 and ID500 scanners were setup to capture fingerprints. The OKI EQ5051A was setup to capture iris scans. None of the equipment was connected during the experiment, as we were only interested in testing the session interface. All biometric data "captured" by the session interface was fake data. This was explained to the participants in advance.

TSA agents will be using this workstation for the collection of a massive amount of biometric data.

Test Objectives

The experiment was conducted to assess how long each collection step took in the session interface and to determine if the interface facilitated the flow of the workstation. We also looked for any physical problems associated with the flow of the workstation and how well the session interface supported the operator during the data collection.

Method

Participants

Eight participants were tested: 5 males and 3 females.

All participants were NIST employees. They had basic computer knowledge but were not knowledgeable in biometrics.

Participants were solicited by e-mail and word of mouth. There were no key characteristics considered in the selection of participants.

As they all work at NIST, there is the possibility that the participants for this test had more computer knowledge than the average user population for this interface.

For the duration of this report, participants will be referred to as "operators." The operators interacted with three developers during the experiment. One developer was an observer who administered the experiment and answered any questions the operator had. A second developer played the role of the "user," who was the person having their biometric data collected. The third developer acted as the "assistant," who helped the operator and positioned the user for each collection sequence (photographs, fingerprinting, and iris scanning).

Context of Product Use in the Test

During the actual biometric collection in the field, there will probably be several people (users) waiting in line to use the workstation. There will also be a second assistant using a separate workstation to register those users waiting in line. The possible confusion caused by these interactions was not addressed in the experiment. Also, our users and assistants were more knowledgeable about the system than actual users will be.

Tasks

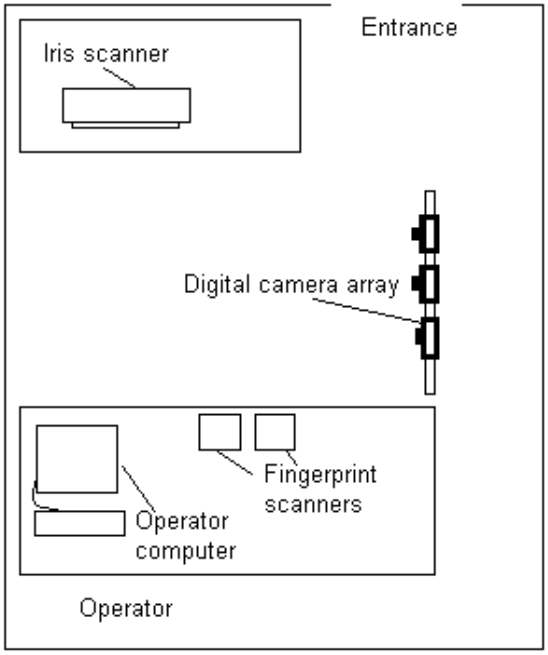
The operators were asked to use the session interface to collect biometric data from a user. In doing this, they were using the task flow presented in the session interface, ensuring that the proper data was collected and that the data was acceptable. They also needed to direct the assistant to position the user correctly for each type of biometric collection.

This task was selected to evaluate the usability of the interface and gather an approximation of the time needed to complete the collection procedures.

Completion of the task was achieved after photo, fingerprint, and iris scans were collected.

Test Facility

The test was conducted in a biometrics lab. The spaced used was about 12' x 8'. The operator sat on one side of a table while the fingerprint scanners were placed on the other side, facing out. The digital camera array was positioned to the left and perpendicular to the operator. The iris scanner was positioned directly across the room from the operator.



Participant's Computing Environment

The computer used in the experiment was a Dell Precision 360 with a Pentium 4 processor running Windows NT.

Display Devices

A ViewSonic VG700b 17" flat LCD monitor was used. Resolution was 1024 x 768 and 32-bit color was used.

Manual Input Devices

Standard mouse

Test Administrator Tools

A paper-based questionnaire was used to elicit usability feedback and suggestions. The questionnaire had six (6) five-point Likert scale statements with room for comments after each statement. There was room to comment on the interface as a whole at the end of the questionnaire.

The computer running the session interface had Camtasia running in the background. Camtasia is a commercially available program that captures the video of the computer screen and saves it as an AVI file. A microphone was also used with Camtasia to capture any comments the operator may have had.

An observer made notes and collected timing data.

Experimental Design

The operators were asked to step through the biometric collection process using the session interface. After being introduced to the assistant and user, the operators did three sessions of biometric data collection with the interface.

During the first session everything was normal in the interface and there were no errors. During the second session, two of the scanners were offline and the operator had to modify the normal sequence based on the notification of this in the user interface. The third session had three separate image errors that the operator had to deal with. All operators did these sessions in the same order.

Procedure

The participants were greeted as they walked into the lab and handed an Informed Consent form to fill out. They were also handed a more detailed participant write-up. The participants were asked to play the role of "operator" both verbally and in the physical write-up. They were given a manual for the session interface and a brief explanation of its function. The assistant and user were introduced, and the operator then collected biometric data (fake data) from the user. This collection process was repeated three times with a questionnaire after each session. At the end of the experiment the operator was thanked for his/her participation, given a copy of the Informed Consent form, and allowed to leave.

Error collection (captured by the observer) - Errors were defined as the following:

1. Incorrectly or forgetting to prompt the assistant
2. Skipping a step that can be done
3. Accepting a corrupted image

The beginning of a task was defined as the session interface highlighting that task; the end of a task was defined as the session interface highlighting the next task.

There were no time limits on tasks.

The operators were free to ask questions during the experiment. Calculated task times do not include the time used for questions. Operators were told to prompt the assistant to position the user, but there were no set rules on direct interaction with the user. This was because part of the experiment was to see how these interactions played out. The prompts from the operator to the assistant were displayed in the user interface.

There were three people who interacted with the operator: the observer, who took notes, ran Camtasia, and answered questions; the user, who had fake data collected from him/her; and the assistant, who positioned the user after prompting from the operator.

For a few of the tests there was an extra observer taking notes in the background.

All time was volunteered from the participants and they were not paid.

Participant General Instructions

The operators had the following general instructions:

> This study is being performed to test the usability of an operator interface that will be used to help collect data for a biometric workstation. You will be asked to act as an operator at the biometric workstation. Biometric workstation developers will play the roles of assistants and subjects. Using the operator interface, you will collect biometric data from the developers acting as the subjects in the experiment. You will be given training on the use of the operator interface, and then the actual experiment will begin.
>
> During the experiment your comments (about the interface and to the assistants) and interactions with the interface will be recorded. There will be at least one investigator taking notes and a video of the experiment will be recorded. There will be a short questionnaire for you to fill out as well.

Participant Task Instructions

The operators had the following instructions during the beginning of the experiment:

> This study is being performed to test the usability of an operator interface that will be used to help collect data for a biometric workstation. You will be asked to act as an operator at the biometric workstation. Two other people will play the roles of assistant and user. Using the operator interface, you will collect biometric data from the user in the experiment. You will ask

your assistant to position the user for each task. When your assistant is ready he/she will let you know.

Your assistant will have had training on the collection equipment in the workstation, but this will be the first time he/she has been exposed to the biometric workstation. You should prompt the assistant on the task order and what he/she needs to do.

The operator interface you will be using is a prototype. The data collected will be fake data and not collected in real time. Therefore, the photos may not be of the person acting as the subject, however this should not interfere with the experiment as we would like you to focus on the *interface* and not the specific data being collected.

The photos will be taken from nine (9) different angles and displayed together. As long as the photos represent the subject as he/she is supposed to look, you should accept them. It does not matter if the photos are not completely centered as long as the face is visible.

When taking the fingerprint and iris scans, the data captured will appear briefly in the Sensor Feedback window and then disappear. This is because the equipment automatically accepts correct images. If there is an image problem, the interface will alert you.

You will be given a manual describing the operator interface. You are free to ask questions about the workstation and the collection procedure. You may also ask for help during the experiment if necessary. When you are ready to start the experiment, please let us know. Thank you for your participation.

Usability Metrics

Effectiveness was measured by counting the number of errors (see error definition under "Procedure" section).

Efficiency was measured using the time to complete each session and time to complete each task (face photos, fingerprints, and iris scans).

User satisfaction was measured by using the results of the questionnaires (*see Appendix A for questionnaire*).

Results

Data Analysis

Much of the data was taken from the timing of the tasks. The participant comments also figured prominently in the re-design of the session interface.

Presentation of the Results

Performance Results ❖

Effectiveness: Session 1

User #	Incorrect Prompting	Skipping a doable task	Accepting bad image
Participant 1			
Participant 2			
Participant 3	1		
Participant 4	2		
Participant 5			
Participant 6	1		
Participant 7	1		
Participant 8			
Total	5		

Effectiveness: Session 2

User #	Incorrect Prompting	Skipping a doable task	Accepting bad image
Participant 1	1		
Participant 2		2	
Participant 3			
Participant 4			
Participant 5	1		
Participant 6			
Participant 7			
Participant 8		1	
Total	2	3	

Effectiveness: Session 3

User #	Incorrect Prompting	Skipping a doable task	Accepting bad image
Participant 1			
Participant 2			
Participant 3			1
Participant 4	1		
Participant 5			
Participant 6			
Participant 7			
Participant 8			1
Total	1		2

There were few errors committed during the testing. Most of the errors that did occur were based around incorrect prompting. There were fewer errors committed as the session progressed, even though scenarios two and three had various sensor and image errors.

Skipping a doable task and accepting a bad image were scenario specific errors (scenarios 2 and 3 respectively). The doable tasks that were skipped in scenario 2 were due to confusion with the prompts, which didn't skip with the tasks correctly. The two bad images that were accepted were face photographs that had one image corrupted (out of a grid of the nine photos taken). This may have been due to the size and placement of the photos relative to the rest of the interface. The photo grid was displayed in the upper left-hand corner. It is our belief that displaying the photos larger and in the middle of the screen will draw the operator's focus more effectively.

Efficiency (in seconds – rounded to nearest second)

User #	Scenario 1	Scenario 2	Scenario 3	Face photos	Fingerprints	Iris scans
Participant 1	250*	131*	239	48	36	7
Participant 2	379*		304	37	50	22
Participant 3	255	98	202	20	36	19
Participant 4	147*	116*	169	24	20	9
Participant 5	267*		188	18	38	18
Participant 6	343	136	220	40	40	16
Participant 7	234	124	190	22	34	18
Participant 8	220	143*	217	22	37	18
Mean	262	125	224	29	37	17

* Some sessions had missing time data. For the cells that were missing data, the average of a particular task was used to create the estimated session time. The blank cells are scenarios that did not have task times captured.

	Face Avg	Fingerprint Avg	Iris Avg	Overall Avg
Scenario 1	36	40	17	262
Scenario 2	24	39		125
Scenario 3	25	33	17	224
Mean	29	37	17	208

The average time per scenario appears to decrease as the scenarios progress. Scenario 2 is noticeably shorter in duration because two of the sensors weren't working during that scenario. However, combined with the error data it appears that repetition speeds up the process, and Scenario 3 is noticeably faster than Scenario 1 even with the image errors introduced in Scenario 3 (both scenarios had all the sensors in working order). Hence we infer that as the operator gets more experience the time will be shorter. However, our users were knowledgeable and cooperative. With naïve users the flow may not be as smooth.

The face photos, fingerprint scans, and iris scans all had reasonable average times, but it must be noted that these numbers do not take into consideration the actual "true" equipment timing. These averages are based on a 1.6 second simulated scan/display time. The collection times (photos, fingerprints, iris scans) stayed fairly constant across participants/scenarios, which implies that the timesavings between the scenarios are mostly due to an increased understanding of the procedure

and tasks. The participants were given only a brief overview of the interface and it's functioning before using it. Operators in the field will have more knowledge of the procedures, but this early testing indicates that the training and learning curve probably won't be too steep.

Satisfaction Results

Satisfaction: Questionnaire Responses (see Appendix A for questionnaire)
1 = Easy; 5 = Hard

User #	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6
Participant 1						
Session 1	2	4	4	2	3	2
Session 2	2	4	2	2	2	2
Session 3	1	3	2	2	2	2
Participant 2						
Session 1	1	2	3	1	1	1
Session 2	5		1	3	4	3
Session 3	1		1	1	1	1
Participant 3						
Session 1	1	1	2	1	1	1
Session 2	1	1	1	1	1	1
Session 3	1	1	1	1	1	1
Participant 4						
Session 1	1		1	1	3	1
Session 2	2	1	1	1	3	1
Session 3	1	1	1	1	3	1
Participant 5						
Session 1	1		1	1	1	1
Session 2		1	1	1	1	1
Session 3	1	1	1	1	1	1
Participant 6						
Session 1	1	1	1	1	2	2
Session 2	2	1	1	1	2	2
Session 3	1	1	1	1	1	2
Participant 7						
Session 1	4	5	1	1	3	2
Session 2	1	5	3	1	3	2
Session 3	2	3	2	2	3	2
Participant 8						
Session 1	1	1	1	1	3	3
Session 2		2	1	1	5	2
Session 3	1	1	1	1	2	2
Mean	1.55	2.00	1.46	1.25	2.17	1.63

The interface used was fairly straight forward (*see Appendix B)*, so the results are not surprising. Almost all of the participants rated the interface and its components as easy to use, and it should be noted that satisfaction generally increased with use. There were also several comments and suggestions to make the interface better. A couple of the more frequent suggestions involved positioning the prompts in closer proximity to the task list and making it clearer when a user needs to remove his or her glasses (for a photo or iris scan).

After observing several participants it became apparent that the operator talked more directly with the user after the first set of fingerprints had been taken. At that point several operators ignored the assistant and told the user directly what to do. This raises the question of whether an assistant is necessary (though it must be noted that our users knew more about the system than the average user in the field will). More testing needs to be done to see if the assistant can be removed with little negative effect. Removing the assistant would save training time and money during deployment of the workstation and should be carefully considered.

There is also the question of how long an operator can use the interface without a decrease in effectiveness or efficiency. This was not tested here but needs to be examined. This needs to take into consideration concentration issues as well as the possibility of boredom. Removing the assistant may not only save money but also engage the operator more in the data collection. It must be determined how to efficiently rotate operators between the registration interface and the session interface during the course of a day, allowing some down time and a change of task.

Status

Currently the session interface has been revamped with consideration to the comments and observations made during the testing. Future work includes testing the workstation without an assistant. There also needs to be some testing done with naive users to better estimate the time required to gather biometric data. Long term testing needs to be done to determine timing platuaus and the length of time an operator can use the interface before effectiveness and efficiency decrease.

Appendix A – Interface Questionnarie

Questionnaire **Subject_____ Iteration___**

With relation to the interface you just used, please circle the number that corresponds to your experience. Below each question is a space for you to comment on your specific experience.

1. The procedure for collecting the face photo was

   Very easy to conduct 1 2 3 4 5 Very difficult to conduct

   Comments:_____

2. Asking the subject to remove his glasses for the second photo was

   Very easy to remember 1 2 3 4 5 Very difficult to remember

   Comments:_____

3. Prompting the assistant on how to maneuver the subject was

   Very easy to remember 1 2 3 4 5 Very difficult to remember

   Comments:_____

4. The fingerprints were

   Very easy to obtain 1 2 3 4 5 Very difficult to obtain

   Comments:_____

5. Overall, the interface was

   Very easy to understand 1 2 3 4 5 Very difficult to understand

   Comments:_____

6. The timing of the tasks was

   Very Fast 1 2 3 4 5 Very Slow

   Comments:_____

What did you dislike about the interface? How would you change the interface to make it better?

Appendix B – Screenshot of Operator Interface