



**CTN Report
93-002**



**Computer-Assisted
Data Acceptance
(CADA)
Performance Test Report**

9 November 1992

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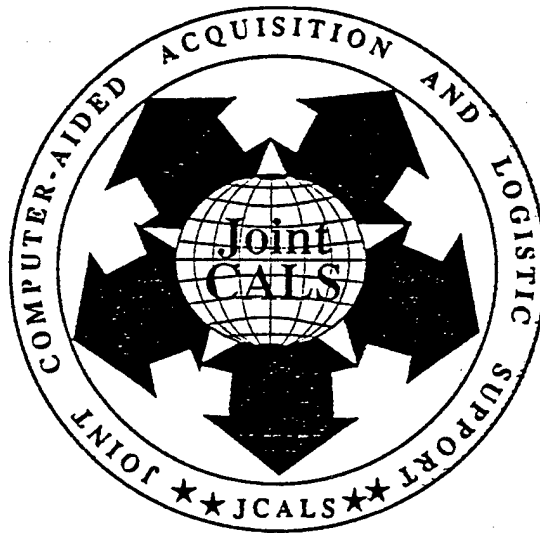
**Computer-Assisted Data Acceptance (CADA)
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9 November 1992

FINAL

Prepared by:

Department of the Army
JCALS



DTIC QUALITY INSPECTED 3

Joint
Computer-aided Acquisition
and Logistic Support (JCALS)

CALS Technology Center (CTC)

**Computer-Assisted Data Acceptance (CADA)
Performance Test Report**

CONTRACT NO.: DAAB07-89-D-A047

TASK NO.: 92-012

9 November 1992

FINAL

Prepared for:

Department of the Army
PM JCALS

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The views, opinions, and findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision, unless designated by other documentation.

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Executive Summary

Data Acceptance (DA) is defined as the means by which the Government officially accepts product or technical publication data from a contractor, based on the quality of the data. Quality is defined, for CALS engineering drawing data, as the clarity and fidelity of digital representation. The clarity and fidelity must be such that, when the data are retrieved from or reproduced at the repository, the user can read, interpret, and measure objects depicted in the drawing image area and clearly interpret the key identification data (ID) within the title block or tabular fields of the engineering drawing. Computer-Assisted Data Acceptance (CADA) has been defined as the unattended, objective, and uniform quality evaluation of contractor-delivered CALS raster data.

Previous tests have been conducted which evaluate the effectiveness of the individual and combined CADA image algorithms in the acceptance of raster image data as well as the recognition accuracy of various OCR and ICR vendor products. This report presents the component response times and system throughput performance of the CADA tools when tested on a Sun-based platform and a PC-based platform. Testing contractor provided CALS raster data will provide additional system response and accuracy performance results which will be documented in *Computer-Assisted Data Acceptance (CADA) Contractor Data Test Report*, due to be delivered December 18, 1992.

The approach taken was to first integrate the CADA tools into a Sun platform and a PC platform. A common suite of test data was prepared on six CALS magnetic tapes which were used to test the two platforms. The test data represents the different sizes and densities of engineering drawing data. The suite of image test data contained 100 assorted "A" size images, 100 assorted "C" size images, 100 assorted "E" size images and 299 assorted "A" through "E" size images. The suite of ID recognition test data was made up of 121 images of engineering drawings with ANSI-type format standard title blocks.

The image response times for loading the CALS magnetic tapes, CADA evaluation of the image data, displaying each CADA tool screen, viewing 10% of the images, and performing CADA image transformation operations were recorded for each of the two platforms (Sun and PC). The results, summarized in Section 5, indicate that these response times are reasonably fast.

The performance tests, using the suite of ID test data, were run on both the Sun and PC platforms. These tests involved testing the CADA pre-processing time, the ICR vendor recognition time and the post-processing time. The pre-processing tests involved measuring the times to locate the border, ANSI title block, and location of strings within the title block. The results indicate that the main performance bottleneck is the border location time. A fast approach to border location was tried and shows good promise. It is recommended that this approach be pursued further. The results are summarized in section 5, and provided in detail in Appendix A.

Disclaimer

The use of trade names in this document or discussion of a particular product does not constitute an endorsement or approval of the use of such commercial equipment. This document may not be cited for the purpose of advertisement.

1 INTRODUCTION

This report presents the Laboratory Performance Tests of Computer Assisted Data Acceptance (CADA) software tools that have been integrated into two stand-alone platforms: a Sun based platform and a Personal Computer (PC) based platform. The tests measure the response times of various components as well as the system throughput on the two platforms.

1.1 Background

Previous tests have been conducted which evaluate the effectiveness of the individual and combined image algorithms as well as the recognition accuracy of various OCR and ICR vendor products. This testing phase will focus on the performance aspect, within the laboratory environment, prior to field testing the prototype CADA tools.

1.2 Objectives

The objective of these tests is to conduct Level Performance Testing of the CADA tools on the Sun and PC platforms within the laboratory. The main objectives of the performance testing are two fold.

1. Measure screen response times. These tests will measure the response times of various screens that an operator has to step through when using the CADA tools; therefore, they are important from a human factors standpoint. The results identify areas where performance should be improved and an indication of what can be expected when the tools are implemented in the field on these platforms.
2. Measure system throughput performance. These tests will measure the time required to load the images, evaluate the data, and display the results. Since the image evaluation is in an unattended mode, this measure is more important from a scheduling and planning standpoint than from a human factors standpoint.

1.3 Scope

The scope of the performance testing involves testing the CADA tools on two stand-alone platforms. A suite of engineering drawing test data, that represents the different drawing sizes of CALS-ready production data on CALS-compliant magnetic tape media, was used in conducting the performance tests on the two platforms. The following performance parameters were measured on each platform:

1. the average response time, in seconds, of each interactive operation including the response times for image transformation operations like rotation and zooming;
2. the average time to load and evaluate CALS MIL-STD-1840 formatted media with different size images;

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3. the average time to evaluate the quality of images of different sizes; and
4. the average time to locate, recognize and match the identification data for images of different sizes.

2 TESTING OUTLINE

2.1 Location

Laboratory Performance Testing of the CADA tools, analysis of the test results and preparation of this test report was performed at the Army PM JCALS CALS Technology Center (CTC) at Fort Monmouth, New Jersey, for the CALS Test Network Office.

2.2 Test Plan

A test plan was prepared that defined the preparation of the suite of test data to be used and the specific tests to be performed.

3 LABORATORY PERFORMANCE TEST PARAMETERS

Dates:

September, October, and November 1992

Evaluators:

Army CALS Technology Center Personnel
PM JCALS, SFAE-PS-CAL-T
Fort Monmouth, New Jersey

ACCURATE Information Systems, Inc. Personnel
Meridian Center One,
Two Industrial Way,
Eatontown, New Jersey 07724

Data Types:

MIL-R-28002 Raster Type 1 binary image data representing engineering drawing data of differing sizes from DSREDS and EDCARS sites.

System Description:

CADA Platform I Hardware: Sun IPX; 48MB RAM, 1.3GB H. Disk, HP Tape Drive

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CADA Platform I Software:	SunOS 4.1.1, Sun NewsServer - X11R4 compliant MOTIF Window Manager 1.1
CADA Software:	CADA Tools Ver. 0.5 with: XVT Portability Toolkit Ver. 3.0 UniSoft's Sun Imaging Library Ver. 5.1 CTN's Tape Tool Ver. 1.2.8 NestorReader SunSPARC Ver. 1.2
CADA Platform II Hardware:	PC Gateway 2000, 50MHZ - 486 DX2 with: 16MB RAM, 340MB SCSI Hard Disk
CADA Platform II Software:	SCO UNIX Open Desktop 2.0 X11R4 Server MOTIF Window Manager 1.1
CADA Software:	CADA Tools Ver. 0.5 with: XVT Portability Toolkit Ver. 3.0 UniSoft's PC Imaging Library Ver. 5.1 CTN's Tape Tool Ver. 1.2.8 NestorReader PC Ver. 1.2

4 LABORATORY PERFORMANCE TEST PROCEDURE SUMMARY

The main steps in the performance of the tests involved preparing the suite of test data on six separate magnetic tapes (formatted in accordance with MIL-STD-1840), loading the tapes, individually, viewing the results of the image performance tests and identification tests. The test procedure steps are described in Sections 4.1 through 4.3.

4.1 Test Data Preparation

Six tapes containing 'A' through 'E' size image data were prepared.

1. Tape 1: contained 100 assorted images of 'A' size pages, which were used for image quality testing only.
2. Tape 2: contained 100 assorted images of 'C' size pages, which were used for image quality testing only.
3. Tape 3: contained 100 assorted images of 'E' size pages, which were used for image quality testing only.
4. Tapes 4 & 5: contained 299 assorted images; each group contained a uniform mix of 'A' through 'E' size pages, which were used for image quality testing only and

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5. Tape 6: contained 121 images of engineering drawings with ANSI type format standard title blocks, which were used for ID recognition testing only.

4.2 Tape Load, Quality Evaluation and Screen Response Times

The following operations were performed on each of the two platforms (Sun and PC), using tapes 1 through 5, to obtain response times and system through-put performance results:

1. loading the tape(s) while measuring load times;
2. performing image quality evaluation and measuring evaluation times for the image sizes represented on each of the five (5) tapes;
3. recording screen response times for each of the different CADA tool screens;
4. viewing 10% of the images and recording the response times; and
5. performing image transformation operations and recording the response time (e.g., rotate and zoom).

4.3 Identification Data Response Time Tests

The tests as described below were performed on each of the two platforms (Sun and PC) using Tape 6:

1. pre-processing software was run and the times for the following operations were recorded for each image:
 - a) image decompression,
 - b) border location,
 - c) location and cropping of ANSI title block, and
 - d) location of strings within the title block;
2. recognition software was run on the strings located in the previous step and the time for that operation recorded; and
3. post-processing software was run on the recognition results of the previous step and the time for that operation recorded.

For border location, two different approaches were tried, the "slow" approach and the "fast" approach. The fast approach is still in experimental stage, but shows significant promise. Results from both the approaches are documented in the Section 5 to show the potential improvement in performance with the fast approach.

5 RESULTS

5.1 Test Results

The detailed results may be found in the Appendix. The following tables give a summary of the results obtained for each platform.

5.1.1 Platform I Results (Sun)

The Sun IPX platform was configured as shown in Figure 5-1. The printer's performance was not evaluated during these tests. A high resolution monitor was not used for the tests performed on the Sun platform; the monitor used had a resolution of 1152 x 900. The results of the tests for this platform are shown in Tables 5-1 through 5-5.

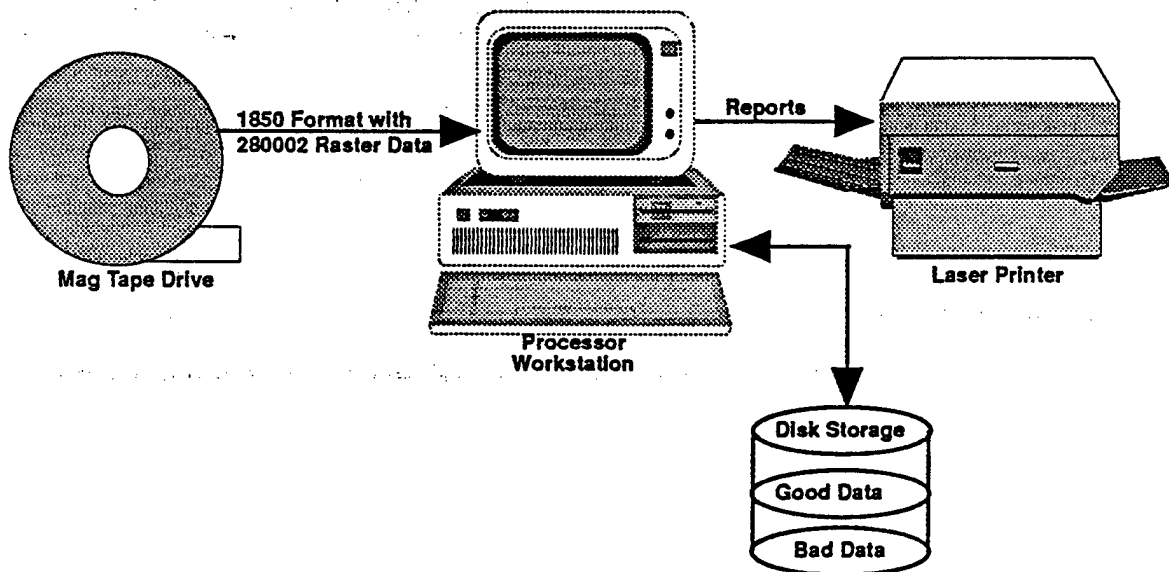


Figure 5-1. Configuration of Platforms I and II

Table 5-1. Screen response times

Best response time per screen operation	0.35 sec.
Average response time per screen operation	1.55 sec.
Worst response time per screen operation	4.01 sec.

Table 5-2. Tape load and evaluation times

Average load and evaluation time for a tape of 100 assorted images	138.31 sec.
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Table 5-3. Image quality evaluation times

IMAGE SIZE	AVERAGE QUALITY EVALUATION TIME (SECONDS)
A	2.8 sec.
C	6.88 sec.
E	20.06 sec.

Table 5-4. Image viewing operation times

IMAGE SIZE	AVERAGE VIEW TIME	AVERAGE ROTATION TIME	AVERAGE ZOOM TIME	AVERAGE INVERT TIME
A	1.07 sec.	0.56 sec.	0.55 sec.	0.61 sec.
C	1.38 sec.	0.69 sec.	0.69 sec.	0.72 sec.
E	3.58 sec.	1.56 sec.	0.88 sec.	1.24 sec.

Table 5-5. ID recognition times

IMAGE SIZE	AVERAGE DE-COMPRESSION TIME (in seconds)	AVERAGE BORDER LOCATION TIME (in seconds)		AVERAGE TITLE BLACK LOCATION/CROPPING TIME (in seconds)	AVERAGE STRING LOCATION TIME (in seconds)	AVERAGE RECOGNITION TIME (in seconds)	AVERAGE POST-PROCESSING TIME (in seconds)	AVERAGE TOTAL TIME (in seconds)	
		SLOW APPROACH	FAST APPROACH					SLOW APPROACH	FAST APPROACH
A	5	35	8	3	2	5	0	51	23
B	7	75	16	4	3	7	0	96	37
C	12	109	26	9	3	8	0	141	58
D	30	344	79	17	4	4	0	399	134
E	43	307	85	28	4	7	0	379	167
F	31	249	69	18	3	7	0	308	128

5.1.2 Platform II Results (PC)

The PC platform was configured as shown in Figure 5-1. The printer's performance was not evaluated during these tests. A high resolution monitor was installed for the PC; the resolution was 1600 x 1280. The results of the tests for this platform are shown in Tables 5-6 through 5-10.

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Table 5-6. Screen response times

Best response time per screen operation	0.65 sec.
Average response time per screen operation	3.14 sec.
Worst response time per screen operation	9.05 sec.

Table 5-7. Network load and evaluation times

Average load and evaluation time for 100 assorted images	273.39 sec.
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Table 5-8. Image quality evaluation times

IMAGE SIZE	AVERAGE QUALITY EVALUATION TIME (SECONDS)
A	2.46 sec.
C	5.79 sec.
E	16.79 sec.

Table 5-9. Image viewing operation times

IMAGE SIZE	AVERAGE VIEW TIME	AVERAGE ROTATION TIME	AVERAGE ZOOM TIME	AVERAGE INVERT TIME
A	2.11 sec.	1.01 sec.	0.84 sec.	0.97 sec.
C	2.86 sec.	0.92 sec.	0.83 sec.	1.04 sec.
E	4.76 sec.	1.63 sec.	1.37 sec.	1.69 sec.

Table 5-10. ID recognition times

IMAGE SIZE	AVERAGE DE-COMPRESION RATE	AVERAGE BORDER LOCATION TIME (FAST APPROACH) (in seconds)	AVERAGE TITLE BLOCK LOCATION/CROPPING TIME (in seconds)	AVERAGE STRING LOCATION TIME (in seconds)	AVERAGE RECOGNITION TIME (in seconds)	AVERAGE POST-PROCESSING TIME (in seconds)	AVERAGE TOTAL TIME (FAST APPROACH) (in seconds)
A	9	7	2	1	5	0	19
B	7	13	2	2	6	0	30
C	11	19	4	2	7	0	43
D	31	54	8	3	5	0	101
E	40	56	13	3	6	0	118
F	31	45	8	3	6	0	93

6. CONCLUSIONS

1. The PC platform is faster for image quality evaluation and id recognition.
2. The Sun platform is faster for screen operations and image viewing operations. (this may be due to the fact that 38 Mb RAM and a low resolution monitor was used on the Sun, while the PC had 16 Mb RAM and a high resolution monitor.)
3. For both the platforms, the main performance bottleneck is the id recognition component. Within the id recognition component, it is the border location that takes the maximum amount of time.
4. A tape containing 600 "C" sized images will take approximately 25 hours using the slow approach and about 11 hours using the fast approach on the Sun platform for image quality evaluation and id recognition. On the PC platform, the same tape will take about eight hours using the fast approach.

7. RECOMMENDATIONS

1. The fast approach for border location should be further pursued because it shows significant performance gains.
2. Efforts should be made to improve the screen response times for the PC platform. Adding more main memory to that platform is one solution that should be tried.

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3. Efforts should be made to improve the image quality evaluation and id recognition times on the Sun platform. Upgrading the machine to a faster CPU is one of the possible solutions.
4. For both machines, improvements in algorithms for making the processes faster should be explored.

APPENDIX A

DETAILED RESULTS

Tape Load Times for Platform I and File Transfer for Platform II

Tape Load Times				
Sun IPX				
Tape Name	Number of Files	Import Time (Sec)	Sec. Per File	Sec Per 100 files
A_size	100	118	1.18	118.00
C_size	100	149	1.49	149.00
E_size	100	352	3.52	352.00
CECOM_mixed	299	300	1.00	100.33
DSREDS_mixed	299	323	1.08	108.03
Total	898	1242	1.38	138.31
File Transfer Times				
PC-486				
File Set Name	Number of Files	Import Time (Sec)	Sec. Per File	Sec Per 100 files
A_size	100	294	2.94	294.00
C_size	100	178	1.78	178.00
E_size	100	434	4.34	434.00
CECOM_mixed	299	736	2.46	246.15
DSREDS_mixed	299	813	2.72	271.91
Total	898	2455	2.73	273.39

Image Quality Performance Tests on Platform I and II

Image Quality Evaluation Times (Sec)				
Sun IPX			PC-486	
A-Size			A-Size	
Total Time	280		Total Time	246
Total Images	100		Total Images	100
Average	2.8		Average	2.46
C-Size			C-Size	
Total Time	688		Total Time	579
Total Images	100		Total Images	100
Average	6.88		Average	5.79
E-Size			E-Size	
Total Time	2006		Total Time	1578
Total Images	100		Total Images	94
Average	20.06		Average	16.79

Screen Response Times for Platforms I and II

Screen Response Times			
Sun IPX			PC-486
Screen No.	Time (Sec)	Screen No.	Time (Sec)
1	4.01	1	9.05
2	2.51	2	6.24
3	0.41	3	2.06
4	0.35	4	1.98
5	2.11	5	0.65
6	1.13	6	1.10
7	0.41	7	2.24
8	1.61	8	3.50
9	1.41	9	1.41
Total	13.95	Total	28.23
Average	1.55	Average	3.14

Image View Operation Times for Platforms I and II -- Mixed Set

Image Viewing Operation Times - Mixed Sets				Image View Operation Times - Mixed Sets					
Image No.	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)	Image No.	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)
Sun IPX						PC-486			
CECOM 299 Mixed Set						CECOM 299 Mixed Set			
1	1.69	0.56	0.55	0.71	1	4.38	1.85	0.78	0.60
2	0.94	0.41	0.52	0.64	2	5.75	0.97	0.55	0.64
3	0.96	0.48	0.75	0.62	3	2.09	0.77	0.61	0.63
4	0.87	0.58	0.52	0.55	4	1.61	0.69	0.55	0.66
5	0.89	0.45	0.50	0.62	5	1.76	0.70	0.55	0.49
6	0.85	0.58	0.48	0.45	6	1.74	0.82	0.62	0.78
7	0.75	0.54	0.64	0.59	7	2.08	1.00	0.66	0.87
8	0.83	0.47	0.48	0.52	8	1.71	0.79	0.64	1.01
9	0.80	0.46	0.52	0.59	9	1.64	0.87	0.73	0.86
10	0.76	0.48	0.55	0.58	10	1.70	0.95	0.69	0.91
11	0.93	0.65	0.69	0.70	11	2.10	1.00	0.95	0.82
12	0.99	0.58	0.71	0.75	12	2.48	0.82	0.78	1.03
13	0.85	0.48	0.58	0.74	13	2.34	0.84	0.72	0.79
14	0.80	0.46	0.56	0.53	14	1.56	1.01	0.59	0.94
15	0.75	0.48	0.50	0.52	15	1.88	0.94	0.76	0.76
16	0.77	0.41	0.48	0.60	16	1.46	0.77	0.83	0.78
17	0.80	0.68	0.66	0.65	17	1.53	0.73	0.72	0.94
18	0.70	0.65	0.70	0.59	18	1.60	0.81	0.81	0.89
19	0.65	0.43	0.47	0.52	19	1.80	0.70	0.90	0.87
20	0.62	0.46	0.50	0.51	20	1.68	0.78	0.72	0.88
21	0.65	0.45	0.48	0.50	21	2.80	0.80	0.59	0.82
22	0.71	0.40	0.55	0.60	22	1.62	0.71	0.65	1.01
23	0.70	0.41	0.50	0.59	23	1.60	0.80	0.68	0.78
24	0.80	0.50	0.49	0.53	24	1.58	0.92	0.57	0.85
25	0.71	0.45	0.52	0.53	25	1.66	0.85	0.80	0.69
26	0.89	0.42	0.53	0.55	26	1.65	0.83	0.67	0.88
27	0.69	0.41	0.49	0.52	27	1.62	0.90	0.65	0.87
28	0.95	0.43	0.46	0.70	28	1.68	0.99	0.84	0.86
29	1.05	0.46	0.48	0.50	29	1.69	0.74	0.58	0.80
Total	24.35	14.22	15.86	17.00	Total	58.79	25.35	20.19	23.71
Average	0.84	0.49	0.55	0.59	Average	2.03	0.87	0.70	0.82

Image View Operation Times for Platforms I and II -- Mixed Set

Sun IPX	View		Rotate		Zoom		Invert		PC-486		EDCARS 299 Mixed Set	
Image No.	Time (Sec)	Time (Sec)	Time (Sec)	Time (Sec)	Time (Sec)	Time (Sec)	Time (Sec)	Time (Sec)	Image No.	Time (Sec)	Time (Sec)	Time (Sec)
1	2.01	0.46	0.65	0.52	0.65	0.52	0.52	0.84	1	5.69	0.84	0.94
2	0.86	0.81	0.58	0.46	0.58	0.46	0.46	0.79	2	2.87	0.79	0.92
3	0.83	0.57	0.60	0.53	0.60	0.53	0.53	0.80	3	1.42	0.80	0.66
4	0.69	0.45	0.55	0.56	0.55	0.56	0.56	1.31	4	1.31	1.31	0.70
5	0.87	0.55	0.46	0.47	0.46	0.47	0.47	0.93	5	1.45	0.93	0.85
6	0.76	0.60	0.75	0.50	0.75	0.50	0.50	1.13	6	1.22	1.13	0.57
7	1.01	0.53	0.50	0.67	0.50	0.67	0.67	1.11	7	1.34	1.11	0.67
8	0.92	0.48	0.70	0.69	0.70	0.69	0.69	1.06	8	1.44	1.06	0.76
9	0.90	0.47	0.51	0.57	0.51	0.57	0.57	0.99	9	1.32	0.99	0.70
10	0.97	0.46	0.53	0.58	0.53	0.58	0.58	1.12	10	1.52	1.12	0.65
11	0.79	0.49	0.40	0.59	0.40	0.59	0.59	0.75	11	1.30	0.75	0.66
12	0.61	0.40	0.41	0.37	0.41	0.37	0.37	0.83	12	1.36	0.83	0.69
13	0.92	0.45	0.40	0.49	0.40	0.49	0.49	1.04	13	1.41	1.04	0.77
14	0.87	0.54	0.50	0.73	0.50	0.73	0.73	1.02	14	1.68	1.02	0.67
15	1.09	0.52	0.46	0.52	0.46	0.52	0.52	1.25	15	1.81	1.25	0.64
16	1.26	0.55	0.52	0.65	0.52	0.65	0.65	1.24	16	2.18	1.24	0.73
17	1.30	0.61	0.53	0.59	0.53	0.59	0.59	1.41	17	2.50	1.41	0.67
18	0.95	0.50	0.57	0.64	0.57	0.64	0.64	0.79	18	2.63	0.79	0.74
19	3.20	0.62	0.61	1.62	0.61	1.62	1.62	3.11	19	5.91	3.11	1.63
20	4.54	0.70	0.56	2.15	0.56	2.15	2.15	3.25	20	8.05	3.25	1.83
21	1.22	0.60	0.72	1.05	0.72	1.05	1.05	1.47	21	4.13	1.47	1.09
22	1.55	0.85	0.70	0.98	0.70	0.98	0.98	1.90	22	3.27	1.90	0.69
23	2.60	0.76	0.78	1.45	0.78	1.45	1.45	2.37	23	4.97	2.37	1.12
24	0.85	0.40	0.55	0.48	0.55	0.48	0.48	0.60	24	2.33	0.60	0.72
25	0.96	0.50	0.52	0.59	0.52	0.59	0.59	0.96	25	1.78	0.96	0.68
26	1.20	0.48	0.49	0.60	0.49	0.60	0.60	0.84	26	2.25	0.84	0.83
27	1.48	0.52	0.70	0.65	0.70	0.65	0.65	0.69	27	1.60	0.69	0.75
28	1.11	0.59	0.90	0.73	0.90	0.73	0.73	1.20	28	1.98	1.20	0.59
29	0.75	0.79	0.80	0.52	0.80	0.52	0.52	1.03	29	1.90	1.03	0.78
Total	37.07	16.25	16.95	20.95	16.95	20.95	20.95	35.83	Total	72.62	35.83	23.86
Average	1.28	0.56	0.58	0.72	0.58	0.72	0.72	1.24	Average	2.50	1.24	0.82

Image View Operation Times for Platforms I and II -- A, C and E Sizes

Image Viewing Operation Times									
Image No.	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)	Image No.
Sun IPX									
PC-486									
A-Size									
1	2.41	0.60	0.55	0.71	6.24	0.88	0.97	1.25	1
2	1.62	0.64	0.60	0.72	1.82	1.06	1.01	1.10	2
3	0.71	0.49	0.59	0.53	1.76	1.10	1.03	0.87	3
4	0.83	0.52	0.45	0.46	1.43	0.99	0.71	0.92	4
5	0.72	0.48	0.60	0.58	1.56	1.01	0.63	0.96	5
6	0.89	0.60	0.58	0.59	1.89	1.07	0.86	0.90	6
7	0.85	0.70	0.49	0.46	1.55	0.86	0.73	0.75	7
8	0.65	0.55	0.52	0.59	1.56	1.05	0.86	0.88	8
9	0.92	0.52	0.56	0.55	1.41	1.03	0.78	1.01	9
10	1.05	0.53	0.60	0.90	1.87	1.04	0.79	1.05	10
Total	10.65	5.63	5.54	6.09	21.09	10.09	8.37	9.69	Total
Average	1.07	0.56	0.55	0.61	2.11	1.01	0.84	0.97	Average
C-Size									
Image No.	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)	Image No.
1	2.55	0.90	0.50	0.58	7.51	0.90	1.00	1.50	1
2	1.62	0.95	0.56	0.82	2.21	1.10	0.79	1.10	2
3	1.15	0.98	0.95	0.71	2.75	1.01	0.78	0.89	3
4	1.21	0.61	0.72	0.73	2.61	0.69	0.65	1.15	4
5	1.14	0.48	0.64	0.61	2.16	0.88	1.07	0.92	5
6	1.36	0.64	0.61	0.74	1.82	0.84	0.79	0.88	6
7	0.89	0.58	0.84	0.58	2.50	0.75	0.75	1.01	7
8	1.89	0.59	0.75	0.77	2.70	0.95	0.90	1.00	8
9	1.03	0.62	0.71	0.90	2.68	0.94	0.78	1.08	9
10	0.94	0.56	0.59	0.75	1.69	1.15	0.80	0.91	10
Total	13.78	6.91	6.87	7.19	28.63	9.21	8.31	10.44	Total
Average	1.38	0.69	0.69	0.72	2.86	0.92	0.83	1.04	Average

Image View Operation Times for Platforms I and II -- A, C and E Sizes

Sun IPX																				
E-Size																				
Image No.	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)	Image No.	View Time (Sec)	Rotate Time (Sec)	Zoom Time (Sec)	Invert Time (Sec)							
1	5.90	0.95	0.90	1.15	7.89	1.65	1.28	1.40	1	7.89	1.65	1.28	1.40							
2	3.27	1.59	1.05	1.48	5.18	1.73	1.36	2.24	2	5.18	1.73	1.36	2.24							
3	4.58	2.50	1.20	1.70	3.34	1.32	0.91	1.44	3	3.34	1.32	0.91	1.44							
4	4.90	2.90	0.64	0.67	6.99	2.75	2.09	2.43	4	6.99	2.75	2.09	2.43							
5	2.80	0.98	0.77	1.28	5.07	1.99	2.11	1.85	5	5.07	1.99	2.11	1.85							
6	3.89	1.17	0.75	1.40	4.40	1.18	1.18	1.84	6	4.40	1.18	1.18	1.84							
7	2.12	0.80	0.67	1.05	5.27	2.02	1.80	1.95	7	5.27	2.02	1.80	1.95							
8	1.46	0.91	0.55	1.10	3.21	1.29	0.99	1.24	8	3.21	1.29	0.99	1.24							
9	2.72	1.52	0.58	0.96	3.09	1.27	0.94	1.12	9	3.09	1.27	0.94	1.12							
10	4.19	2.31	1.68	1.60	3.16	1.13	1.06	1.34	10	3.16	1.13	1.06	1.34							
Total	35.83	15.63	8.79	12.39	47.60	16.33	13.72	16.85	Total	47.60	16.33	13.72	16.85							
Average	3.58	1.56	0.88	1.24	4.76	1.63	1.37	1.69	Average	4.76	1.63	1.37	1.69							

ID Recognition Performance Tests on Platform (Sun) -- Slow Approach

filename	size (1=A,2=B,...)	decompression time (secs.)	border location time (secs.)	string location time (secs.)	cropping time (secs.)	recognition time (secs.)	post-proc. time (secs.)
D003R130	3	12	106	4	9	7	0
D003R133	4	33	333	5	18	8	0
D003R170	4	29	351	5	16	4	0
D003R171	4	30	365	5	18	4	0
D003R172	4	29	371	5	16	4	0
D003R174	4	26	336	5	14	4	0
D004R273	1	6	25	3	6	27	0
D004R319	4	12	142	3	7	6	0
D004R329	4	33	323	4	21	5	0
D004R330	4	29	316	4	15	5	0
D004R332	4	28	313	3	14	5	0
D004R333	4	31	341	4	19	6	0
D004R334	2	7	43	5	4	12	1
D004R345	4	28	335	4	16	3	0
D004R346	4	37	346	4	24	3	0
D004R347	4	34	424	3	15	2	0
D004R379	4	29	383	4	18	4	0
D004R387	4	29	316	4	17	4	0
D004R391	4	32	405	5	18	10	1
D004R392	4	32	369	4	17	3	0
D004R400	2	7	54	3	5	6	1
D004R401	2	6	53	4	4	6	0
D004R402	2	5	52	3	4	5	0
D004R403	4	29	338	3	18	5	0
D004R404	2	6	56	3	5	7	0
D004R416	2	6	42	3	4	12	0
D004R440	4	31	391	4	18	1	0
D004R441	4	29	318	4	17	3	1
D005R287	5	55	331	4	41	9	0
D005R301	5	42	327	5	26	7	0
D005R302	5	64	340	4	50	8	1
D005R320	5	38	277	5	23	10	0
D005R334	5	38	291	5	22	14	0

ID Recognition Performance Tests on Platform (Sun) -- Slow Approach

filename	size (1=A,2=B,...)	decompression time (secs.)	border location time (secs.)	string location time (secs.)	cropping time (secs.)	recognition time (secs.)	post-proc. time (secs.)
D005R336	5	35	286	4	21	8	0
D005R337	5	36	286	4	21	4	1
D005R338	5	52	314	4	37	4	0
D005R342	5	34	328	4	18	7	0
D005R416	4	28	313	4	15	3	0
D005R417	4	33	364	4	21	2	0
D005R419	4	35	368	4	20	6	0
D005R422	4	37	412	3	25	3	0
D005R425	4	26	290	4	13	3	0
D005R430	4	32	377	4	20	5	0
D005R432	5	41	298	5	26	6	0
D005R439	5	42	303	4	28	4	0
D005R451	4	33	381	4	22	3	0
D005R473	1	6	30	3	4	8	0
D005R474	1	4	30	3	2	7	0
D005R475	1	5	31	3	3	8	0
D005R476	1	5	31	3	3	2	0
D005R477	1	4	31	3	3	7	0
D005R478	1	4	29	3	3	7	0
D005R485	1	4	27	2	3	4	0
D005R486	1	6	29	2	5	4	0
D005R487	1	6	28	2	4	4	1
D005R488	1	4	26	2	2	4	0
D005R490	1	4	26	3	2	5	0
D005R491	1	4	27	2	3	4	1
D005R492	1	3	26	2	2	4	0
D005R493	1	5	27	2	3	4	0
D005R494	1	4	26	2	2	4	0
D005R495	1	5	28	2	3	5	0
D005R496	1	5	28	2	4	4	0
D005R497	1	7	30	2	6	3	0
D005R498	1	4	27	2	3	4	0
D006R102	2	9	108	4	6	10	0

ID Recognition Performance Tests on Platform (Sun) -- Slow Approach

filename	size (1=A,2=B,..)	decompression		border location		string location		cropping		recognition		post-proc.	
		time (secs.)	time (secs.)	time (secs.)	time (secs.)	time (secs.)	time (secs.)	time (secs.)	time (secs.)	time (secs.)	time (secs.)	time (secs.)	
D006R135	2	7		103		3		5		4		0	
D008R003	1	5		47		3		3		3		0	
D008R008	3	10		109		3		10		6		1	
D008R053	3	18		115		3		14		1		0	
D008R068	3	11		106		3		8		8		0	
D008R255	3	11		115		3		7		6		0	
D008R335	1	5		45		2		3		0		0	
D009R002	1	11		156		2		7		5		0	
D009R020	3	11		108		3		7		8		0	
D009R032	3	12		103		3		7		9		1	
D009R100	2	10		116		3		5		9		1	
D009R102	2	10		116		4		7		7		0	
D009R104	2	10		112		3		4		5		0	
D009R115	1	5		52		3		4		7		1	
D009R118	2	9		108		4		6		12		0	
D009R119	2	9		111		3		5		5		0	
D009R149	2	8		88		3		5		8		0	
D009R150	2	8		90		3		5		10		0	
D009R155	2	10		107		4		4		10		0	
D009R157	3	16		115		3		12		1		0	
D009R175	3	18		119		4		11		7		1	
D009R240	3	11		115		3		7		5		0	
D010R045	1	8		60		3		5		6		0	
D011R010	3	19		193		4		15		0		0	
D012R379	3	16		131		5		17		32		1	
D012R420	3	11		74		4		11		25		0	
D015R008	2	5		50		3		3		7		0	
D015R021	3	10		100		3		7		7		0	
D015R024	3	10		98		4		7		7		0	
D015R034	2	6		52		4		4		6		0	
D015R036	3	10		99		4		6		6		0	
D015R039	3	13		100		4		14		24		1	
D015R040	6	33		255		4		20		8		0	

ID Recognition Performance Tests on Platform (Sun) -- Slow Approach

filename	size (1=A,2=B,..)	decompression time (secs.)	border location time (secs.)	string location time (secs.)	cropping time (secs.)	recognition time (secs.)	post-proc. time (secs.)
D015R042	6	34	252	4	22	8	0
D015R043	6	28	241	3	13	5	0
D015R049	3	10	107	4	9	12	0
D015R050	3	9	106	3	6	7	0
D015R051	3	12	101	3	8	6	0
D015R063	3	9	109	3	6	6	0
D015R064	3	12	103	3	8	6	0
D015R074	3	11	105	4	9	7	0
D015R080	2	6	53	3	5	5	0
D015R081	3	11	109	3	9	10	0
D015R083	2	6	53	2	4	5	0
D015R085	3	11	108	3	8	10	0
D015R086	2	7	55	3	5	6	0
D015R087	3	12	103	3	9	8	1
D015R091	4	26	332	4	12	10	1
D015R135	2	6	54	2	4	5	0
D015R282	3	13	131	3	11	2	0
D015R298	3	11	94	3	8	6	0
D015R299	2	8	62	3	7	5	0
D015R487	3	11	96	3	9	8	0

ID Recognition Performance Tests on Platform I (Sun) -- Fast Approach

filename	size (1=A,2=B,...)	decompression		border location		string location		cropping		recognition		post-proc.	
		time(secs.)	time(secs.)	time(secs.)	time(secs.)	time(secs.)	time(secs.)	time(secs.)	time(secs.)	time(secs.)	time(secs.)	time(secs.)	
D003R130	3	12	25	4	9	7	1						
D003R133	4	33	76	6	18	6	0						
D003R170	4	29	81	4	16	2	0						
D003R171	4	30	83	5	18	4	0						
D003R172	4	29	82	6	16	3	0						
D003R174	4	26	79	5	14	4	0						
D004R273	1	6	6	4	6	27	1						
D004R319	4	12	40	4	7	6	1						
D004R329	4	33	76	3	21	4	0						
D004R330	4	29	76	4	15	5	0						
D004R332	4	28	75	3	14	5	0						
D004R333	4	31	78	4	19	6	0						
D004R334	2	7	11	4	4	12	0						
D004R345	4	28	78	4	16	6	0						
D004R346	4	37	80	4	25	4	0						
D004R347	4	34	98	3	15	3	0						
D004R379	4	29	83	4	19	3	0						
D004R387	4	29	76	4	16	3	0						
D004R391	4	32	92	5	18	9	0						
D004R392	4	32	87	4	17	4	0						
D004R400	2	7	12	4	4	6	1						
D004R401	2	6	13	3	4	5	0						
D004R402	2	5	12	4	4	6	0						
D004R403	4	29	79	4	17	5	0						
D004R404	2	6	12	4	5	6	0						
D004R416	2	6	10	4	3	11	0						
D004R440	4	31	86	4	18	2	0						
D004R441	4	29	77	4	17	3	0						
D005R287	5	55	90	5	39	8	0						
D005R301	5	42	87	4	26	7	0						
D005R302	5	64	89	4	49	5	0						
D005R320	5	38	80	5	22	10	0						
D005R334	5	38	83	5	22	15	0						

ID Recognition Performance Tests on Platform I (Sun) -- Fast Approach

filename	size (1=A,2=B,...)	decompression time(secs.)	border location time(secs.)	siring location time(secs.)	cropping time(secs.)	recognition time(secs.)	post-proc. time(secs.)
D005R336	5	35	81	5	21	8	0
D005R337	5	36	83	5	20	4	0
D005R338	5	52	89	4	38	5	0
D005R342	5	34	92	4	18	5	0
D005R416	4	28	75	3	16	2	0
D005R417	4	33	81	4	21	2	0
D005R419	4	35	84	4	24	4	0
D005R422	4	37	91	4	25	4	0
D005R425	4	26	74	4	14	3	0
D005R430	4	32	87	4	20	4	0
D005R432	5	41	83	4	26	6	0
D005R439	5	42	85	4	28	4	1
D005R451	4	33	87	4	23	4	0
D005R473	1	6	7	3	4	9	0
D005R474	1	4	7	4	3	7	0
D005R475	1	5	7	4	3	7	0
D005R476	1	5	7	2	3	3	0
D005R477	1	4	7	3	2	7	0
D005R478	1	4	7	3	3	7	0
D005R485	1	4	7	2	3	4	0
D005R486	1	6	6	3	4	4	0
D005R487	1	6	7	2	4	4	1
D005R488	1	4	7	2	3	4	0
D005R490	1	4	7	3	3	5	0
D005R491	1	4	7	3	2	4	0
D005R492	1	3	7	2	2	4	0
D005R493	1	5	7	2	3	4	0
D005R494	1	4	7	2	3	4	0
D005R495	1	5	7	2	3	4	1
D005R496	1	5	6	2	4	3	0
D005R497	1	7	7	2	5	4	0
D005R498	1	4	6	2	2	3	0
D006R102	2	9	23	4	6	10	1

ID Recognition Performance Tests on Platform I (Sun) -- Fast Approach

filename	size (1=A,2=B,...)	decompression time(secs.)	border location time(secs.)	string location time(secs.)	cropping time(secs.)	recognition time(secs.)	post-proc. time(secs.)
D006R135	2	7	22	3	3	2	0
D008R003	1	5	12	2	3	1	0
D008R008	3	10	26	4	10	6	0
D008R053	3	18	27	3	14	1	0
D008R068	3	11	25	4	7	7	0
D008R255	3	11	26	4	6	5	0
D008R335	1	5	11	3	3	3	0
D009R002	1	11	31	3	8	5	0
D009R020	3	11	26	4	7	7	0
D009R032	3	12	25	3	8	9	0
D009R100	2	10	23	3	5	10	0
D009R102	2	10	25	3	7	7	0
D009R104	2	10	24	3	4	5	0
D009R115	1	5	11	3	4	8	0
D009R118	2	9	24	4	6	12	1
D009R119	2	9	24	3	5	5	0
D009R149	2	8	21	3	4	8	0
D009R150	2	8	21	3	4	9	0
D009R155	2	10	23	4	4	9	0
D009R157	3	16	27	3	12	1	0
D009R175	3	18	27	4	10	8	0
D009R240	3	11	27	4	7	5	0
D010R045	1	8	14	3	5	7	0
D011R010	3	19	42	3	16	1	0
D012R379	3	16	30	5	17	32	0
D012R420	3	11	19	5	11	26	0
D015R008	2	5	11	4	4	7	0
D015R021	3	10	35	6	11	10	0
D015R024	3	10	37	6	9	8	1
D015R034	2	6	12	4	4	6	0
D015R036	3	10	24	4	7	6	0
D015R039	3	13	24	4	15	24	0
D015R040	6	33	70	4	21	8	0

ID Recognition Performance Tests on Platform I (Sun) -- Fast Approach

filename	size (1=A,2=B,..)	decompression time(secs.)	border location time(secs.)	string location time(secs.)	cropping time(secs.)	recognition time(secs.)	post-proc. time(secs.)
D015R042	6	34	70	4	21	8	0
D015R043	6	28	68	4	13	6	0
D015R049	3	10	25	4	9	12	1
D015R050	3	9	25	3	6	7	1
D015R051	3	12	24	4	8	6	0
D015R063	3	9	25	4	9	11	0
D015R064	3	12	25	4	8	6	0
D015R074	3	11	25	3	9	8	0
D015R080	2	6	12	3	4	5	0
D015R081	3	11	26	3	8	10	0
D015R083	2	6	12	3	4	5	0
D015R085	3	11	25	4	8	10	0
D015R086	2	7	12	3	4	6	0
D015R087	3	12	25	4	8	7	0
D015R091	4	26	77	5	13	9	0
D015R135	2	6	12	3	5	5	1
D015R282	3	13	29	4	10	2	0
D015R298	3	11	23	3	7	7	0
D015R299	2	8	14	3	6	5	0
D015R487	3	11	23	4	9	7	0

ID Recognition Performance Tests on Platform II (PC) -- Fast Approach

filename	size (1=A,2=B,...)	decompression time(secs.)	border location time(secs.)	string location time(secs.)	cropping time(secs.)	recognition time(secs.)	post-proc. time(secs.)
D003R130	3	11	18	3	4	7	1
D003R133	4	40	54	5	10	9	1
D003R170	4	30	55	4	7	4	1
D003R171	4	32	57	4	8	6	1
D003R172	4	30	56	3	7	6	1
D003R174	4	32	54	4	6	6	0
D004R273	1	4	6	3	4	15	1
D004R319	4	16	35	3	3	7	1
D004R329	4	31	51	3	10	5	1
D004R330	4	29	50	3	8	6	1
D004R332	4	29	51	3	6	6	0
D004R333	4	31	53	3	9	6	1
D004R345	4	29	55	3	7	5	0
D004R346	4	32	54	4	12	5	0
D004R347	4	39	65	3	7	5	0
D004R379	4	30	57	3	8	5	1
D004R387	4	31	51	3	7	5	1
D004R391	4	34	63	4	9	7	1
D004R392	4	35	58	3	8	5	1
D004R400	2	6	10	3	3	6	1
D004R401	2	6	10	2	2	6	1
D004R402	2	6	9	2	2	6	1
D004R403	4	30	52	3	8	6	1
D004R404	2	7	10	3	3	6	0
D004R416	2	5	9	3	2	9	1
D004R440	4	32	58	3	8	4	1
D004R441	4	30	50	3	7	4	0
D005R287	5	44	59	4	20	7	0
D005R301	5	41	56	4	12	6	1
D005R302	5	47	59	4	24	6	0
D005R320	5	38	51	3	11	8	1
D005R334	5	38	53	3	11	9	1
D005R336	5	37	52	4	9	7	1

ID Recognition Performance Tests on Platform II (PC) -- Fast Approach

filename	size (1=A,2=B,..)	decompression time(secs.)	border location time(secs.)	string location time(secs.)	cropping time(secs.)	recognition time(secs.)	post-proc. time(secs.)
D005R337	5	36	54	3	10	5	1
D005R338	5	43	59	4	18	6	1
D005R342	5	38	60	4	7	5	0
D005R416	4	29	50	3	7	5	0
D005R417	4	33	58	3	10	4	1
D005R419	4	32	58	4	12	5	1
D005R422	4	35	61	3	11	5	1
D005R425	4	28	49	3	6	5	0
D005R430	4	30	58	4	9	5	1
D005R439	5	46	57	4	13	6	0
D005R451	4	35	60	3	11	5	1
D005R473	1	4	7	3	2	7	0
D005R474	1	4	7	2	1	6	1
D005R475	1	4	7	2	1	6	0
D005R476	1	4	6	2	2	3	1
D005R477	1	3	7	2	2	6	1
D005R478	1	3	7	2	2	6	1
D005R485	1	4	7	2	2	4	0
D005R486	1	4	6	2	2	4	1
D005R487	1	5	6	1	2	4	1
D005R488	1	3	7	3	2	5	1
D005R490	1	4	6	2	1	4	1
D005R491	1	6	6	2	2	5	0
D005R492	1	3	7	1	1	4	1
D005R493	1	3	6	1	1	4	1
D005R494	1	4	6	2	2	4	0
D005R495	1	4	6	2	2	4	1
D005R496	1	5	7	2	2	3	1
D005R497	1	5	7	2	3	4	0
D005R498	1	4	7	1	1	4	1
D006R102	2	9	18	3	3	7	1
D006R135	2	9	16	3	1	5	1
D008R003	1	4	9	1	2	2	0

ID Recognition Performance Tests on Platform II (PC) -- Fast Approach

filename	size (1=A,2=B,...)	decompression time(secs.)	border location time(secs.)	string location time(secs.)	cropping time(secs.)	recognition time(secs.)	post-proc. time(secs.)
D008R008	3	11	19	3	6	6	1
D008R053	3	14	20	2	7	3	1
D008R068	3	12	19	3	3	7	1
D008R255	3	11	20	3	3	6	1
D008R335	1	5	10	2	2	4	1
D009R002	1	11	24	2	4	4	1
D009R020	3	11	19	3	3	6	1
D009R032	3	11	19	2	3	8	1
D009R100	2	10	18	3	2	9	1
D009R102	2	10	18	3	3	6	0
D009R104	2	9	18	2	2	5	1
D009R115	1	5	11	2	2	7	1
D009R118	2	10	18	3	3	8	1
D009R119	2	9	18	3	3	5	0
D009R149	2	10	16	3	2	6	1
D009R150	2	9	15	3	3	6	1
D009R155	2	10	18	3	3	9	0
D009R157	3	13	19	3	6	3	0
D009R174	3	14	19	2	7	6	0
D009R175	3	15	22	3	5	7	1
D009R240	3	14	20	3	3	6	0
D010R045	1	6	12	3	3	6	2
D011R010	3	16	33	2	7	2	0
D012R379	3	14	23	3	9	19	0
D012R420	3	9	15	3	6	14	1
D015R008	2	6	10	3	2	6	0
D015R021	3	11	18	3	3	7	1
D015R024	3	11	18	3	3	7	1
D015R034	2	6	10	3	2	6	1
D015R036	3	11	18	3	3	6	0
D015R040	6	32	46	4	10	7	1
D015R042	6	33	45	3	10	7	0
D015R043	6	29	44	3	5	6	0

ID Recognition Performance Tests on Platform II (PC) -- Fast Approach

filename	size (1=A,2=B,..)	decompression time(secs.)	border location time(secs.)	siring location time(secs.)	cropping time(secs.)	recognition time(secs.)	post-proc. time(secs.)
D015R049	3	12	21	3	6	10	1
D015R050	3	12	19	2	3	7	0
D015R051	3	11	18	3	4	7	1
D015R063	3	10	19	3	5	11	1
D015R064	3	12	21	3	4	6	1
D015R074	3	11	19	3	4	7	1
D015R080	2	5	14	3	3	6	1
D015R081	3	12	19	3	4	8	0
D015R083	2	6	10	2	2	7	1
D015R085	3	11	19	3	4	7	1
D015R086	2	6	10	2	3	5	0
D015R087	3	10	21	3	4	7	1
D015R091	4	29	52	4	5	7	1
D015R135	2	6	9	2	2	7	1
D015R282	3	12	22	3	5	5	1
D015R298	3	10	18	2	3	7	1
D015R299	2	7	12	2	3	6	0
D015R487	3	10	18	2	4	7	1
D015R487	3	10	18	2	4	7	1
D015R487	3	10	18	2	4	7	1