

GIANNINION
TECHNOLOGIES GROUP

NIST



Donald T. Gantz, PhD
Mark A. Walch

FLASH ID

*Handwriting Derived
Biometric Analysis Software*

June 4, 2013

NIST

**Measurement Science
and Standards in Forensic
Handwriting Analysis
Conference**

FLASH ID: *Introduction*

FLASH ID: Forensic Language Independent Analysis System for Handwriting Identification

We describe the workings of the FLASH ID system in the following steps:

1. Image Processing
2. Writer Modeling
3. Writer Scoring

We then present the results of our tests of the system

FLASH ID: *Framework*

FLASH ID has a well-defined frame for comparing handwriting; it combines

- a method for segmenting writing into graphs;

he does not answer their call

- an **isomorphic** classification for graphs;

 *Isomorphism Class 4;112.0*

- a meaningful **shape** definition for graphs.



Shape Class

This frame allows that writings be compared in a “like to like” manner.

FLASH ID: *Image Processing*

Image Processing: FLASH ID takes a scanned image (300 dpi) of a document, segments it, and skeletonizes each segment, yielding a one pixel wide skeleton. The writing can be regarded as a combination of **graphs** with nodes and edges.

Original Word:

The image shows the word "London" written in a cursive, handwritten style using black ink on a white background. The letters are connected and have a natural, fluid appearance.

*Original Word
with skeleton
exposed:*

The image shows the word "London" from the previous image, but with a yellow skeleton overlaid on top of the black ink. The skeleton consists of thin, single-pixel-wide lines that trace the central path of each letter and the connections between them.

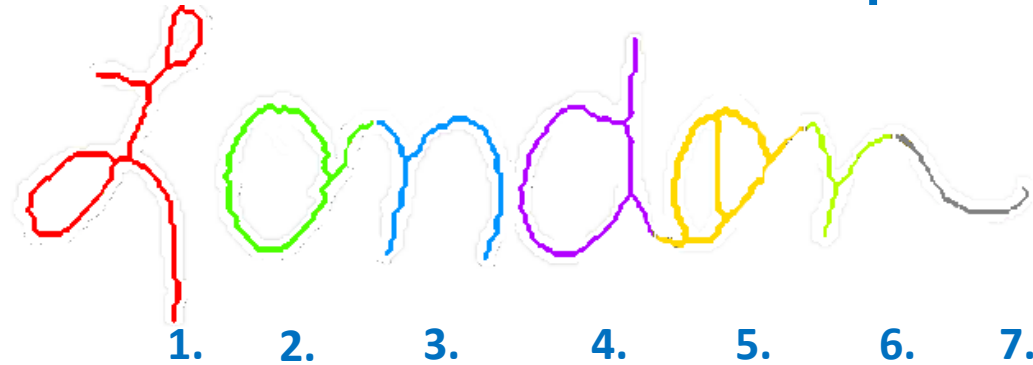
*Extracted
Skeleton
(graph):*

The image shows the extracted skeleton of the word "London" from the previous image. The black ink has been removed, leaving only the yellow skeleton. The skeleton is a graph where nodes are the junctions and endpoints of the strokes, and edges are the single-pixel-wide lines connecting them.

FLASH ID: Segmentation into *Proto-graphemes*

Proto-graphemes: these are combined to form Graphemes.

Original Proto-graphemes:



Combined Proto-graphemes:
Forms
Graphemes



Embeddings
from selected
Proto-graphemes:



FLASH ID: *Encoding Handwriting as Data*

The connectivity pattern of the nodes and edges defines the **isomorphism class** of graphs.

Neither bending the edges, changing the length of the edges, reorienting the image, nor reflecting the image changes the isomorphism class.

Each graph has a *Feature Vector* of physical measurements.

The **shape class** of a graph is determined by the geometric relationships between parts of the graph.



Handwritten text

Isomorphism Class 4;112.0

*Shape Class for
handwritten text*

FLASH ID: *Encoding Handwriting*

Graphemes:



*Isomorphic
Classes:*



*Class
Feature
Vector:*

2001_2_1	2001_4_1	2001_4_2	2001_4_3	2001_4_4	2001_8_1	2001_8_2	2001_8_3	2001_8_4	2001_16_1
4.4721	20.2781	2.2361	24.7133	2.2361	36.4005	2.2361	40.8044	2.2361	22.4939
5.099	11.2154	2.6352	16.3144	2.5055	22.561	3.1623	27.6586	2	13.8339
4.1231	13.1432	2.1541	17.2658	2.01	24.5153	2.2361	28.6356	2	15.2845
22.4722	12.6549	24.2389	30.1249	10.6367	24.1868	32.8024	40	18.0278	35.0105
4.1231	12.6549	2.0881	18.6182	2.0396	24.1868	2.2361	28.0713	2	14.6227
27.7849	17.1363	15.1691	31.5691	14.5809	31.6228	17.4929	40.4475	15.0333	25.8871

FLASH ID: *Fully Automated*

FLASH ID contains proprietary software which automatically segments writing and assigns an **isomorphism class** and a **shape class** to each graph.

FLASH ID: *Language Independence*

Handwritten Cursive English and Handwritten Arabic are segmented into graphemes by a common algorithm.

English Script:

he doesn't answer their call

English "Mirror Writing":

we don't answer their call

Arabic:

البيت قد رحل من طلبة الجريد كجوليت

FLASH ID: *Writer Modeling*

Modeling based on Writers' known writings:

The combination of an isomorphism class and a shape class defines a *Grapheme Type*.

Categorical Modeling at the document level: The Table classifying the Grapheme Types for a Writer's known writings characterizes that Writer, and it is used to identify the Writer of Questioned Writing.

Writing is also modeled at the *Grapheme Type level*.

Feature Space Modeling: The physical measurements within the Feature Vector of the graph are used to form pairwise comparisons of Writers whose known writings exhibit instances of the Grapheme Type.

Stored results from the pairwise comparisons of Writers are used to identify the Writer of Questioned Writing.

FLASH ID: *Feature Space Modeling*

FLASH ID incorporates Feature Space Modeling at the Grapheme Type level.

The known writings for Writers in a database of interest are compared to writings from an unrelated Reference Set of Writers each of whom has a large known writing corpus.

The comparisons provide a stored scoring database that is used to evaluate potential writership of a questioned writing by members of the database of interest.

FLASH ID: *Writer Scoring*

Scoring of Questioned Writing:

The Questioned Writing is preprocessed yielding *Analysis Graphemes*.

Each Writer in the database of interest whose known writings contain instances of the Grapheme Type of the Analysis Grapheme receives a *Reward Score* for the Analysis Grapheme.

Writers' Reward Scores are accumulated for all Analysis Graphemes in the Questioned Writing.

Writers in the database of interest are *ranked* according to their cumulative Reward Scores for the Questioned Writing.

FLASH ID: *Writer Scoring*

The histograms on the next slide show the scores for two test documents written by the writer illustrated below. Language-independent segmentation was used.

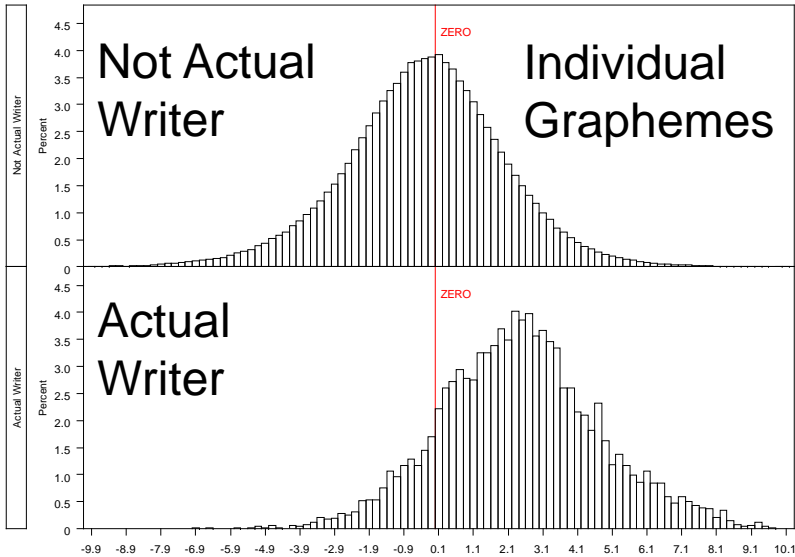
Note that the individual grapheme scores for the actual writer tend to be positive while the scores for the non-writers tend to center closer to zero.

When *pseudo documents* are created by sampling the graphemes, the scores over the pseudo documents move to the right for the actual writer (as the size of the pseudo-document increases) and do not for the non-writers.

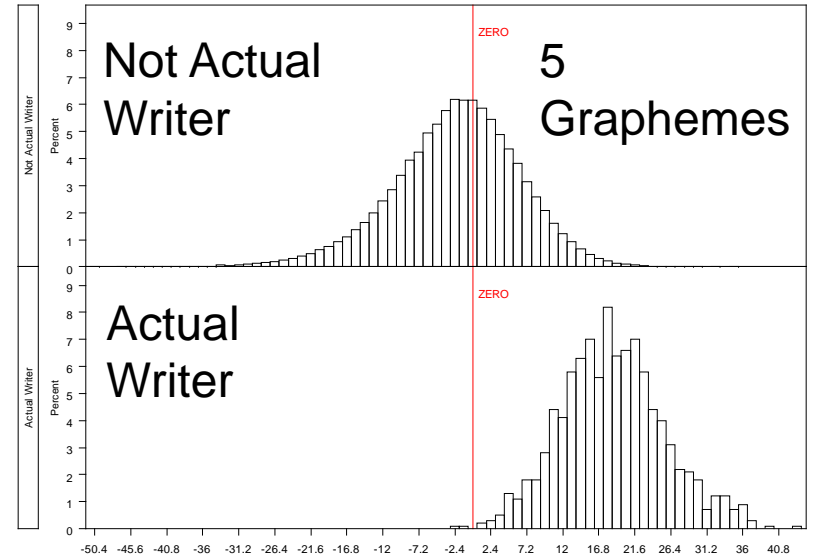
Our London business is good, but Vienna and Berlin are quiet. Mr. G. Lloyd has gone to Switzerland and I hope for good news. He will be there for a week at 1496 Zermott St. and then goes to Turin and

FLASH ID: *Writer Scoring*

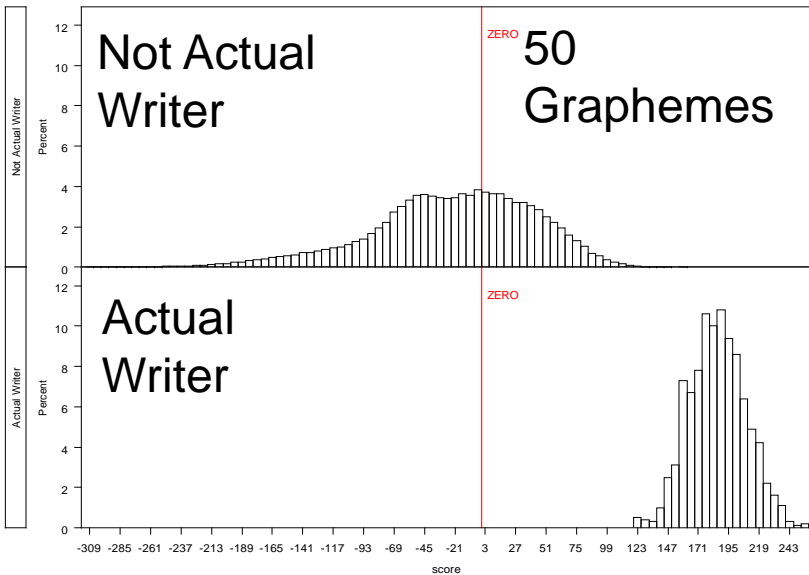
Actual Writer vs. Not for Individual Graphemes



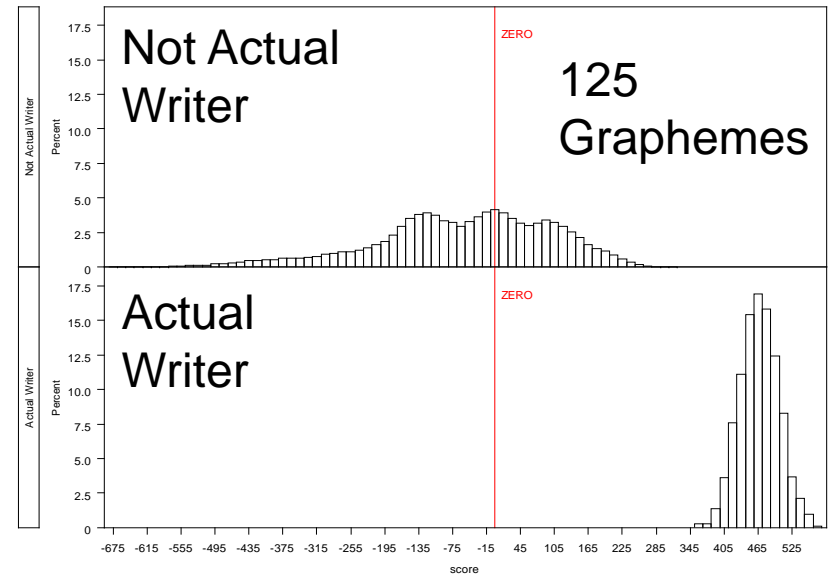
Actual Writer vs. Not for Pseudo Documents of Size 5 Graphemes



Actual Writer vs. Not for Pseudo Documents of Size 50 Graphemes



Actual Writer vs. Not for Pseudo Documents of Size 125 Graphemes



FLASH ID: *Testing the Technology*

[AAFS 2009] Our testing results use writings from the “FBI 500.” The FBI Lab acquired handwriting samples from about 500 writers (both script and print). We will give results for 449 writers for whom we have access to script samples. Each writer wrote about five “London paragraphs.”

The first 300 writers formed the database of interest. We used three paragraphs for modeling and two for Closed Set testing. The remaining 149 writers were “not in the database of interest” and they were used in the Open Set testing.

In each study, we created pseudo-documents by random sampling from available graphemes. In the character-based studies, we created for each test writer 1000 pseudo-documents of sizes 10 to 40 characters and 500 of sizes 50 to 80. In the language-independent studies, we created 500 pseudo-documents for each writer for each pseudo-document size.

FLASH ID: *Testing the Technology*

For each study, we computed an accuracy rate for the “closed set problem” which is to identify the writer in the database of interest most likely to have written the test document. (For our studies, “correct” means that the *actual writer was ranked first.*)

We also calculated an *Equal Error Rate* for the “open set problem” which is to decide whether or not the writer of a test document is in the database of interest. The equal error rate results from adjusting the *Inclusion Criterion* (in our case, the difference in score between the first and second ranked writers) so that the rates of false inclusion and false exclusion are the same.

The results are summarized in Tables 1 and 2 below.

FLASH ID: *Testing the Technology*

The Latin character-based studies used ground truth segmentation into actual Latin Characters as graphs. For testing, we used only graphemes of the “T” (4;112.0 code) isomorphism representing lower case letters *n, e, r, u, a, l, s, h, o, c, l*.

Table 1: Character-based Data		
Pseudo-document Size	Accuracy Rate	Equal Error Rate
10 characters	89.49%	17.37%
20 characters	98.20%	10.51%
30 characters	99.56%	7.43%
40 characters	99.84%	5.80%
60 characters	99.94%	4.91%
60 characters	99.97%	4.37%
70 characters	99.99%	3.93%
80 characters	100.00%	3.66%

Different writers used different numbers of these characters to write their paragraphs, but on average the particular characters used in this study comprised less than 16% of the available characters in the London paragraph.

FLASH ID: *Testing the Technology*

The language-independent studies used all grapheme types.

Pseudo-document Size	Including Document 62		Excluding Document 62	
	Accuracy Rate	Equal Error Rate	Accuracy Rate	Equal Error Rate
50 graphemes	97.26%	12.86%	97.69%	12.63%
100 graphemes	99.03%	7.51%	99.49%	7.24%
200 graphemes	99.37%	4.86%	99.85%	4.58%
300 graphemes	99.41%	4.10%	99.91%	3.82%
400 graphemes	99.44%	3.63%	99.94%	3.35%
500 graphemes	99.47%	3.34%	99.97%	3.06%
600 graphemes	99.48%	3.16%	99.98%	2.90%
700 graphemes	99.49%	3.06%	99.99%	2.80%
800 graphemes	99.49%	2.98%	99.99%	2.71%
900 graphemes	99.49%	2.92%	99.99%	2.66%
1000 graphemes	99.50%	2.87%	100.00%	2.63%
1500 graphemes	99.50%	2.79%	100.00%	2.55%
2000 graphemes	99.50%	2.72%	100.00%	2.51%

[AAFS 2010] The Open Set Problem Revisited:

We introduced a new inclusion criterion, that is, the score used to evaluate the difference between the first and second ranked writers in order to make the open set decision. We used our “**Vector of Counts**” methodology, which has demonstrated great potential to improve open set results.

The “**Vector of Counts**” (VOC) methodology requires a **reference** set of documents from writers neither in the database of interest nor likely to have written a questioned document.

FLASH ID: *Testing the Technology*

We create a Grapheme Type level, Feature Space Modeling system from documents of writers in this new reference set. This modeled system is **different** than the modeled system first used to score the questioned document.

For each grapheme in a questioned document, the writer in the reference set most likely to have written that grapheme is recorded. A *frequency Vector of Counts* is thus created for the questioned document.

The pattern of proportions of graphemes assigned to writers in the reference set characterizes the writer of the questioned document.

FLASH ID: *Testing the Technology*

Our finding is that documents written by the same writer have similar (or at least “close”) VOCs. We can measure closeness using a ***chi-squared statistic***.

By treating the known writings for the database of interest writers as questioned documents, we create a VOC for each writer.

We take the **difference** between the closeness of the first place and second place VOCs to the questioned document VOC.

If the questioned document **is actually** written by the first place writer, the difference should be relatively **large**. If the document **is not** written by a writer in the database of interest, the difference should be relatively **small**.

FLASH ID: *Testing the Technology*

[AAFS 2010] Results:

The equal error rate (EER) improved between 10% and 50% by using the VOC information in addition to the score difference information.

For instance, if the score difference EER had been 5 percent, the improved EER would have been between 2.5% and 4.5%.

FLASH ID: USACIL 1,000 Writer Blind Test

Reference match 868 and unknown image AAA

"Our London business is good, but Vienna and Berlin are quiet. Mr. D. Sloyd has gone to Switzerland and I hope for good news. He will be here for a week at 179th Zerkow Street and then goes to Turin and Rome and will join Col. Perry and arrive at Athens, Greece, Nov. 17th or Dec. 2nd. Letters there should be addressed King James Blvd., 3580. We expect Char. E. Fuller Tuesday, Dr. L. McQuaid and Robt. Unger, Esq. left on the 'Y. K.' Express tonight and paid \$12.34 for tickets."

"Our London business is good, but Vienna and Berlin are quiet. Mr. D. Sloyd has gone to Switzerland and I hope for good news. He will be here for a week at 1396 Zerkow Street and then goes to Turin and Rome and will join Col. Perry and arrive at Athens, Greece, Nov. 17th or Dec. 2nd. Letters should be addressed King James Blvd., 3580. We expect Char. E. Fuller Tuesday, Dr. L. McQuaid and Robt. Unger, Esq. left on the 'Y. K.' Express tonight and paid \$12.34 for tickets."



USACIL Closed Set Blind Test: 56 London paragraphs had a match among a data base of 1,000 London paragraphs. 55 were top ranked by FLASH ID.

Reference match 892 and unknown image BBB

"Our London business is good, but Vienna and Berlin are quiet. Mr. D. Sloyd has gone to Switzerland, and I hope for good news. He will be here for a week at 1396 Zerkow Street and then goes to Turin and Rome and will join Col. Perry and arrive at Athens, Greece, Nov. 17th or Dec. 2nd. Letters there should be addressed King James Blvd., 3580. We expect Char. E. Fuller Tuesday, Dr. L. McQuaid and Robt. Unger, Esq. left on the 'Y. K.' Express tonight and paid \$12.34 for tickets."

"Our London business is good, but Vienna and Berlin are quiet. Mr. D. Sloyd has gone to Switzerland, and I hope for good news. He will be here for a week at 1396 Zerkow Street and then goes to Turin and Rome and will join Col. Perry and arrive at Athens, Greece, Nov. 17th or Dec. 2nd. Letters there should be addressed King James Blvd., 3580. We expect Char. E. Fuller Tuesday, Dr. L. McQuaid and Robt. Unger, Esq. left on the 'Y. K.' Express tonight and paid \$12.34 for tickets."

Reference match 360 and unknown image AA

"Our London business is good, but Vienna and Berlin are quiet. Mr. D. Sloyd has gone to Switzerland, and I hope for good news. He will be here for a week at 1396 Zerkow Street and then goes to Turin and Rome and will join Col. Perry and arrive at Athens, Greece, Nov. 17th or Dec. 2nd. Letters there should be addressed King James Blvd., 3580. We expect Char. E. Fuller Tuesday, Dr. L. McQuaid and Robt. Unger, Esq. left on the 'Y. K.' Express tonight and paid \$12.34 for tickets."

"Our London business is good, but Vienna and Berlin are quiet. Mr. D. Sloyd has gone to Switzerland, and I hope for good news. He will be here for a week at 1396 Zerkow Street and then goes to Turin and Rome and will join Col. Perry and arrive at Athens, Greece, Nov. 17th or Dec. 2nd. Letters there should be addressed King James Blvd., 3580. We expect Char. E. Fuller Tuesday, Dr. L. McQuaid and Robt. Unger, Esq. left on the 'Y. K.' Express tonight and paid \$12.34 for tickets."

Rank	Results		
	Number	Percent	Cumulative
1	55	98.2	98.2
2	0	0	98.2
3	0	0	98.2
4	0	0	98.2
5	0	0	98.2
6-10	1	1.8	100.0

FLASH ID: *FBI End User Enhancement Final Report*

FBI End User Enhancement Final Open Set Test: 1,025 Test Writer Documents were compared to a data base of 1,025 writers.

An Inclusion Criterion was used to decide if the top ranked data base writer was the writer of a test document.

Of the 525 writers with a match, the matching writing was ranked first for 523, but 5 of these were determined to be not a match by the inclusion criterion. (Error rate is $7/525 = 1.3\%$)

Of the 500 writers without a match, by the inclusion criterion 493 top ranked data base writers were declared not to have a match and 7 were declared to be a match. (Error rate is $7/500 = 1.4\%$)

FLASH ID: Implementation—the FDE Workstation

The screenshot displays the FLASH ID software interface, which is used for document identification. The interface is divided into three main sections:

- Test Documents:** A list of documents on the left side, including file names like "AFGP-2004-0000-004599-2_Page_02.tif" and "NMEC-2011-0000-238621-1_Page_02.tif". A search filter "Filter Test Documents" is located at the bottom left.
- Reference Set:** A list of reference documents on the right side, including file names like "0021", "0027", "0011", and "NMEC-2012-0000-310135 (AverageScore: 0.9191)". A search filter "Filter Reference Set" is located at the bottom right.
- Central Logo:** The logo of the Federal Bureau of Investigation Laboratory Division, featuring a microscope, a DNA helix, and a fingerprint.

FLASH ID: Side-by-Side View

The screenshot displays the FLASH ID software interface, which is used for document analysis. The window is titled "FLASH ID" and has a menu bar with "File", "View", "Export", and "Help".

The interface is divided into several panes:

- Test Documents:** A list of documents including "br0001a-0075.tif", "br0001b-0075.tif", "br0004a-0100.tif", "EG001-0001A_1.tif", "br0002a-0087.tif", and "tmpBCD7.tmp".
- Document 1 (br0001a-0075.tif):** Shows a handwritten note: "stay calm. This is a robbery. I & the money. No dyepacks!".
- Document 2 (0075A.tif):** Shows a handwritten letter: "Our London business is good, but Veen & Lord has gone to Switzerland and will be there for a week at 496 Zeehuis and home and will join Mr. Greece. Nov 27th on Dec 2nd. Letters 3580 King James Blvd. We expect Dr. L. McQuaid and Roger Unger, Esq tonight. My daughter chastised me. I reception hall within walking distance. I quelled my daughter's concerns. It was just a five minute cab ride 6.84 for this year."
- Reference Set:** A list of 16 reference documents with their scores, such as "1. 0075 (Score: 121.2439)", "2. 0011 (Score: 72.676)", "3. 0035 (Score: 72.5605)", "4. 0023 (Score: 45.4645)", "5. 0100 (Score: -13.1574)", "6. 0087 (Score: -60.529)", "7. 0027 (Score: -63.5112)", "8. 0061 (Score: -65.2183)", "9. 0121 (Score: -126.8141)", "10. 0123 (Score: -133.3015)", "11. 0013 (Score: -134.4179)", "12. 0084 (Score: -135.4393)", "13. 0029 (Score: -137.4415)", "14. 0080 (Score: -141.8129)", "15. 0021 (Score: -175.2672)", and "16. 0010 (Score: -217.6488)".

The software also includes a "Filter Test Documents" section at the bottom left and a "Filter Reference Set" section at the bottom right. The main document panes have "Recognize" and "Read" buttons and a zoom level of 24%.

FLASH ID: Identity Heat Map View

FLASH ID Forensic Document Examiner workstation at FBI Laboratory

FLASHID

File View Export

Test Documents

br0001b-0075.tif

Recognize Read 24% Loc: N/A

I have a bomb. Put all the 20's and 50's in a bag. Set off the alarm and everyone dies!

90th Percentile
80th Percentile
70th Percentile
60th Percentile
50th Percentile

Reference Set

FBI15wRMS

FBI16

1. 0075 (Score: 136.3856)

2. 0035 (Score: 62.1459)

3. 0023 (Score: -25.7689)

4. 0011 (Score: -27.192)

5. 0100 (Score: -64.2015)

6. 0027 (Score: -73.3198)

7. 0061 (Score: -78.9853)

8. 0087 (Score: -79.1312)

9. 0029 (Score: -82.5325)

10. 0123 (Score: -136.6195)

11. 0080 (Score: -155.569)

12. 0021 (Score: -160.3581)

13. 0084 (Score: -163.8133)

14. 0013 (Score: -168.461)

15. 0121 (Score: -176.0943)

16. 0010 (Score: -189.3386)

br0001b-0075.tif - Hide Traceability - FBI16

Key	IsoKey	Caddy	0075	0035	0023
8260	3,224	02	1.63914935632827	0.680667233748793	-2.93707213566976
8261	4,234.0	030			
8268	4,98.0:64.0	020	2.26315781382732	-0.482016622134855	0.359968171297637
8274	4,112.0	012	1.40142151226921	1.00640873948794	-3.36167900006315
8282	4,112.0	023	2.94976552289116	1.08066265464599	1.16017984385641
8283	6,112.96.0	02300	1.7344252045599	1.60906779389115	-4.80026357566898
8284	4,112.0	023	1.67359011537821	1.63819567950408	1.7792398327486

Filter Test Documents

Filter Reference Set

FLASH ID: Trial Exhibit Support

Outline of writing characteristics showing strong “biometric signal”

FLASH ID

File View Export

Test Documents

- br0001a-0075.tif
- br0001b-0075.tif
- br0002a-0087.tif
- br0002b-0087.tif
- br0003a-0084.tif
- br0003b-0084.tif
- br0014a-0013.tif
- br0014b-0013.tif
- br0016a-0121.tif
- br0016b-0121.tif
- br0018a-0029.tif
- br0018b-0029.tif
- br0019a-0023.tif
- br0019b-0023.tif
- br0020a-0021.tif
- br0020b-0021.tif
- br0022a-0010.tif
- br0022b-0010.tif
- br0023a-0011.tif
- br0023b-0011.tif

br0001b-0075.tif

Recognize Read 218% Loc: N/A

ll the 21
me dies!

90th Percentile
80th Percentile
70th Percentile
60th Percentile
50th Percentile

Reference Set

- FBI15wRMS
- FBI16
- 1. 0075 (Score: 136.3856)
- 2. 0035 (Score: 62.1459)
- 3. 0023 (Score: -25.7689)
- 4. 0011 (Score: -27.192)
- 5. 0100 (Score: -64.2015)
- 6. 0027 (Score: -73.3198)
- 7. 0061 (Score: -78.9853)
- 8. 0087 (Score: -79.1312)
- 9. 0029 (Score: -82.5325)
- 10. 0123 (Score: -136.6195)
- 11. 0080 (Score: -155.569)
- 12. 0021 (Score: -160.3581)
- 13. 0084 (Score: -163.8133)
- 14. 0013 (Score: -168.461)
- 15. 0121 (Score: -176.0943)
- 16. 0010 (Score: -189.3386)

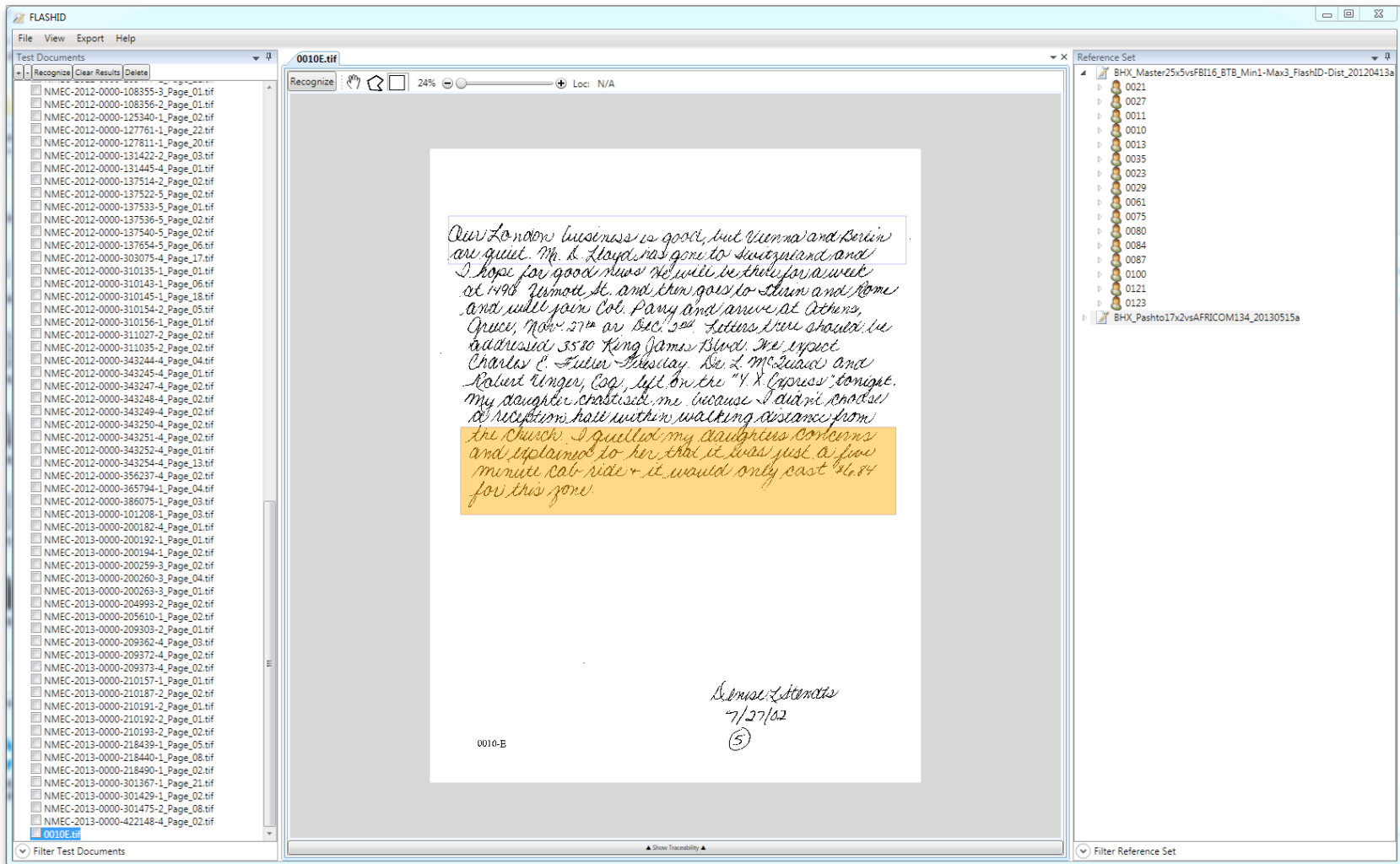
Key	IsoKey	Caddy	0075	0035	0023
8390	4:98.0:64.0	131	6.11476395282421	0.324698606160721	1.23083196722787
8445	6:112.96.0	01300	5.65569070666981	1.83108567999245	-1.29524302067203
8366	6:112.96.0	01300	5.55711675036951	3.12196783972035	-0.588426032500358
8356	8:104.32.48.64.0:0.32	3023003	5.07087166195782	4.18167345325863	-1.2250339300232
8335	6:112.96.0	01300	4.61187309899961	5.47356894635368	0.419537990139812
8443	8:112.24.24.0.0	1230122	4.43887505415923	-0.259777024452543	-0.714893708636566
8301	6:112.96.0	31230	4.34134092801163	1.68153291945192	

Filter Test Documents

Filter Reference Set

FLASH ID: Text Selection Capability

Ability to select text of interest from within documents.



FLASH ID: Language Independent

Works across multiple languages and scripts.

The screenshot displays the FLASHID application window. The main area shows a handwritten Arabic document titled "EG001-0001A1.tif" with a zoom level of 57%. The text is:

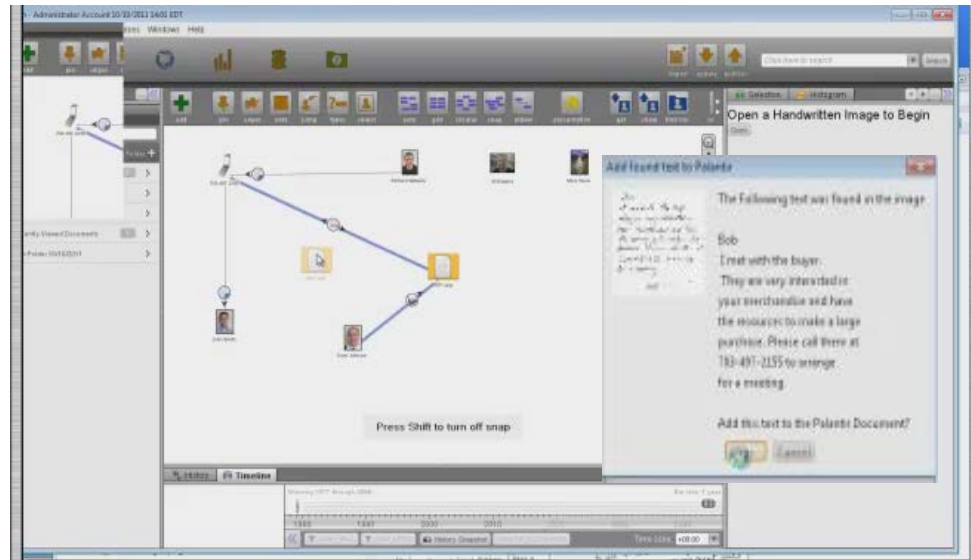
رَبِّهِمْ سَمَاءٌ مِنْ قَوْسٍ الدَّرَجَاتِ
يَوْمَ لَا يَكُونُ لَكُمُ الْمُدَّةُ فِي
سُحْرِ الْمَرْوَعَةِ بِالسَّاحِ وَتَحْوِجُ
الَّذِي لَدْرِيهِ دَرَعٌ مَدْرُ الْمَوْجِ
وَمَوْجُونَ وَسَامِي كَمَا الر
وَمَادَنَهُ لَعْنَةُ الْعَصِيَّةِ وَالصَّعْدِ
عَلَى مَا فِيهِ وَهَلْ رَكِبَ الْعَصَارِ

The interface includes a menu bar (File, View, Export, Help), a "Test Documents" list on the left, and a "Reference Set" list on the right. The reference set is titled "ArabicTestBHC" and contains 35 items, each with a score. The scores range from 479.4953 to -107.3181.

Item	Score
1. EG001-0001	479.4953
2. EG001-0014	126.0272
3. EG001-0023	120.0009
4. EG001-0034	105.7375
5. EG001-0022	78.7355
6. EG001-0013	66.3429
7. EG001-0007	39.0677
8. EG001-0032	35.8629
9. EG001-0050	31.6059
10. EG001-0033	14.3668
11. EG001-0042	12.3722
12. EG001-0002	10.5195
13. EG001-0026	8.1413
14. EG001-0019	3.4273
15. EG001-0030	-1.7949
16. EG001-0021	-5.3717
17. EG001-0048	-15.0886
18. EG001-0003	-17.218
19. EG001-0005	-18.6605
20. EG001-0020	-27.7292
21. EG001-0036	-34.3044
22. EG001-0008	-38.338
23. EG001-0043	-40.4438
24. EG001-0025	-44.5039
25. EG001-0004	-50.8258
26. EG001-0031	-53.0197
27. EG001-0018	-54.5491
28. EG001-0011	-60.7086
29. EG001-0039	-61.1177
30. EG001-0049	-62.6631
31. EG001-0040	-72.6255
32. EG001-0010	-79.9778
33. EG001-0028	-90.498
34. EG001-0015	-99.5778
35. EG001-0027	-107.3181

FLASH ID: *Palantir Integration and Cluster View*

Integrated as a “helper” in Palantir Analytical Platform.



Cluster view provides “big data” visualization perspective to handwritten document collections.

