The 2010 NIST Fingerprint Compression Study

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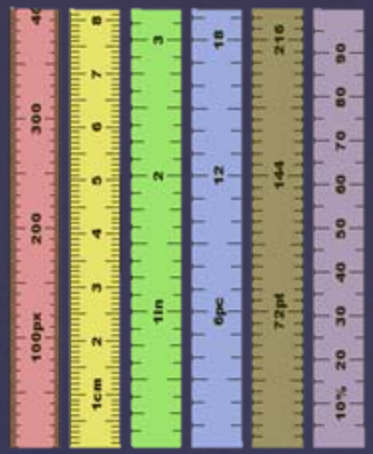

At NIST we specialize in measurement science and standards to promote interoperability, compatibility and/or repeatability of a process.

Our most recent effort involved measurement of the impact of compression on 1000ppi fingerprint images.

NIST Fingerprint Compression Study

Why compress fingerprints? →

A crash course in fingerprint image compression:

Why compress fingerprints?

This single rolled print is about a 600 kilobytes in size without compression. The set of 10 would require almost 6 megs of space.

May not sound like much now, but 20 years ago this was a big deal. Its actually still a big deal considering the ever-increasing volume of biometric data floating around.

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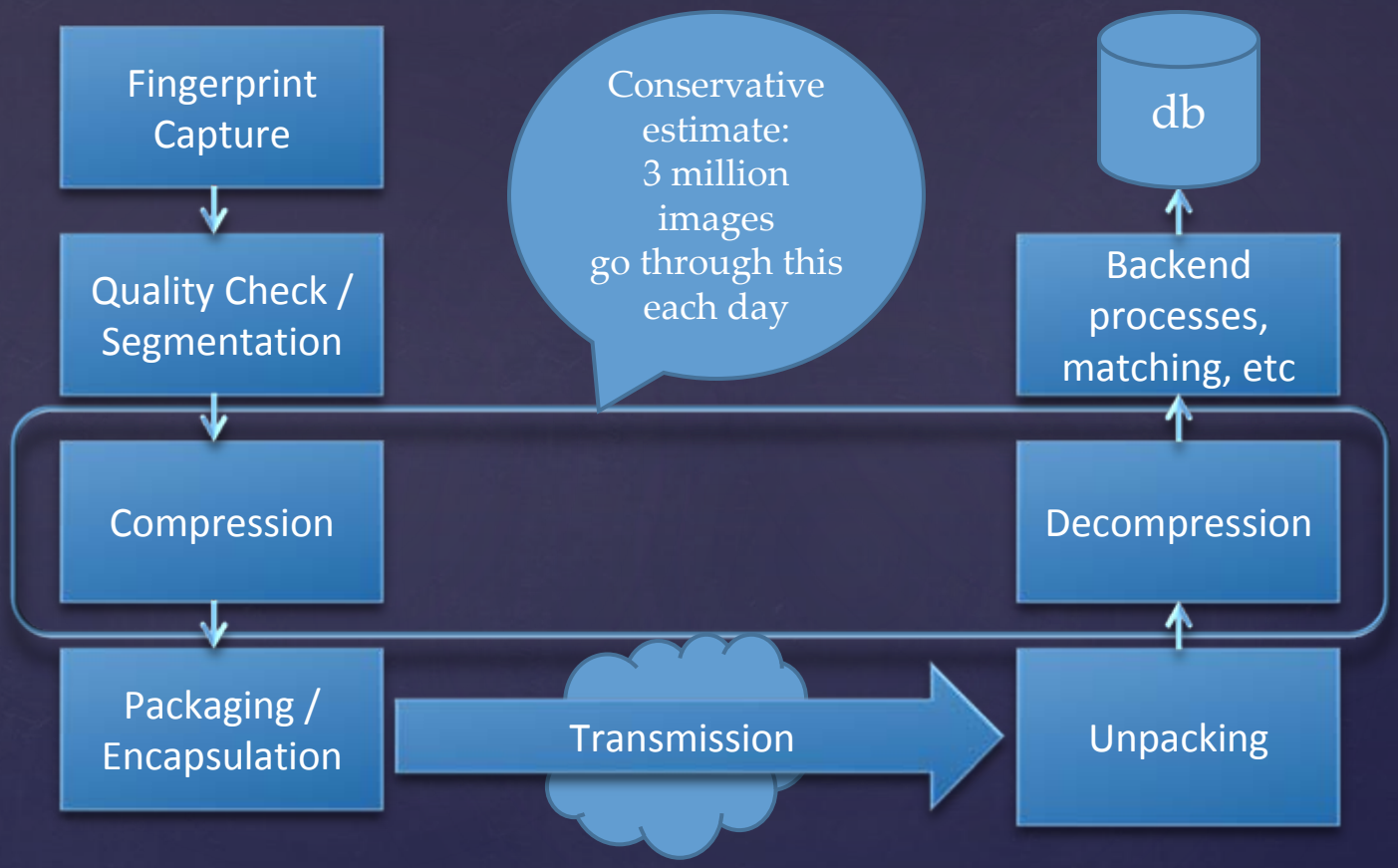
Anatomy of a hypothetical system →

Anatomy of a hypothetical fingerprint identification system:



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A crash course on compression →

A crash course in fingerprint image compression:

So what can you do to reduce the size of these fingerprint images? You compress them.

Basic commodity/simple [lossless] compression approach: This will yield about 2:1 or 3:1 compression ratio.

More advanced approach: Can compress it much more (i.e., 15:1), if you're willing to sacrifice a bit of detail. This is the predominant approach for compressing fingerprints right now.

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How do you compress fingerprints? →

A crash course in fingerprint image compression:

Now, how do you compress a fingerprint?

You need an implementation of a compression algorithm (aka CODEC, aka the tool that will do the compression for you), but must be standardized by/for all parties.

You need a recipe on how to drive the above algorithm. In the case of more advanced algorithms, one of the things you provide using your recipe is how much detail loss you're willing to live with, and must be agreed to by all parties.

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Why do you need standards? →

A crash course in fingerprint image compression:

What happens if you don't use a standardized algorithm and recipe? Are we talking doom and gloom here?!

If you don't, the following will very likely be negatively impacted:

-System throughput

-System performance

-Your ability to exchange data with peers

-Ultimately, the ability to make use of those images for identifications/verification purposes

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Where can you find the algorithm standard/recipe? →

A crash course in fingerprint image compression:

So how do you get in on all this?

For the **algorithm**: The FBI has issued the WSQ algorithm standard, and certification pathway . The standard is free and open, and has been available for well over a decade.

For the **recipe**: The receiving entity usually provides guidance for this (varies, for FBI see EBTS 9.1 pg. 86). The IAI did a study in 1994 to determine how to best utilize WSQ and this has become the basis for most of the published guidance.

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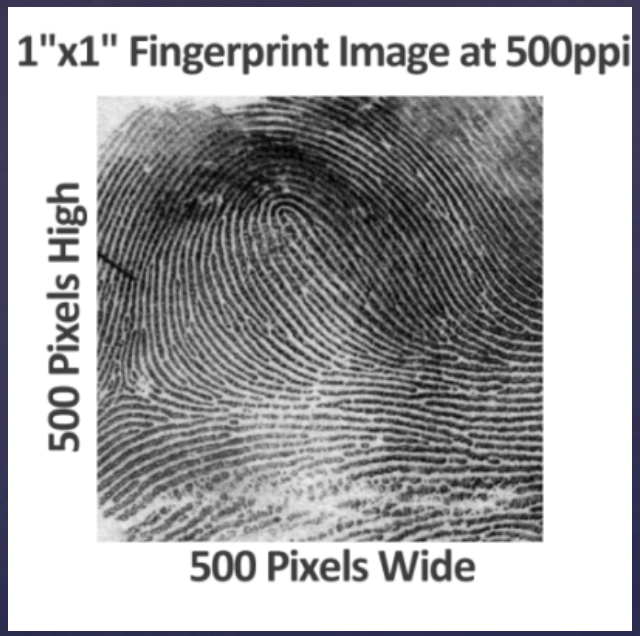
We've covered 500ppi so far… →

Everything we've talked about so far has been about 500ppi.

500ppi means that if a fingerprint is 1 inch by 1 inch square, the fingerprint is 500 pixels by 500 pixels in geometry.



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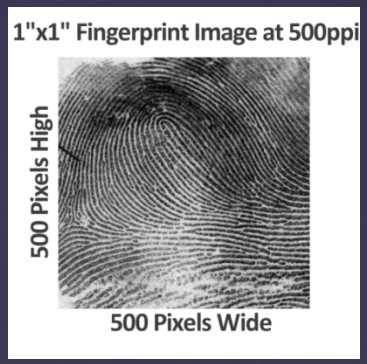
What's the next big thing after 500ppi? →

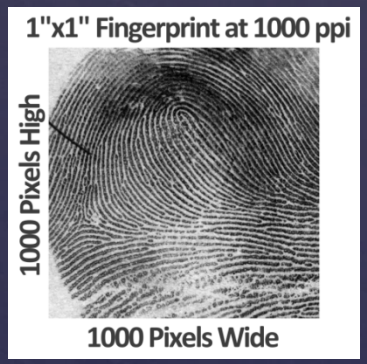


State-of-industry (aka, what is in widespread use):

Capture, compress, transmit, process at 500ppi.

Why 500ppi?

500ppi was attainable for the masses two decades ago (financially as well as technologically), and studies proved it to be effective for biometric identification/verification.



State-of-Art (defined here as "what's next"):

Capture, compress, transmit, process at 1000ppi.

Why go to 1000ppi?

- Higher fidelity to the original sample
- Possible improvement in identification
- Possible new/novel identification methods that simply can't be done at 500ppi (see next slide)

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A real live 1000 ppi to 500 ppi comparison →

Actual Specimen Images: 500ppi vs. 1000ppi

500ppi

1000ppi

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What's been established for 1000 ppi so far? →

Here is what's happened so far in 1000ppi:

-The community has agreed to use JPEG-2000 and this is backed by the FBI. (JPEG-2000 is the "CODEC "as mentioned in slide 6)

-MITRE has issued a recipe (MTR-04B0000022) for 15:1 compression of fingerprint imagery.

Based on experiences with WSQ, we identified some gaps that warranted further study so working with both the FBI and MITRE we conducted an experiment to see if we can help address these gaps.

What were some of the gaps identified? →

Some gaps identified in the current 1000ppi compression approach/guidance:

⇨Most of the existing guidance has been based only on ink-rolled prints (not slaps, flats, livescan)

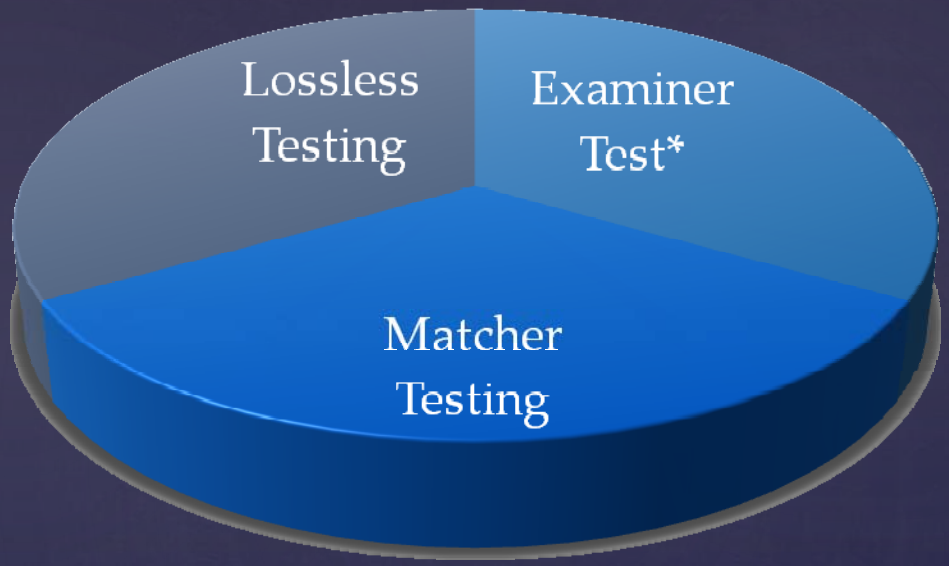
⇨Most of the existing guidance and research has been based on a few compression ratios ('recipes'), namely 5:1, 10:1, 15:1 and 20:1.

⇨Self-certification: Lessons learned from WSQ support a more formalized certification process

⇨Lessons learned from WSQ support formal traceability for JPEG-2000 CODECs

Our study at 32000 feet →

The 2010 Compression Study has 3 Components to it:



*: Focus of this presentation, modeled after IAI study

NIST Fingerprint Compression Study

How our test built on the IAI & MITRE work →

The NIST 2010 compression study is modeled after the IAI study and builds on MITRE's work (MTR-04B0000022). In a nutshell:

- ⇨Largest scale test of its kind on compression (as far as we know/so far), 56000 image pairs x 3 judges.
- ⇨Tested wider range of compression ratios from, much wider in scope than the original IAI study (IAI looked at 5:1, 10:1, 15:1 & 20:1). We did 2, 5, 7, 10, 12, 15, 17, 20, 22, 26, 30, 34, 38.
- ⇨Test wider range of impression types: rolled, flat, slaps, as well as cross comparisons of each type, including ident/non-ident cases
- ⇨Tested live-scan in addition to ink-card scan (everyone asked for it)

Quick look at the data set →

Preliminary Look at Results*:

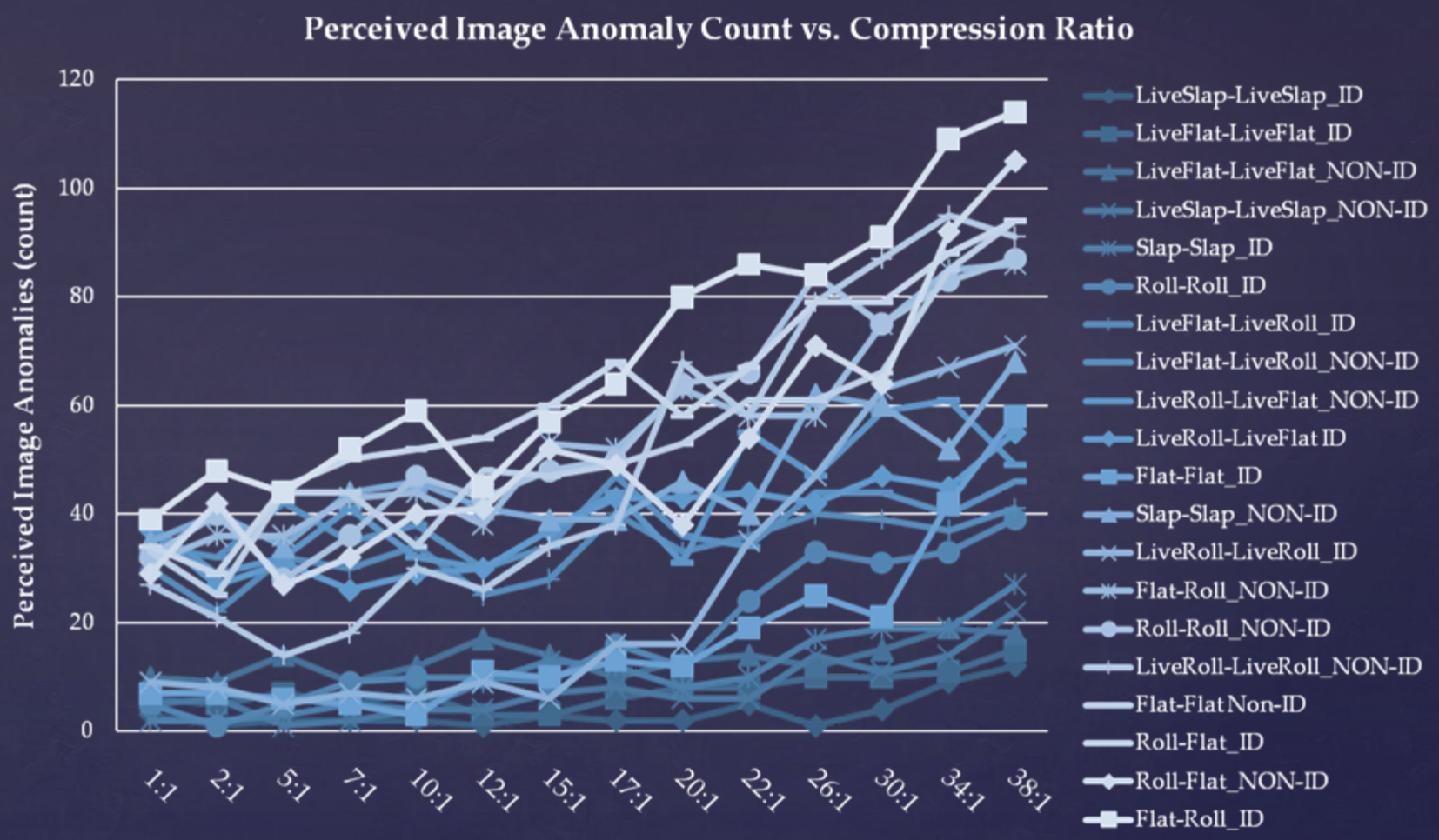
- ✓ 15:1 is a viable recipe for rolled-print compression and results on card-scan rolled-prints seem to verify this.

12:1 appears to be a good target for some cases. Need further analysis to evaluate benefit/disadvantages of going to 12:1.

Compression loss can at times help (low-pass filtering).

*: Pending further analysis, and incorporation of results from live-scan data.

A peek at what the raw data looks like →



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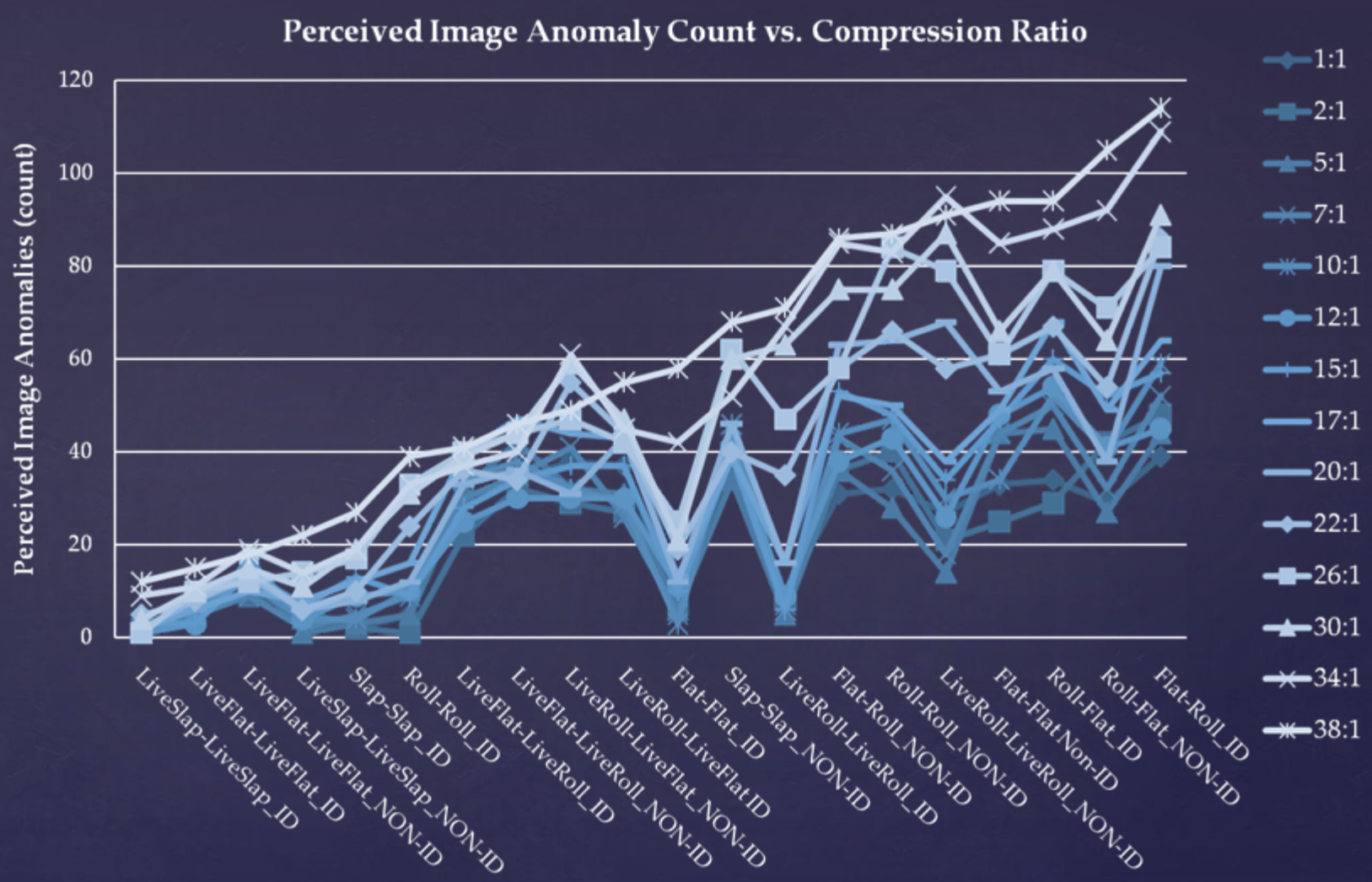
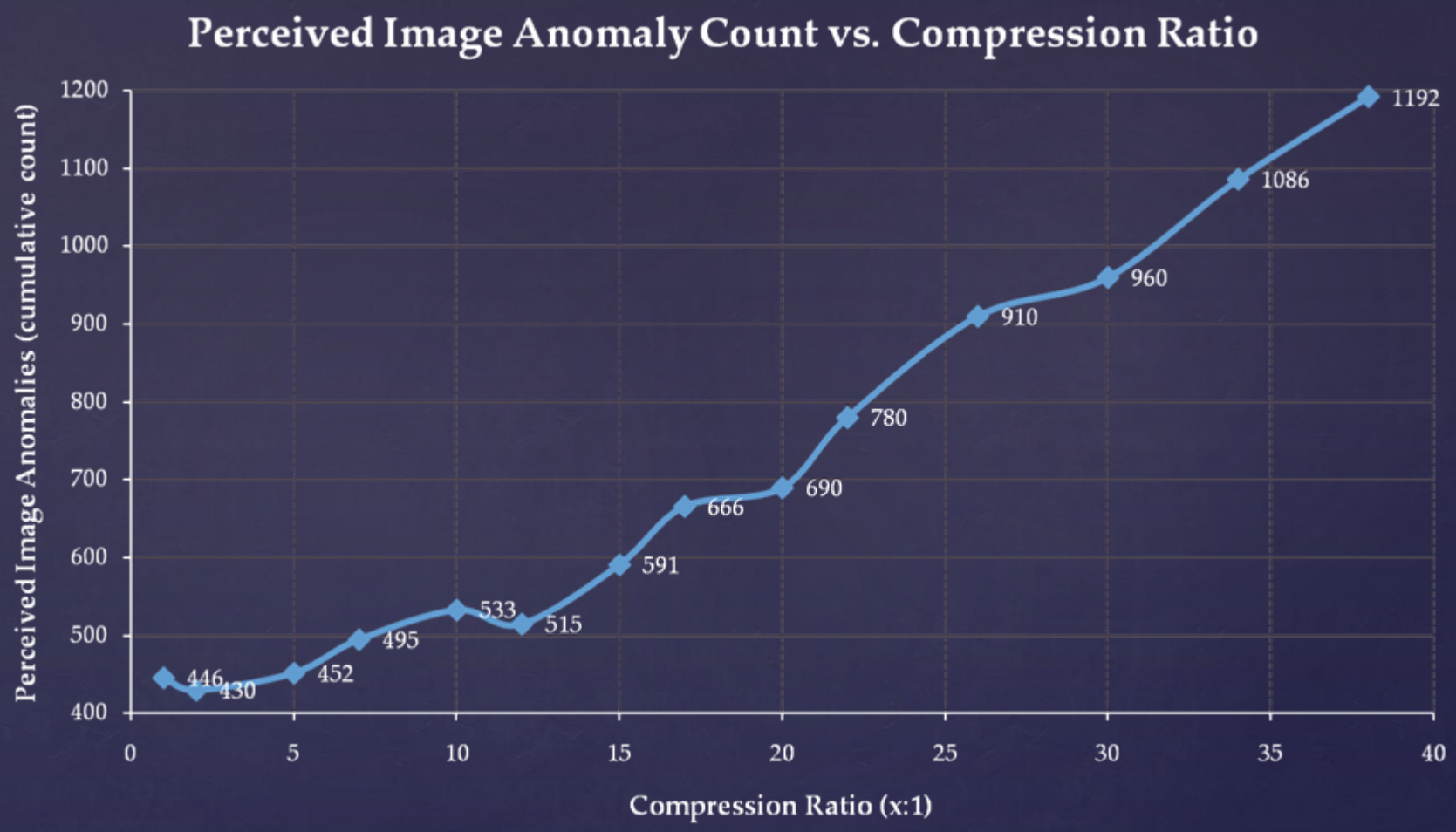
The raw results, tamed down a bit →



NIST Fingerprint Compression Study

The raw results, tamed down a bit more →



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Conclusion →

In Conclusion:

- Early results show 15:1 holds its own for 1000ppi.
- 12:1 may be a good candidate for some cases (pending analysis).

Next steps:

- Need to process matcher data, weigh relevance
- Will publish study results by year end (will include matcher results and lossless test results as well)
- Will work with all stakeholders if new compression guidance emerges.
- Will recommend to the FBI a certification pathway.
- Will recommend to the FBI a traceability strategy.
- Watch http://fingerprint.nist.gov for news.

Acknowledgements →

Compression Study Team

Shahram Orandi	Principal Investigator
John M. Libert	Principal Researcher - Examiner Testing, Data Analysis, Compression SME
John D. Grantham	Lead Research Engineer - Examiner Testing, Data Analysis, Test Software Framework
Stephen S. Wood	Principal Researcher - Matcher Testing, Data Analysis, AFIS SME
Kenneth Ko	Research Engineer - Matcher testing, CODEC Analysis
Stephen G. Harvey	Research Engineer, Lossless CODEC Analysis
Bruce Bandini	Research Engineer, CODEC Analysis, Testing and Data Validation

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Q & A?

Questions: Free to ask…
Answers: $0.05/each
Right answers: $0.25/each
:-)

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