Diagnostic Indicators for 3D Bullet Scan Quality

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Funded by NSF Grant 1757900

BACKGROUND

Due to the high level of expertise required to create quality bullet scans, and the repetitious nature of the process, scan data is highly susceptible to human errors. The goal of this study is to identify and mitigate these human errors using a program with real-time feedback, and leave a foundation to create a more refined filter.

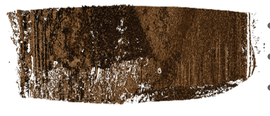
DATA DESCRIPTION

Good Scan

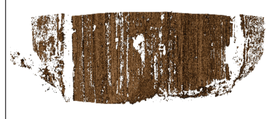
- Minimal missing matrix values
- Sufficient breakoff
- Visible striation markings

Bad Scans

- No break-off
- Insufficient number of values
- Missing values affect striation markings



- Tank-rash or Pitting
- Insufficient number of values
- Visible striation markings



- Misaligned
- Over abundance of missing values

x3p file

main.xml md5checksum.hex	data.bin

DATA ANALYSIS

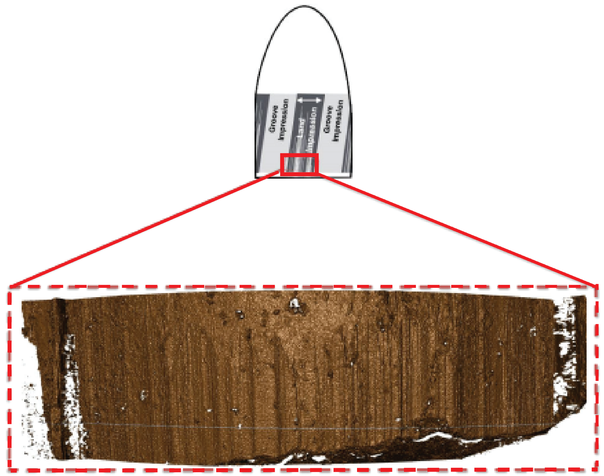


Figure 1. An example of a high resolution 3D scan of a bullet land engraved area (LEA). Often, a bullet will have 6 LEAs in total.

Percent missing was analyzed using C++ algorithm

Figure 2. The LEA is partitioned into a 3x3 grid to measure the percent of missing values in each section.

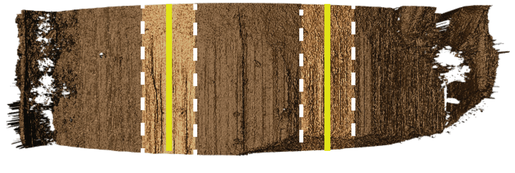


Figure 3. Data values surrounding the columns display slope values to determine misaligned placement of bullet.

RESULTS

```
Total % Missing: 0.0508
Block % Missing:
|    0.0277|         0|    0.0114|
|    0.0543|         0|    0.0646|
|    0.0543|    0.0001|     0.245|
Left Slope: -0.0061
Right Slope: -0.016
```

Good Scan
Minimal missing values
Sufficient missing values in left and right blocks

```
Total % Missing: 0.1384
Block % Missing:
|    0.0725|    0.0086|    0.3474|
|    0.0864|    0.0106|    0.2941|
|    0.1248|    0.0084|    0.2913|
Left Slope: -0
Right Slope: -0
```

No Break-Off
Bottom right has insufficient missing values for good break-off

```
Total % Missing: 0.2099
Block % Missing:
|    0.1736|     0.016|    0.2317|
|    0.2025|    0.0041|    0.2476|
|    0.3063|    0.1448|    0.5627|
Left Slope: -0
Right Slope: -0
```

Misalign
Right, left and bottom blocks indicate high amounts of missing values

```
Total % Missing: 0.1267
Block % Missing:
|    0.2698|    0.0001|    0.1901|
|     0.174|    0.0002|    0.1167|
|    0.1995|    0.0003|      0.19|
Left Slope: 0
Right Slope: 0
```

Tank Rash
High values missing on both left and right blocks indicate evidence of tank rash

CONCLUSION

The statistical data obtained from the scans show significant deviations between scans. The discrepancies appear to justify the process towards identifying human errors, though the measures taken are not refined enough to distinguish between error types. However, even if the error cannot be specified, reporting the existence of an error is beneficial for the operator to remedy the issue by way of rescanning.

FUTURE WORK

- Develop a more accurate diagnostic to devise a threshold indicating acceptability scans and distinguish error types
- Conduct a study to evaluate the effectiveness of scan duration and accuracy

REFERENCES

- Hare, E., Hofmann, H., & Carriquiry, A. (2017). Automatic matching of bullet land impressions. The Annals of Applied Statistics, 11(4), 2332-2356. doi:10.1214/17-aoas1080
- Wiora, G. (2014, August 29). OpenGPS® - open source software for 3D surface characterisation. Retrieved from http://open-gps.sourceforge.net/