

Automated Groove Identification in 3D Bullet Land Scans (we'll change the title)

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Abstract

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1 Background

Thanks to (1), we can do stuff. Hamby et al. (1)

2 Data Source

3 Methodology

We first need to remove the global structure of the bullet land.

3.1 Global Structure Removal

The non-traditional data structure necessitates employing non-traditional methods to model and remove the global structure. The data are made up of two competing structures: the LEA data, of which we would like to model the global structure, and the GEA data, which we would like to consider as outlying data. Traditional statistical modeling techniques minimize the least squared vertical distance from each data point to a fit line; this results in undue influence by GEA points, which pull any fit lines towards their unusual points.

While bullets are traditionally circular, it is unwise to use a rigidly quadratic model to fit the global structure. We cannot assume that fired bullets will retain a neatly circular shape, especially at the level of detail scans are captured. The significant amount of physical pressure that acts upon bullets as they are fired through a barrel also can lead to some warping or slight deformations (*find a citation from JFS or AFTE about warping/deformation of bullets?*). Finally, the placement of the land relative to the plane of reference when a 3D scan is being captured can vary slightly, meaning that the 2D crosscuts can be slightly tilted or rotated. This will not translate into a clean quadratic-shaped(?) crosscut.

To avoid the potential risks arising from using a quadratic linear model, we instead use a locally weighted regression (LOESS) which fits linear regression models on small pieces of the data and combines predictions to result in a non-parametric predicted fit of the data structure.

However, since LOESS is still rooted in traditional regression techniques, it is unable to adequately identify and address the separation between GEA and LEA data structures. To address this, we implement a robust version of LOESS which iteratively downweights unusual data points and re-fits a LOESS model to each land. This robust LOESS is an adapted version of the robust LOESS proposed by (2).

This model is fit as follows:

The subsequent prediction methods for shoulder location are based on the residuals calculated from the fit to the global structure of each land. One method uses penalized two-class classification techniques to classify each data point into “LEA” or “GEA”, while the second uses Bayesian changepoint analysis to predict the data points at which the shoulders begin on either side.

3.2 Two-Class Classification

3.3 Bayesian Changepoint Analysis

4 Results

5 Conclusions

6 References

References

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