INSIGHTS

Recognition of Overlapping Elliptical Objects in a Binary Image

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Link: forensicstats.link/EllipticalObjects-DOI

OVERVIEW

A common objective in bloodstain pattern analysis is identifying the mechanism that produced the pattern, such as gunshots or blunt force impact. Existing image-based methods often ignore overlapping objects, which can limit the number of usable stains. Researchers funded by CSAFE established a novel technique for image analysis to provide more accurate data.

GOALS

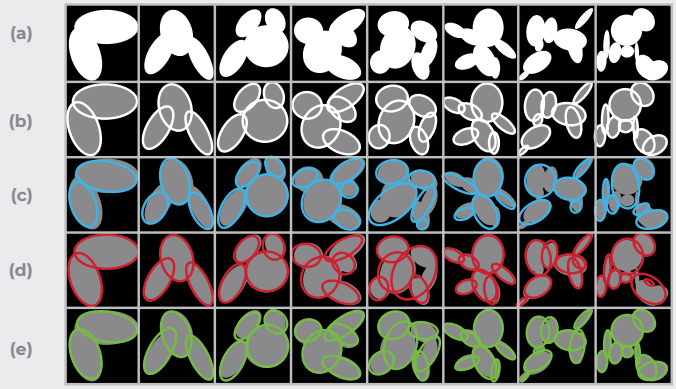
1. Develop a method to classify shapes in complex images.
2. Apply this method to data of different types including bloodstain patterns.
3. Compare the new method's accuracy to existing methods.

APPROACH AND METHODOLOGY

When analyzing bloodstain patterns, the individual stains may appear as clumps comprised of overlapping objects (e.g., droplets). Zou et al. developed a new computational method that identifies the individual objects making up each clump. The method proceeds as follows:

1. Generate a large number of elliptical shapes that match the overall contours of the clump.
2. Use an empirical measure of fit to reduce the set of candidate ellipses.
3. Identify concave points in the clump's contour and set up an optimization to determine the best fitting ellipses.

IMAGE PROCESSING



Examples of ellipse fitting results for synthetic data. (a) Original binary image; (b) Ground truth; (c) DEFA model; (d) BB model; (e) DTECMA. The number of true ellipses increases from 2 (leftmost column) to 9 (rightmost column). Rows (c) and (d) are results from existing methods; row (e) gives results for Zou et al.'s DTECMA algorithm.

The researchers tested the method on a set of over 1,600 test images with overlapping shapes, emulating bloodstains (row a).

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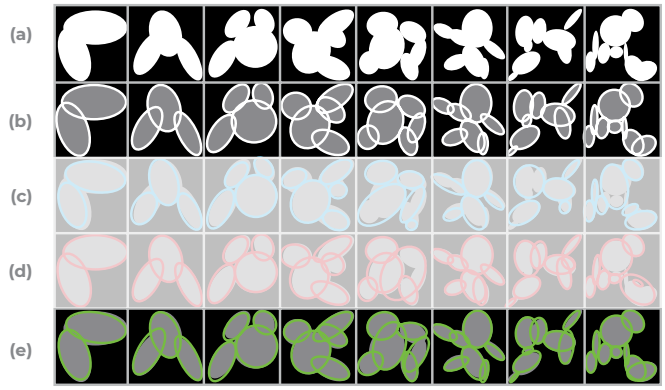
STUDY RESULTS

- Across four different metrics, the new approach outperformed existing approaches.
- The current methods struggled to correctly recognize shapes as the number of ellipses per picture grew. Only the new method was able to maintain consistent accuracy.



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FOCUS ON THE FUTURE

- The new approach to identifying elliptical-shaped objects in complex images shows marked improvement over current methods. This is demonstrated using simulated data and biological data for which the underlying truth is known.
- While these results are promising, there is currently no way to quantify the performance of these models for bloodstain pattern analysis. The paper shows that the new method seems to do well based on visual inspection.
- The next stage of the research is to use the identified ellipses as summaries of the images that can be used to develop statistical methods for analyzing bloodstain patterns.

LEARN MORE

Access the full research study to learn more: forensicstats.link/EllipticalObjects

Additionally, explore relevant publications:

- Code Used for Developed Computational Method to Break Complex Images Down Into Clumps of Elliptical Objects forensicstats.link/EllipticalObjectsComputationMethod
- Set of Microscopic Cell Images Dataset to Test Computational Method forensicstats.link/NuclearSegmentationInCellImages
- Set of Bloodstain Patterns Dataset to Test Computational Method forensicstats.link/DataSetOfBloodstainPatterns
- Automatic Classification of Bloodstain Patterns Caused by Gunshot and Blunt Impact at Various Distances forensicstats.link/Bloodstain-Patterns-Various-Distances
- Determining the Region of Origin of Blood Spatter Patterns Considering Fluid Dynamics and Statistical Uncertainties forensicstats.link/Blood-Splatter-Fluid-Dynamics

FUNDING

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