Dice Detection and Classification

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Presentation Outline

1. Introduction
2. Background Research
3. Method
4. Conclusion

Introduction

- Dice value identification is important in industries such as gaming, and disability assistance.
- Most people have access to a device that can capture imagery and process it in realtime.
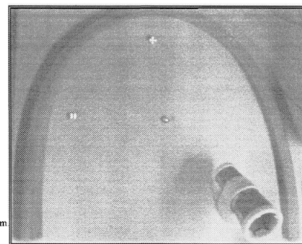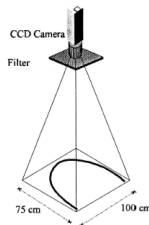- This is a good fit for computer vision and machine learning.

Automated Detection and Classification of Dice (1995)[1]

The "SORTE" system was commissioned by the Portuguese Gaming Inspection Authorities for use in casinos.

Limitations:

- Designed for a specific kind of die and surface.
- Requires a birds-eye view.
- Requires a careful lighting setup.

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[1] B. A. B. Correia, J. A. Silva, F. D. Carvalho, R. Guilherme, F. C. Rodrigues, and A. M. de Silva Ferreira, "Automated detection and classification of dice," in *Machine Vision Applications in Industrial Inspection III*, F. Y. Wu and S. S. Wilson, Eds., SPIE, 1995. DOI: 10.1117/12.205506.

Computer Vision Based Reliability Control for Electromechanical Dice Gambling Machine (2000)[2]

This system was designed to detect dice rolls from within an electronic gaming machine. Under controlled conditions, this method has a 100% success rate.

Limitations:

- Requires fixed die size.
- Requires fixed camera distance.
- Uses template matching for identification.
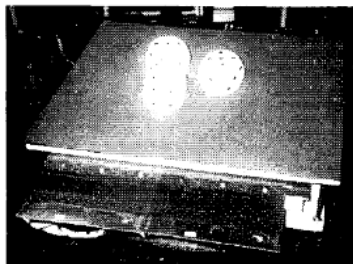
[2]I. Lapanja, M. Mraz, and N. Zimic, "Computer vision based reliability control for electromechanical dice gambling machine," in *Proceedings of IEEE International Conference on Industrial Technology 2000 (IEEE Cat. No.00TH8482)*, Jaico Publishing House. DOI: 10.1109/icit.2000.854173.

An Auto-Recognizing System for Dice Games Using a Modified Unsupervised Grey Clustering Algorithm (2008)[3]

This algorithm uses a modified unsupervised gray clustering algorithm to determine the value of each die.

Limitations:

- Requires birds-eye view.
- Requires number of dice to be known in advance.
- Requires low noise background.
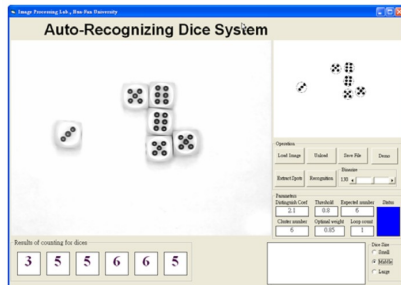
[3]K.-Y. Huang, "An auto-recognizing system for dice games using a modified unsupervised grey clustering algorithm," *Sensors*, vol. 8, no. 2, pp. 1212–1221, 2008. DOI: 10.3390/s8021212.

Image Identification Scheme for Dice Game (2009)[4]

This algorithm uses image feature detection and the least distance criterion to detect die values.

Limitations:

- Requires birds-eye view.
- Requires specific die colors and contrast with background.
- Only tested with four dice.

(a)   (b)

(c)
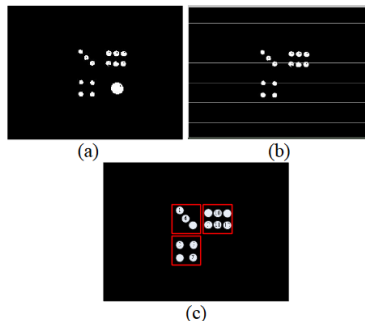
[4]C. H. Chung, W. Y. Chen, and B. L. Lin, "Image identification scheme for dice game," in *International Conference on Advanced Information Technologies*, Ta Hwa Institute of Technology, 2009.

Method

Instead of performing perfectly under specific conditions, like all prior research, my method works under all conditions with mediocrity!

- Image capture
- Image pre-processing
    - Grayscale
    - Binary threshold
    - Gaussian blur
- Canny edge detection
- Contour area and shape rejection
- Die face processing
    - Face isolation
    - Face rotation and resize
    - Convolutional neural network[5] for value classification
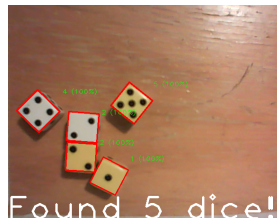

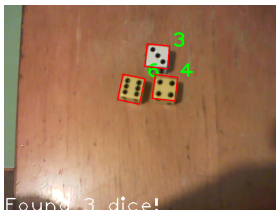[5]CNN trained on 1200 images to 97% accuracy.

Results

The detection method:

- Is rotation invariant.
- Will reliably detect yellow and white dice.
- Is not likely to go rogue and take over the world.

Limitations:

- Very sensitive to lighting levels and surface features.
- More work needs to be done to filter out noise.

Conclusion

A dice detection method was designed using basic image processing and feature detection techniques. A convolutional neural network was used to classify each die face with 97% accuracy.

Unlike prior research, the proposed solution works (somewhat) under a range of operating conditions.

In future, more work needs to be done to remove noise and lighting artifacts during image pre-processing and to support detection of dark-coloured dice.