Shape object selection using the chi-square method

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Abstract. This paper is focused on identifying the shape of the object. There are some basic shape objects such as rectangle, circle, triangle, square, hexagonal, an ellipse. The method that used in this paper was chi-square feature selection to select a relevant feature toward those basic shape objects. Then, the proximity calculation between the training image and real image that was already available in the database. The chi-square feature selection process eliminates the irrelevant features in each figure that was in the image database. As final results, the system succeeds to detect an appropriate shape of an object by determining the distance of Euclidean between training image and the real image.

1. Introduction

The concept of objects that exist around is based on and influenced by the concept of a simple object called three-dimensional space geometry such as length, width, and height. However, in the design and depiction, we use only two-dimensional images — not all types of features used to perform the computation of extraction results.

There are some methods used in object shape recognition for robot application. Some of them are angle detection to detect the hindered condition object [1]. The object recognition system using angle detection is the basis of computer vision for extracting some features and summarizing the contents of an image which will then be used as the basis for the decision making of the given command. Some other research used correlation feature to reduce the time process [2], chain code [3] and backpropagation [4].

Feature selection is a process to find out the features that correlate with each other without having to use the overall result of the feature extraction [5]. We use the chi-square with selection features in this research

2. Feature shape extraction

There are some basic standards of a regularly shaped object such as circle, rectangle, square, triangle, pentagon, hexagon and some others. The feature of the shape object is distinguished into two categories: basic feature and morphology feature. The basic features of shape object are Diameter (D), Physiological length (Lp), Physiological width (Wp), Area (A) and Perimeter (P). The morphology features of the object are [5]: Aspect Ratio (AR), FormFactor (FF), Rectangularity (R), Narrow Factor (NF), Perimeter of diameter (PoD), Perimeter ratio of Lp and Wp (PLW). All of them are shown in the equation below:
\[ \text{AspectRatio} = \frac{L_p}{W_p} \]  
\[ \text{FormFactor} = \frac{4\pi A}{P^2} \]  
\[ \text{Rec} = \frac{LP_{Pr}}{A} \]  
\[ NF = \frac{D}{L_p} \]  
\[ \text{PerimeterOfDiameter} = \frac{P}{D} \]  
\[ \text{PerimeterLp&Wp} = \frac{P}{(L_p + W_p)} \]

2.1. Chi-square

In chi-square feature selection, each term value is sorted from the highest based on the following equation:

\[ X^2(D, t, c) = \sum_{e \in [0,1]} \sum_{e \in [0,1]} \left( \frac{N_{e1e2} - E_{e1e2}}{E_{e1e2}} \right) \]  

Chi-square is usually used in testing the independence of two different variables. The hypothesis will be zero (H_0) if the two variables are independent of each other [5][7].

2.2. Euclidian proximity

The Euclidean proximity is the method that compares the minimum distance of an object in the real image (testing image) with each object in the database (training image). The Euclidean distance of vector x dan y is formulated by:

\[ EU(u,v) = \sqrt{(x_1-x_2)^2 + (y_1-y_2)^2} \]  

If the value of EU(u,v) is low, then the similarity level of the object is high. But if the value of EU(u,v) is high then the low object are not similar[6][8].

3. Result and discussion

The chi-square values then compared to observe whether there is a relationship between feature and object shape. The feature selection is shown in table 1:
Table 1. Selection Feature

| No. | Shape   | Appropriate feature                       | Irrelevant feature |
|-----|---------|-------------------------------------------|--------------------|
| 1   | Circle  | AR, FF, NF, PoD, and PLW                  | R                  |
| 2   | Square  | AR, FF, R, NF, PoD, and PLW               |                    |
| 3   | Triangle| AR, FF, PoD, and PLW                      | R and NF           |
| 4   | Rectangle| AR, FF, R, NF, PoD, and PLW               |                    |
| 5   | Hexagonal| AR, FF, NF, and PLW                       | R and PoD          |
| 6   | Ellips  | AR, NF, and PoD                           | FF, R, and PLW     |

The computational duration of chi-square feature selection for each shape of the object is described in figure 1-9:

**Figure 1.** Duration of selection object for circle using chi-square method

**Figure 2.** Duration of selection object for square using chi-square method
Figure 3. Duration of selection object for triangle using chi-square method

Figure 4. Duration of selection object for rectangle using chi-square method

Figure 5. Duration of selection object for hexagonal using chi-square method
4. Conclusion

Based on the analysis of the results, it can be concluded that the detection of object shape using chi-square feature selection has a short computation time 11.4944 seconds. This time is 3.756 seconds shorter than the duration of shape detection object without chi-square feature selection.

Based on the results described above, we obtain the average time duration of accuracy for detection of the shape of objects using chi-square for the selected feature is 11.494 seconds. The average time duration of the accuracy of object shape detection for the unselected feature is 15.250 seconds.

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References

[1] Kurnia R, Asmita M, and Elfitri I 2017 Object Detection on Hindered Condition by Using Chain Code-Based Angle Detection Proceeding International Conference on Telecommunications and Communication Engineering
[2] Hall M A, 2000 Correlation-based feature selection for discrete and numeric class machine learning In Proceedings of the 17th Intl. Conf. Machine Learning”, pp 359-366
[3] Barua J and Chirgaiya S, Shape Recognition & Matching using Chain Code in www.irdindia.in/journal_ijacte/pdf/vol2_iss5/2.pdf
[4] Mihu I Z, Gellert A, and Suciu C N 2003 Geometric shape recognition using fuzzy and neural techniques. In Proceedings of the 11 th International Scientific Symposium SINTES 11 354-358.
[5] Wang L, Li X, and Fang K 2005 Object Detection Based on Feature Extraction and Morphological Operations ICNN&B ’05. International Conference on Neural Networks and Brain.
[6] Dokmanic I, Parhizkar R and Ranieri J 2015 IEEE Signal Processing Magazine Volume: 32(6).
[7] Sural S, Vadivel A, and Majumdar A K Performance Comparison Of Distance Metrics In Content-Based Image Retrieval Applications Proc. Internat. Conf. Inf. Technol. Bhubaneswar, India, pp. 159–164.
[8] Rastogi R, Khan Z, and Khan M H 2012 IJCSI International Journal of Computer Science Issues 9(2).