# Implementation of Chain Code K-Nearest Neighbor in Qalqalah Reading

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Keywords: Chain Code, Euclidean, KNN, Qalqalah.

Abstract: This study aims to implement the Chain Code method and KNN in *Qalqalah* reading law. The research phase consists of image acquisition, pre-processing, grayscale, feature extraction using chain code, classification using k-Nearest Neighbor k-NN). On the pre-processing process is carried out with image cropping, noise removal and normalization image size 50x25 pixels. The data used are 132 datasets which are divided into 6 test data and 126 training data (63 original data and 63 rotation data). The Chain Code method is used as a method of recognition of image patterns based on the direction of the wind, and the KNN method is used as an image classification method based on the difference in euclidean distance. The KNN method will search for the closest distance from the training data to the test data so that the best K is obtained with the highest accuracy in each class. In the validation calculation, obtained the results of accuracy image classification with an accuracy of 45.23%. This accuracy value is quite low because the Chain Code Method cannot detect images with separate objects so that this method cannot work optimally.

## 1 INTRODUCTION

Al-Quran is a holy book that is owned by the Islamic religion, which contains various kinds of life meanings that can be applied in human life. Al-Quran provides an overview of life in the world and in the hereafter and the effects that occur both positive and negative impacts. So, there must be *tajweed* learning so that the message can be conveyed correctly. Almost all Muslims in the world know how to read the Quran, but some of them cannot read the Quran correctly according to *makhraj* and *tajweed*. People who want to deep in the Quran will usually ask for help from a teacher to learn more about the *makhraj* and *tajweed* recitation of the Quran correctly and adequately. A teacher will observe every *makhraj* law and *tajweed* that are being read, then remind the right tajwid law and guide the reader when there is an error in reading. This method is less effective because a system is needed that can be used at any time when needed. At present, there are several Al-Quran learning software on the market. The usefulness of this software is that users can only read the Quran, but the placement of tajwid laws is not displayed. This software is still less effective for readers in learning tajwid and messages contained therein. Therefore, a system is needed that can detect tajwid patterns so that readers can find out how the laws of tajwid are read, especially the recitation of qalqalah. Based on the related problems, a system was created entitled Implementation of the Chain Code and k-NN Method in the digital image-based recitation law of *qalqalah*. Where chain code functions in pattern detection while k-NN functions in the classification of images obtained. The tested image will be detected based on the direction of the wind direction in the chain code method.

## 2 RESEARCH METHOD

This study uses an image processing methodology with several stages consisting of (1) the stage of image acquisition, which can be defined as a system that functions to retrieve, collect and prepare data, to process it to produce the desired data. (2) *Pre-processing* stage is the stage to cut the character part needed by the image. After the cutting results are obtained, then the *noise* removal is carried out (the part that is not needed). After that, the image size is 50 x 25 pixels uniform. (3) The *Grayscale* stage is



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changing the colour image into a *grey* image *scale*, this matter for simplify the image model. At this stage, not only *Grayscale* stages are used, but there is also some other stage, namely as *a binary* that works to change *Grayscale* images to black and white so that the image can be read clearly, namely *Imcomplement* stage rebrand be the opposite of a binary colour is white- black because usually, the system can only read images with a black background, then the *Thinning* stage is the reduction of the writing object so that the obtained *code chain* produces a short code sequence. (4) *Chain Code* Method, this algorithm is formed with the aim of representing the contours of an object. The intended representation includes pixels from the edges of an object that are interconnected and have a certain direction. The workings of this algorithm to detect an object is to give a rotation sign that is adjusted to the direction of the wind that you want to use, and (5) Classification of KNN is a pattern recognition stage by comparing vector test data and vector training data available using KNN. Stage in this classification is to determine the value of K, then calculate the euclidean distance of each image for the next sort from smallest to largest distance to get the best data by K.

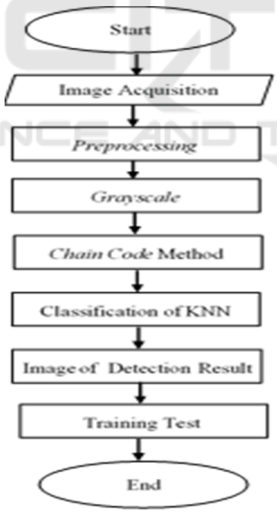



Figure 1: Flowchart Research.

## 2.1 Image Acquisition

Data acquisition stage can be defined as a system that functions to retrieve, collect and prepare data, to process it to produce the desired data. The resulting image is not necessarily digital data, so it needs to be digitized. In this study, the tool used in image capture is using a mobile camera. The following steps are shown in figure 2:

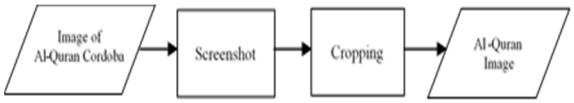



Figure 2: Stage Acquisition

## 2.2 First Section

*Pre-processing* stage is the stage to perform the required cutting portion character image. After the cutting results are obtained, then the *noise* removal is done (the part that is not needed). After that, image size uniformity is done. *Pre-processing* stage, including in Figure 3:

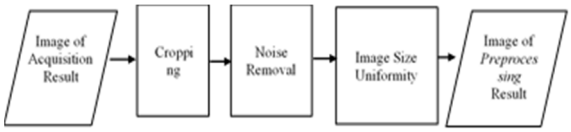



Figure 3: Stage Preprocessing

This stage is shown in table 1 below:

Table 1: Pre-processing

| Result | Stage |
|---|---|
|  | Al-Qur'an Image (Original Image) |
|  | Image after *cropping* |
|  | Image after the elimination of *noise* |
|  | Image after uniform size measurement |

## 2.3 Grayscale

The initial process many done in *image processing* is to change the colour image to *grey* image *scale*; this is used for simplifying the image model.

At this stage, not only *Grayscale* stages are used, but there is also some other stage, namely as *a binary* that works to change *Grayscale* images to black and white so that the image can be read clearly, namely *Imcomplement* stage rebrand be the opposite of a

binary colour is white-black because usually, the system can only read images with a black background, then the *Thinning* stage is the reduction of the writing object so that the obtained *code chain* produces a short code sequence.

The following are the details of the stages:

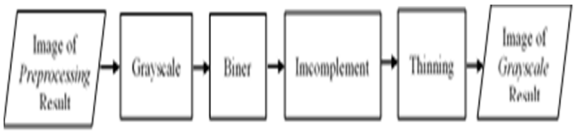



Figure 4: Stage Grayscale

The example of the manual calculation is RGB image changes to grayscale:

The total number of RGB = 762052
Amount of *Red* Value = 248906
Amount of *Green* Value= 247324
Amount of *Blue* Value = 265822

$$R = \frac{248906}{248906+247324+265822} = 0.326626$$

$$G = \frac{247324}{248906+247324+265822} = 0.32455$$

$$B = \frac{265822}{248906+247324+265822} = 0.348824$$

*Grayscale* RGB Value Search (2):

Grayscale = (0.2989*R)+(0.5870*G)+(0.1141*B)
= (0.2989*0.326626)+(0.5870*0.32455)
+(0.1141*0.348824)
= 0.32794

The following is an example in table 2:

Table 2: Grayscale

| Result | Stage |
|---|---|
|  | Image of *pre-processing* results |
|  | The image is changed to *grayscale* |
|  | The image is changed to *Binary* |
|  | The image is changed to *imclomplement* |
|  | The image is changed to *Thinning* |

## 2.4 Metode Chain Code

The method used in this study uses the *Chain Code* method. Algorithm this is formed with the aim of representing the contours of an object. The intended representation includes pixels from the edges of an object that are interconnected and have a certain direction. There are two types of Chain Code, namely in part (a) using a four-way representation and part (b) using an eight-way representation. Each direction shown has different values. The numbering scheme is applied to this method. The workings of this algorithm to detect an object is to give a rotation sign that is adjusted to the direction of the wind you want to use.

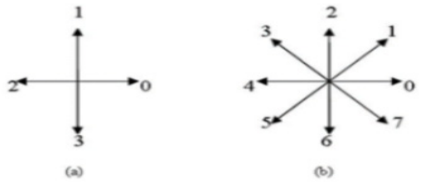



Figure 5: Representation of the wind direction on the *Chain Code*

The steps taken in the *Chain Code* are in figure 6:


Figure 6: Stage *Chain Code*

Examples of manual calculations for letter detection in the *Chain Code* are:

1. Get internal contours

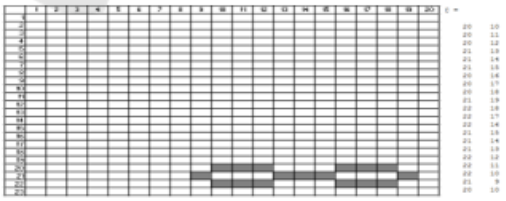


Figure 7: Results of Internal Contour Pattern 1

This pattern 1 on fig. 7 is a point pattern on qof (ق). While on the right is the xy coordinator point that has been obtained by inbound tracing.
Pattern 2 on fig.8 is qaf (ق) pattern without point. While the right is the xy coordinator point obtained by inbound tracing

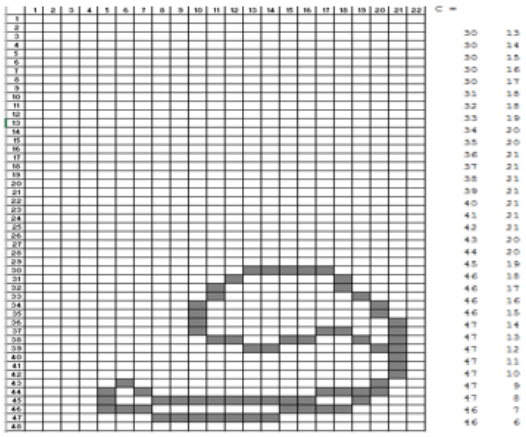


Figure 8: Results of Internal Contour of Pattern 2

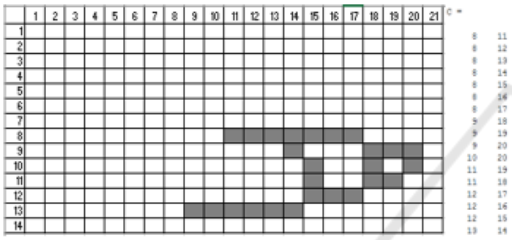


Figure 9: Results of Internal Contour Pattern 3

This pattern 3 on fig. 9 is the pattern of sukun contained in the letter Qof (ق). While on the right is the point of coordinator xy obtained.

2. Obtain *Chain Code*

The value of *Chain Code is* obtained from the detection of patterns based on the direction of the wind

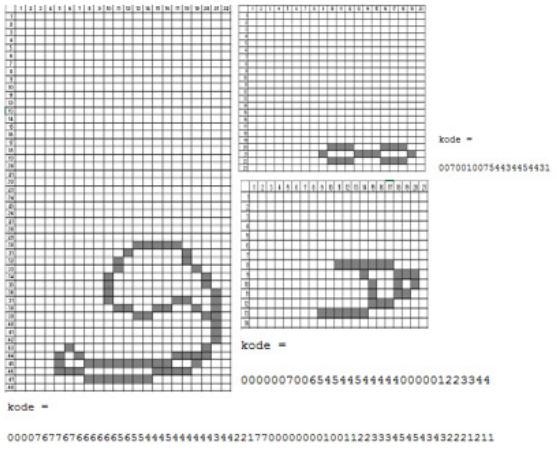



Figure 10: *Chain Code* Results

3. Obtain Image Size through the *Chain Code*

The area of the image can be done with the *Chain code* method, namely by the formula

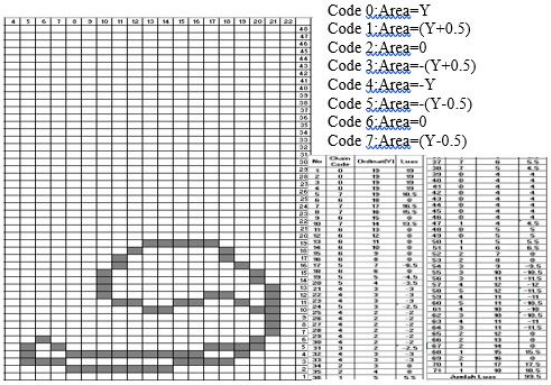
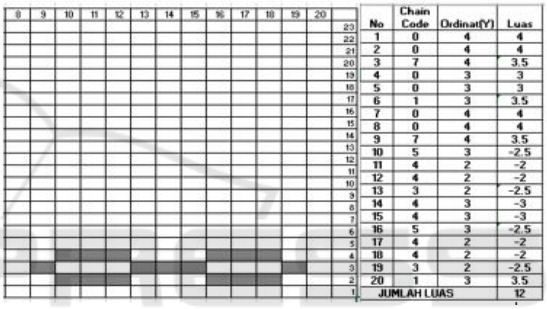
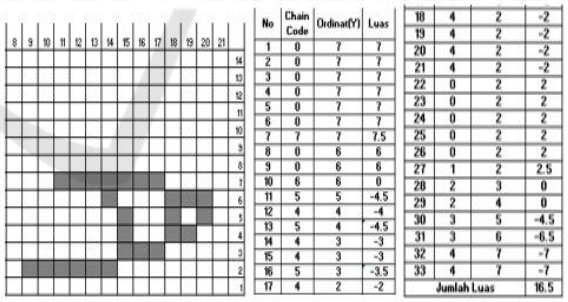



Figure 11: Area of an object on a pattern



| No | Chain Code | Ordinat(Y) | Luas |
|---|---|---|---|
| 1 | 0 | 4 | 4 |
| 2 | 0 | 4 | 4 |
| 3 | 7 | 4 | 3.5 |
| 4 | 0 | 3 | 3 |
| 5 | 0 | 3 | 3 |
| 6 | 1 | 3 | 3.5 |
| 7 | 0 | 4 | 4 |
| 8 | 0 | 4 | 4 |
| 9 | 7 | 4 | 3.5 |
| 10 | 5 | 3 | -2.5 |
| 11 | 4 | 2 | -2 |
| 12 | 4 | 2 | -2 |
| 13 | 3 | 2 | -2.5 |
| 14 | 4 | 3 | -3 |
| 15 | 4 | 3 | -3 |
| 16 | 5 | 3 | -2.5 |
| 17 | 4 | 2 | -2 |
| 18 | 4 | 2 | -2 |
| 19 | 3 | 2 | -2.5 |
| 20 | 1 | 3 | 3.5 |
| JUMLAH LUAS | | | 12 |

Figure 12. Area of Object in Pattern 2.



| No | Chain Code | Ordinat(Y) | Luas |
|---|---|---|---|
| 1 | 0 | 7 | 7 |
| 2 | 0 | 7 | 7 |
| 3 | 0 | 7 | 7 |
| 4 | 0 | 7 | 7 |
| 5 | 0 | 7 | 7 |
| 6 | 0 | 7 | 7 |
| 7 | 7 | 7 | 7.5 |
| 8 | 0 | 6 | 6 |
| 9 | 0 | 6 | 6 |
| 10 | 6 | 6 | 0 |
| 11 | 5 | 5 | -4.5 |
| 12 | 4 | 4 | -4 |
| 13 | 5 | 4 | -4.5 |
| 14 | 4 | 3 | -3 |
| 15 | 4 | 3 | -3 |
| 16 | 5 | 3 | -3.5 |
| 17 | 4 | 2 | -2 |
| 18 | 4 | 2 | -2 |
| 19 | 4 | 2 | -2 |
| 20 | 4 | 2 | -2 |
| 21 | 4 | 2 | -2 |
| 22 | 0 | 2 | 2 |
| 23 | 0 | 2 | 2 |
| 24 | 0 | 2 | 2 |
| 25 | 0 | 2 | 2 |
| 26 | 0 | 2 | 2 |
| 27 | 1 | 2 | 2.5 |
| 28 | 2 | 3 | 0 |
| 29 | 2 | 4 | 0 |
| 30 | 3 | 5 | -4.5 |
| 31 | 3 | 6 | -6.5 |
| 32 | 4 | 7 | -7 |
| 33 | 4 | 7 | -7 |
| Jumlah Luas | | | 16.5 |

Figure 13: Area of Object in Pattern 3

Then the total area of all patterns is 99.5 + 12 + 16.5 = 128

## 2.5 Knn Method

The KNN Classification stage is a pattern recognition stage by comparing the vector of test data and vector of available training data using KNN. The KNN Classification Stage is shown in Figure 14 below:


Figure 14: KNN Method

In manual calculations, the data that has been obtained previously will be calculated using the K-NN method to determine the quality of the data that is owned is good enough to be able to become training data as a basis for making the program. In the K-NN method to determine the class seen from the data that has the closest distance from the calculation test method data. To carry out the data visualization process in this study, 132 datasets were used, which consisted of 126 training data (63 original data and 63 rotation data) and 6 test data—the following classification in Table 3.

Table 3: Classification

| Letter | Reading |
|---|---|
| ق | Qaf 1 |
| ڤ | Qaf 2 |
| ب | Ba' |
| ج | Jim |
| د | Dal 1 |
| ڎ | Dal 2 |

The next step is to classify the data *testing* by calculating the square of the *euclid* distance (*euclidean distance*) of each object against the *training* data provided. The Test Data Image is as follows.

Table 4: Test Data and Training Data

| | |
|---|---|
| ڤ | *Qaf* 1 reading = Test Data |
| ب | *Ba* Reading ' = Training Data 1 |
| ڤ | Reading *Qaf* 2 = Training Data 2 |
| ج | *Jim* Reading = Practice Data 3 |

Here's an example of the calculation:

Data = [ *grayscale*, area]

1. Test Data = [ 0.32794, 128]
2. Training Data 1 = [0.330697, 66]
3. Training Data 2 = [0.32956, 118]
4. Training Data 3 = [0.330695, 54.5]

Using formulas (3)

$$d_{ij} = \sqrt{\sum_{k=1}^{n}(X_{test} - X_{training})^2} \quad (1)$$

Training Data 1

$d_{ab} = \sqrt{(0.32794 - 0.330697)^2 + (128 - 66)^2}$

$= \sqrt{3844.000008} = 62.00000006$

Training Data 2

$d_{ab} = \sqrt{(0.32794 - 0.32956)^2 + (128 - 118)^2}$

$= \sqrt{100.0000026} = 10.00000013$

Training Data 3

$d_{ab} = \sqrt{(0.32794 - 0.330695)^2 + (128 - 54.5)^2}$

$= \sqrt{5402.250008} = 73.50000005$

The Table 5 is the detected image value

Table 5. Detected Image Value

| Training Data | Test Result Value |
|---|---|
| Training Data 1 | 62.00000006 |
| Training Data 2 | 10.00000013 |
| Training Data 3 | 73.50000005 |

Calculation results from 3 training data on 1 test data using *Grayscale* results , Image Area and *Euclidean Distance* based on *Chain Code* , test results obtained from the comparison of the closest distance between test data and training data, can be seen the smallest value of the test result value is 10.00000013 owned by Training Data 2 (reading *Qaf* 2) , which is the closest value to the test data, it can be concluded that Training Data 2 (reading *Qaf* 2) is included in the Test Data group (Read *Qaf* 1), where the two data have in common namely entering into the classification letter Qaf 1 .

# 3 RESULT AND ANALYSIS

In this study the Al-Quran image used was Al-Quran Cordoba in Surah Al-Baqarah. In this image the *Pre-processing* process is carried out by image *cropping*, *noise* elimination and uniform image size 50x25 pixels. Next is the process of changing colored cira to *Grayscale*, then *Binary, Imcomplement* and *Thinning* . The data used are 132 datasets which are divided into 6 test data and 126 training data (63 original data

and 63 rotation data). The *Chain Code* method is used as a method of recognition of image patterns based on the direction of the wind and the KNN method is used as an image classification method based on the difference in *euclidean* image distance. The KNN method will search for the closest distance from the training data to the test data so that the best K is obtained with the highest accuracy in each class.


Figure 15: Display Pattern Detection using *Chain Code*

In Figure 15, it can be seen how the system processes images by detecting patterns using the *Chain Code.* In this method, the image must be detected separately in order to obtain accurate results. This process starts from image changes to *grayscale,*changes to *Grayscale* to *Binary,* changes to binary to *Imcomplement (* negative from binary) and *Thinning* (image reduction). After the image is processed, the *Chain Code* value is searched to get the Area value of the image.


Figure 16: Display of Image Classification Results

In figure 16, we can see the image classification process in class 2 using the KNN method. This method looks for image similarity by calculating the closest distance between test data and training data based on the *grayscale* value and the width of the image so that the best K value is obtained. In this study, 6 Test data were used and 126 training data (63 original data and 63 rotation data). Then obtained must be the following accuracy:

Table 6: Test Results Image Classification Validation

| | | Prediction | | | | | | Σ |
|---|---|---|---|---|---|---|---|---|
| | | Class 1 | Class 2 | Class 3 | Class 4 | Class 5 | Class 6 | Actual |
| Actual | Class 1 | 2 | 0 | 0 | 0 | 0 | 1 | 3 |
| | Class 2 | 2 | 5 | 0 | 0 | 0 | 0 | 7 |
| | Class 3 | 0 | 0 | 3 | 0 | 0 | 0 | 3 |
| | Class 4 | 0 | 0 | 1 | 5 | 6 | 3 | 15 |
| | Class 5 | 0 | 0 | 2 | 2 | 1 | 2 | 7 |
| | Class 6 | 0 | 0 | 1 | 2 | 1 | 3 | 7 |
| ∑ Prediction | | 4 | 5 | 7 | 9 | 8 | 9 | 42 |

Table 7. Summary of Confusion Matrix Image Classification

| | | Prediction | | Σ |
|---|---|---|---|---|
| | | True | False | |
| Actual | True | 19 | 23 | 42 |
| | False | 0 | 0 | 0 |
| | Σ | 19 | 23 | 42 |

Accuracy level for image classification test results:

$$Akurasi = \frac{Tp}{N} = \frac{19}{42} * 100\% = 45.23\%$$

$$Presisi = \frac{Tp}{Tp+Fp} = \frac{19}{19+0} * 100\% = 100\%$$

$$Recall = \frac{Tp}{Tp+FN} = \frac{19}{19+23} * 100\% = 45.23\%$$

$$Fault = \frac{FN+FP}{N} = \frac{23+0}{42} * 100\% = 54.77\%$$

# 4 CONCLUSIONS

Based on the results of the analysis of this study, it can be concluded that the *Chain Code* Method can be used to detect patterns in images and KNN can be used in image classification by calculating the *Euclidean* distance that has been sorted. In this study, the best accuracy results in class 3 were obtained with 100% accuracy. This study uses an image processing methodology with several stages consisting of the stage of image acquisition, *Pre-processing* stage, *Grayscale* stage, *Chain*- Method and Classification of KNN. There is also a design stage consisting of general design including the structure of the navigation and system flowchart and detailed design consisting of the design of the veranda, the design of pattern detection and the design of image classification. The implementation of this system uses the Matlab R2011a application and calculations in *Microsoft Excel*. This system has carried out trials with several stages, namely structural testing, functional testing and validation trials. All these trials are done so that users can use them as best as possible

according to their needs. In the validation calculation, obtained results of accuracy in image classification obtained an accuracy of 45.23%. This accuracy value is quite low because the *Chain Code* Method cannot detect images with separate objects so that this method cannot work optimally.

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## APPENDIX

**Nomenclatures**

| | |
|---|---|
| N | Amount of value |
| Tp | True Positive |
| Fp | False Positive |
| Fn | False Negative |
| $d_{ij}$ | Euclidean Distance |
| $x_{test}$ | Test Data |
| $x_{train}$ | Training Data |

**Greek Symbols**

| | |
|---|---|
| $\sum_{k=1}^{n}$ | Data Summary from k=1 until n |

**Abbreviations**

| | |
|---|---|
| KNN | K- Nearest Neighbor |
| JESTEC | Journal of Engineering Science and Technology |