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ISSN (Print) : 2319-8613
ISSN (Online) : 0975-4024 Dolly Indra et al. / International Journal of Engineering and Technology (IJET)

# Feature Extraction of Bisindo Alphabets Using Chain Code Contour

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***Abstract*—This paper proposes a new method of features extraction of BISINDO (Indonesian Sign Language) alphabet forms. The extracted features play a very important role in the process of hand pattern recognition which expresses BISINDO alphabets and recognize letters when communicating. The proposed method consisted of 5 processes; segmentation, morphology closing, edge detection, contour following, and chain codes formation. 26 hand patterns representing the 26 BISINDO alphabets from A to Z are used during the experiments. The extracted features of each hand pattern (each BISINDO alphabet) are presented in terms of the probability value of occurrence of each chain code direction. The analysis result shows that every hand pattern expressing BISINDO letters has different features. This indicates that the extracted feature by the proposed method is very accurate to be used for BISINDO alphabets recognizing based on the hand pattern feature when communicating.**

**Keyword-** Bisindo, Morphology Closing, Edge detection, Contour following, Chain Code

## I. INTRODUCTION

In Indonesia, the deaf and dumb communicate using sign language. There are two types of sign language; Indonesian Sign Language (BISINDO) and Indonesian Sign Language System (SIBI). BISINDO was developed by deaf people themselves through Gerkatin (Indonesian Deaf Welfare Movement) whilst SIBI was developed by normal people instead of the deaf. SIBI is similar to the sign language used in America called ASL (American Sign Language) [1].

BISINDO alphabets are formed from handshapes [2]. Representing the alphabets A-Z in BISINDO, it can be performed with one hand or two hands. BISINDO alphabets using one hand are C, E, I, J, L, O, R, U, V and Z while alphabets using two hands are A, B, D, F, G, H, K, M, N, P, Q, S, T, W, X, and Y. So in the BISINDO alphabets, representing alphabets A-Z are not uniform or heterogeneous.

It is necessary to do edge detection process to be able to translate the handshape in the BISINDO alphabets. The edge representation of an image significantly reduces the amount of data in the image that will be processed but does not change the real information of the image [3], [4]. At the end, the feature extraction process is performed.

Feature extraction is an important process in constructing each pattern classification which aims to get relevant information of each class characteristic [5]. An appropriate feature contains different information which is able to distinguish one object from the other.

A number of studies about pattern identification techniques or handshape which represents a particular letters or words have been described [6], [7], [8].

Shape features of an object describe characteristics of that object which are used to analyze an image in recognizing the shape of BISINDO alphabets. It is still difficult to translate the image of the handshape that has a heterogeneous form or multiform. Thus, it is important to find out a method which is effective and able to produce accurate shape features for all BISINDO alphabets (A-Z). This became the philosophical foundation of the method proposed in our study.

## II. METHOD

In this section, the suggested method of shape features extraction of BISINDO alphabets is presented. In the method, there are 5 processes i.e.:

1. Segmentation.
2. Morphology closing.
3. Edge detection.
4. Contour following.
5. Formation of chain code.

The process for the proposed system is shown in Fig.1. Each process will be explained in the next section.

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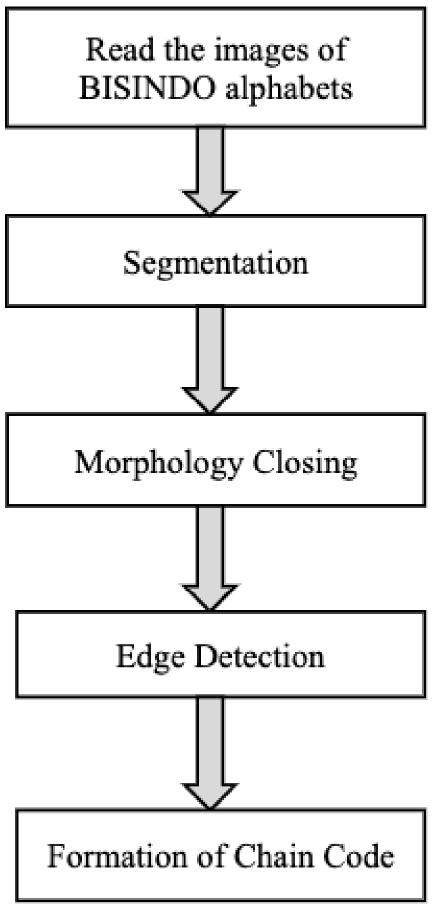



Fig. 1. Schema of the proposed system for the shape feature extraction of BISINDO alphabets

### A. *Images of Bisindo Alphabets*

BISINDO alphabet images used are in RGB format (Red, Green, Blue). Handshape of the images representing BISINDO alphabets has different color to the background. The background used in this study is white. Fig. 2 shows 4 handshapes i.e.: A, B, C, D respectively. A, B, and D use two hands while C uses one hand. Based on Fig. 2, it can be seen that the hand color is used as the parameter to differentiate between the hand and background.

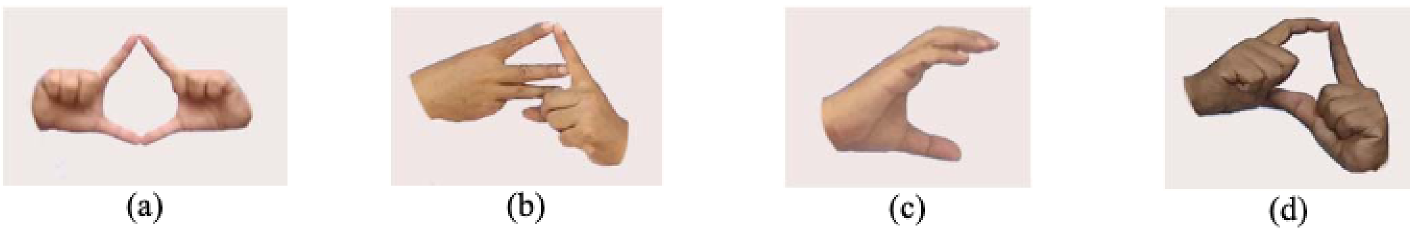



Fig. 2. Images of BISINDO alphabets (a) alphabet A, (b) alphabet B, (c) alphabet C, (d) alphabet D

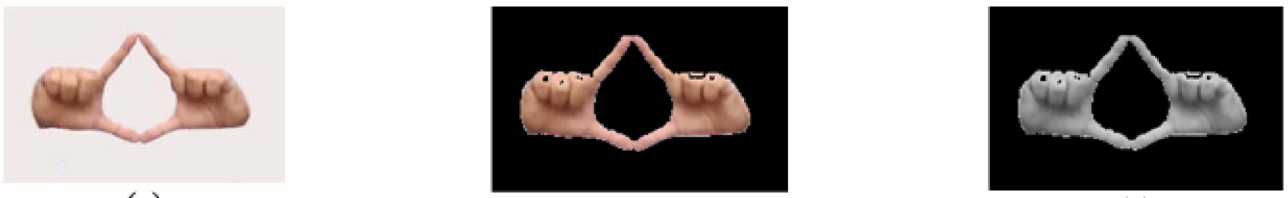
### B. *Segmentation*

Image segmentation process aims to extract objects of interest (OoI) from others which makes it easier to conduct the following analysis [9], [10], [11]. In the process of image segmentation, the most commonly used technique is the threshold value which is used to select the optimal threshold value to separate the desired object area from its background in the image based on gray-level. Thresholding has a very important role in the process of forming a binary image [12]. The segmentation process uses color distance measurement algorithm and threshold values to determine the similarity of skin tone with the colors of each pixel in the image. Referring to the images used is RGB color images, the formula distance used is city block distance or Manhattan distance which can be seen in the equation (1).

$$\Delta E = |R_s - R_p| + |G_s - G_p| + |B_s - B_p| \quad (1)$$

Where Rs, Gs, Bs, are red, green, blue color component of skin color whereas Rp, Gp, Bp, are red, green, blue color component of each pixel P color in the image. If the value of$\Delta E > Th$, then the pixel P is the part of the object area of interest.

In Fig. 3.(b)shows the result of the desired object segmentation that represents the shape of the Alphabet A (Fig. 3.(a)). Fig. 3.(c) is a gray-level image from an image of Fig. 3.(b). The result of segmentation using city block distance is not perfect yet due to some black holes in the fingers. This indicates that it needs another further action to cover the holes.



(a) (b) (c)

Fig. 3. (a) Original image, (b) Segmentation result, (c) Grayscale image from figure 3(b)

### C. Mathematical Morphology

Mathematical morphology is one part of digital image processing used to analyze image [13]. Mathematical morphology uses techniques for digital image processing based on the shape of the object [14]. The mathematical morphology is commonly used the image processing both the binary image and gray-level image. The basic operation of mathematical morphology is dilation and erosion. Dilation is a morphological process to expand the area or size of an object. Dilation image of f by the structure of element B is shown in Equation 2. Erosion is a morphological process to erode or reduce the width of the surface size of an area or object. The erosion image of f by the element structure of matrix B shown in the equation 3.

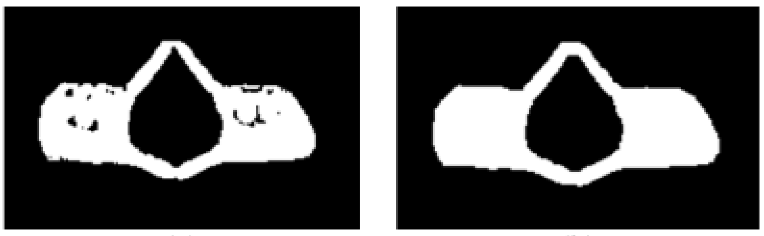
$$f \oplus B = \{s|(B)_s \cap f \neq 0\} \tag{2}$$

$$f \ominus B = \{s|(B)_s \subseteq f\} \tag{3}$$

From these operations, then two other processes were developed, closing and opening. Closing and opening are used as morphological filtering in digital image processing [15]. Closing was the combination of the dilation process and erosion process conducted successively. The dilation result was as the input for the erosion operation as shown in the equation 4. Closing functioned to cover the holes throughout dilation operation and to prevent the change of the object size through erosion operation.

$$f \cdot B = (f \oplus B) \ominus B \tag{4}$$

Fig. 4.(b) shows the binary image which was resulted from the closing process from Fig. 4.(a). It is clear that all holes have been covered without any extension of the object area.



(a) (b)

Fig. 4. (a) Binary image, (b) Binary image was resulted from the closing process

### D. Edge Detection

Edge detection is an image processing technique used to identify and discover sharp discontinuities or to identify object boundaries in an image [16], [17]. The boundaries can be seen due to the intensity differences or the different color between one pixel with the closest neighbor pixels.

In this study, we use the Roberts operator as edge detection. The operator consists of a pair of 2x2 convolution mask is shown in Fig. 5. The results of the edge detection process of the image in the Fig. 4.(b) with use Roberts operator are shown in Fig. 6. Fig. 7 shows the result of edge detection process of alphabet B, C, and D.

| | |
|---|---|
| -1 | 0 |
| 0 | 1 |

$G_x$

| | |
|---|---|
| 0 | -1 |
| 1 | 0 |

$G_y$

Fig. 5. Roberts mask

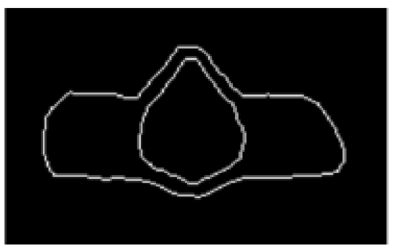


Fig. 6. Image of the edge detection processing for alphabet A

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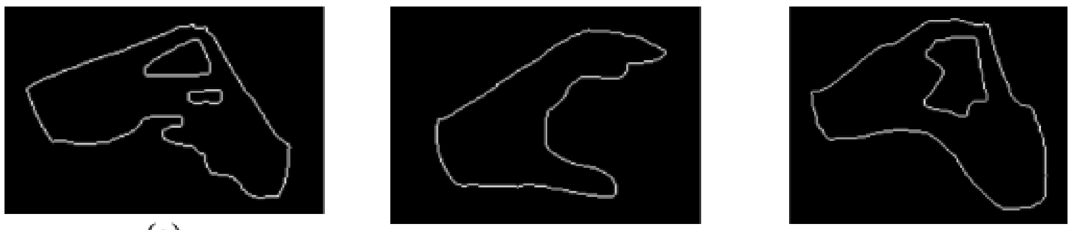

(a) (b) (c)

Fig. 7. Image of the edge detection result of BISINDO alphabet of B, C, D

*E. Contour Following*

Contour is a segment that has a width of one pixel and has a length of one or more pixels while the boundary is an interconnected or uninterrupted contour [18]. Identification of contour or contour extraction is a very important part to analyze the contents of an image.

Contour following is a method to find out the start point of the object edge and then follow it forward to the end of the edge. The following forward technique to determine the movement direction of the contour conducted by using eight neighbor pixels. In our case, the entire contour objects were represented by white pixels where the thickness of the contour was one pixel. The process of the contour following as below:

1. Check each pixel in each row for each column. Either it was the part of the contour or not. If the start point of the contour was found then the second stage was taken, however if it was not found then the fourth stage was taken.
2. Do the following forward trace by using eight neighbor pixels to determine the next contour pixel. Do it continuously to the last pixel from this contour.
3. Return to the first stage to find out the other contour.
4. The following is completed.

*F. Chain Code*

Chain code is used to represent the shape of the contour of the object by using the direction code of the contour movement. The chain code gives the boundary of the characteristics of an image which representing the direction in which pixel is located and has a connection to the starting point [19]. The method for finding contours is also called the Freeman chain code [20]. In this study, we used the eight-direction chain code.

As mentioned above that the contour movement is searched by the approximate direction of the eight neighboring pixels as shown in Fig. 8. The center point is the contour pixel which is tracked by the coordinates (x = 0, y = 0), the next pixel shows the direction of the contour motion encoded with 0 -7 as shown in Table I.

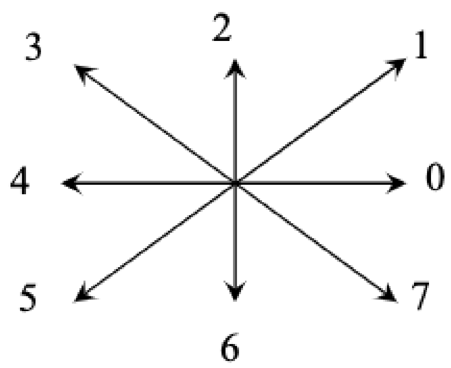


Fig. 8. Eight-direction chain code

TABLE I Direction of contour movement with chain code

| dx | dy | Chain Code |
|---|---|---|
| +1 | 0 | 0 |
| +1 | -1 | 1 |
| 0 | -1 | 2 |
| -1 | -1 | 3 |
| -1 | 0 | 4 |
| -1 | +1 | 5 |
| 0 | +1 | 6 |
| +1 | +1 | 7 |

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In this study, we modify the chain code because BISINDO alphabets have different contours i.e. if there is more than one contour then each contour will be added number 9 as a boundary between the contour one and the other contour.

The chain code contours of the BISINDO alphabets A, B, C, and D in Fig. 6 and 7 are shown in Fig. 9 to 12. Alphabets A and D have two contours so there is only one '9' as the boundary, the alphabet B has three contours so there are two '9' as boundaries, while the alphabet C has only one contour no boundary.

```
0000000000707777676777677077677677077700000000000000170
00000000000000007070707067776776776776676767667666666
6556564454444454444444444444454444444444444444444444
44544544545454545454545445443444444444344343434343443444
344444444344444454444344444434444444444444444442332322
322322222222222212222221121201111111017000000000000000
000000007007000000012111112111111111211211112190000077
67767767777677677777076766766676776676666656665666545
555454545454544545544444334343444334344434333333322232
222222122222122121221111111121121111121121121
```

Fig. 9. Chain code of BISINDO for alphabet A

```
0067000001766707776767676776767676776767677767676776777
777676776777667767767767777077706756666666666665666665
666565656564444444445444434434342343223334234434444443
44432332232222344333334444434444344343423222101010000
001222234444444444444444444544455655555455445445454455
44444445444444444444444344434444444453323323233232323232
322322323223222101101010101001001010100100100101010010
01001001001000100100101010010100101001001010010101010
1000000190000767676767667676666665444445444444444444
44444444444444444443222210111101011010101011010010101
9000000000766666554444434445444443432222100000000
```

Fig. 10. Chain code of BISINDO for alphabet B

```
700000000000070000007070000007007070770700770707665554
544544444454444444444566665655545444444444444344444444444
5555455565665655555555545566656666666666666666667677770
770707070700700007000700070707077077676766666655444444
444344444443444444344443444344444443443444444444344444445445
344444444444444444444444434444445444344333233232323232
232232222232222222222221222000101010111010110110101101
011101101120110110110111011010101101011111110111010101
01110010011000
```

Fig. 11. Chain code of BISINDO foralphabet C

```
000007000707000700000017006676666766766676667667676667667
6676676767676676666767767077700070077766766667767666677667
666667666666666666666666667566666666666666565554455454444
444544444444444443343433333333333333332333323323232342232
34333333333333433433444434444444443444444444454444444544445
4445445444445444444444444444454443333232342323222223223223
222222223210000010100110111011111011101111111101111011101
1010010000010101101110111010111011010000000000000000190000
00000000000077666676666666676666666766766666667666676676666
544444444555566566654444434343443444443444434434322221111
12112112112121222323343334334322221011211210000001000
```

Fig. 12. Chain code of BISINDO for alphabet D

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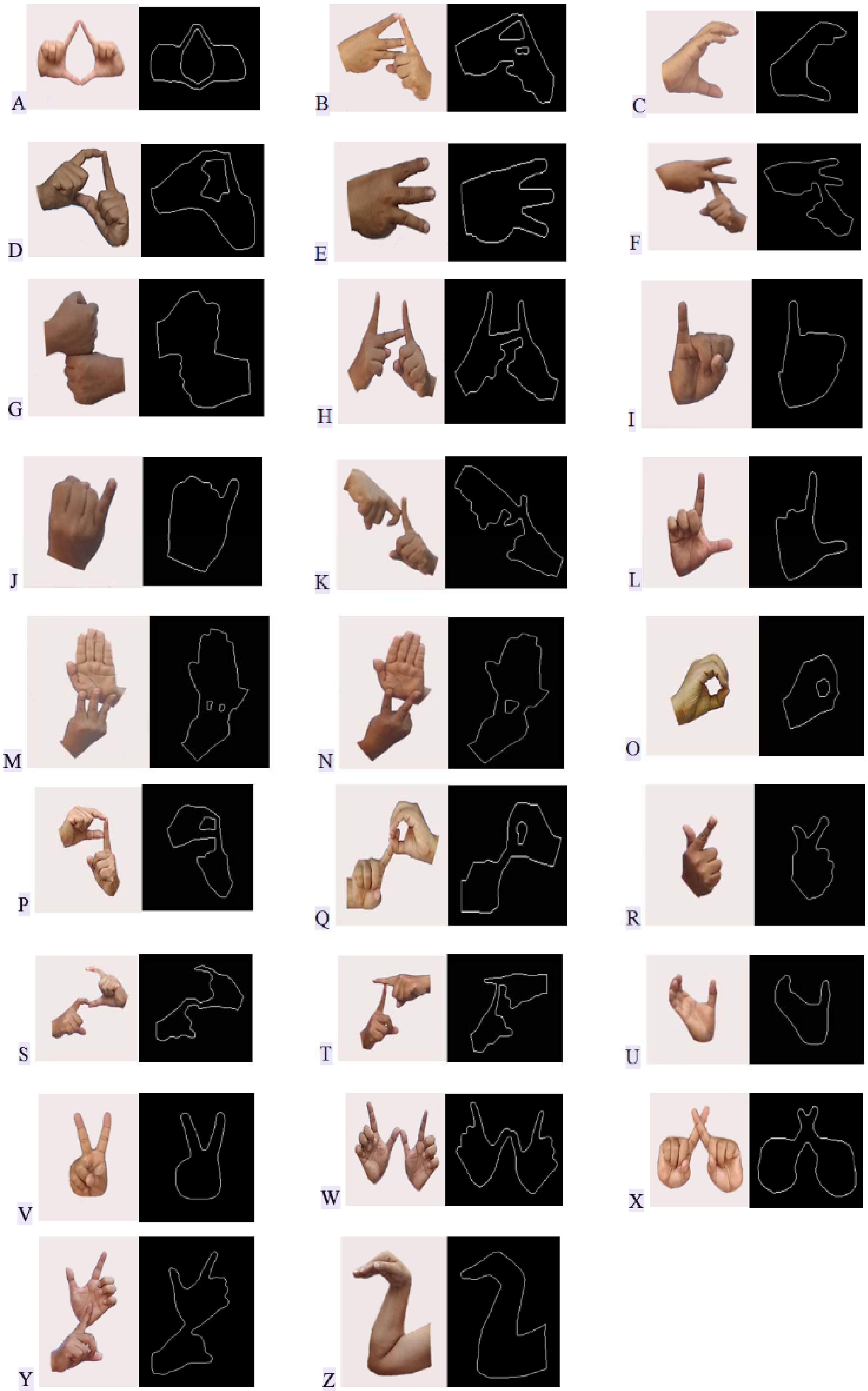


Fig. 13. The extraction result and edge detection of BISINDO alphabets (A- Z)

## III. RESULTS AND ANALYSIS

The suggested method and algorithm resulted a clear edge in one-pixel width. This eases to extract the chain code contour of the handshape that represents BISINDO alphabets. Fig. 13 shows the edge result of the BISINDO alphabets from A to Z. The BISINDO alphabets can be classified according to the number of contours; C, E, F, G, H, I, J, K, L, R, S, T, U, V, W, X, Y, and Z have one closed contour, A, D, N, O, P, and Q have two closed contours, whereas B and M have three closed contours. The contours shaping each alphabet have different chain codes. Therefore, the feature number of the contour of each alphabet and the chain code in each contour can be used as the feature in the process of recognizing the BISINDO alphabets.

The problems in the object size or hand image size were sometimes smaller or bigger during the image acquisition. The size change caused the different length of the chain code even though the shape of the alphabets were still similar. Therefore, in this study, the probability feature of each code in each contour is used to make the chain code independent from the object size change. The probability of each chain code and the contour number (Table II) as a feature in each alphabet is saved in the database which would be used in the process of recognizing BISINDO alphabets.

TABLE II Probability each chain code

| Images | Object Features | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| A.png | 1 | 0.2176 | 0.0937 | 0.0854 | 0.0468 | 0.3306 | 0.0468 | 0.0661 | 0.1129 |
| | 2 | 0.0382 | 0.1465 | 0.1592 | 0.0955 | 0.1529 | 0.0955 | 0.1592 | 0.1529 |
| B.png | 1 | 0.1829 | 0.1019 | 0.0833 | 0.1042 | 0.2384 | 0.0579 | 0.1157 | 0.1157 |
| | 2 | 0.1649 | 0.1753 | 0.0412 | 0.0103 | 0.3814 | 0.0206 | 0.134 | 0.0722 |
| | 3 | 0.3542 | 0.0208 | 0.0833 | 0.0625 | 0.2917 | 0.0625 | 0,1064 | 0.0208 |
| C.png | 1 | 0.2063 | 0.1300 | 0.0673 | 0.0561 | 0.2848 | 0.0807 | 0.0919 | 0.0830 |
| D.png | 1 | 0.1596 | 0.1197 | 0.0665 | 0.1353 | 0,1973 | 0.0355 | 0.1973 | 0,0887 |
| | 2 | 0.1520 | 0.117 | 0.1111 | 0.0994 | 0.1973 | 0.0409 | 0.2398 | 0.0887 |
| E.png | 1 | 0.3354 | 0.0475 | 0.0823 | 0.0506 | 0.3006 | 0.0791 | 0.0601 | 0.0443 |
| F.png | 1 | 0.3038 | 0.0615 | 0.0538 | 0.0885 | 0.2846 | 0.0692 | 0.0654 | 0.0731 |
| G.png | 1 | 0.1640 | 0.0760 | 0.1880 | 0.0560 | 0.1920 | 0.0640 | 0.1920 | 0.0680 |
| H.png | 1 | 0.1153 | 0.1216 | 0.1611 | 0.0869 | 0.1438 | 0.0932 | 0.1927 | 0.0853 |
| I.png | 1 | 0.1692 | 0.0498 | 0.2687 | 0.0398 | 0.1095 | 0.1294 | 0.1791 | 0.0547 |
| J.png | 1 | 0.1383 | 0.1011 | 0.2181 | 0.0532 | 0.1117 | 0.1436 | 0.1702 | 0.0638 |
| K.png | 1 | 0.0827 | 0.0746 | 0.1783 | 0.1329 | 0.1442 | 0.0648 | 0.1394 | 0.1831 |
| L.png | 1 | 0.1801 | 0.0616 | 0.2180 | 0.0521 | 0.1517 | 0.1043 | 0.1706 | 0.0616 |
| M.png | 1 | 0.0922 | 0.0700 | 0,3003 | 0.0768 | 0.0137 | 0.1314 | 0.2560 | 0.0597 |
| | 2 | 0.1364 | 0,0227 | 0.3409 | 0.0227 | 0.0909 | 0.0682 | 0.2955 | 0.0227 |
| | 3 | 0.1471 | 0.0294 | 0.2941 | 0.0294 | 0.1176 | 0.0882 | 0.2647 | 0.0294 |
| N.png | 1 | 0.0860 | 0.1017 | 0.2708 | 0.0688 | 0.0315 | 0.1375 | 0.2536 | 0.0501 |
| | 2 | 0.1707 | 0.0122 | 0.3171 | 0.0244 | 0.1098 | 0.1463 | 0.1341 | 0.0854 |
| O.png | 1 | 0.1399 | 0.1678 | 0.1119 | 0.0490 | 0.2028 | 0.1329 | 0.1189 | 0.0769 |
| | 2 | 0.2424 | 0.0303 | 0.1515 | 0.0909 | 0.1818 | 0.0909 | 0.1515 | 0.0606 |
| P.png | 1 | 0.1210 | 0.0854 | 0.1815 | 0.1068 | 0.1317 | 0.0534 | 0.2349 | 0.0854 |
| | 2 | 0.1667 | 0.0714 | 0.1667 | 0.0238 | 0.2857 | 0.0238 | 0.1905 | 0.0714 |
| Q.png | 1 | 0.1973 | 0.1020 | 0.1474 | 0.0249 | 0.2540 | 0.0952 | 0.1043 | 0.0748 |
| | 2 | 0.1228 | 0.0877 | 0.2281 | 0.0526 | 0.1228 | 0.1404 | 0.1579 | 0.0877 |
| R.png | 1 | 0.1549 | 0.0845 | 0.1761 | 0.1197 | 0.0775 | 0.1479 | 0.1408 | 0.0986 |
| S.png | 1 | 0.2054 | 0.0804 | 0.1116 | 0.0491 | 0.3080 | 0.0536 | 0.0714 | 0.1205 |
| T.png | 1 | 0.2364 | 0.1045 | 0.1182 | 0.0455 | 0.2227 | 0.1136 | 0.1227 | 0.0364 |
| U.png | 1 | 0.1788 | 0.0993 | 0.0927 | 0.1589 | 0.1126 | 0.0861 | 0.1987 | 0.0728 |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| V.png | 1 | 0.0684 | 0.0895 | 0.2421 | 0.0737 | 0.1158 | 0.0579 | 0.2684 | 0.0842 |
| W.png | 1 | 0.1049 | 0.0885 | 0.2164 | 0.1148 | 0.0557 | 0.1246 | 0.2066 | 0.0885 |
| X.png | 1 | 0.1862 | 0.0729 | 0.1579 | 0.1093 | 0.1296 | 0.0972 | 0.1741 | 0.0729 |
| Y.png | 1 | 0.0837 | 0.1255 | 0.2205 | 0.0456 | 0.1293 | 0.1255 | 0.1825 | 0.0875 |
| Z.png | 1 | 0.1271 | 0.1271 | 0.1512 | 0.0481 | 0.2165 | 0.0584 | 0.2062 | 0.0653 |

## IV. CONCLUSION

The suggested method in this study consists of the algorithm for segmentation, closing operation, edge detection, contour following and chain code contour. The method is very effective and produce the edge with a thickness of one pixel. It facilitate the chain code extraction to get the probability which would be used as feature of each BISINDO alphabets. These features were saved in the database to become the feature references in the recognizing process of BISINDO alphabets.

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ISSN (Print) : 2319-8613
ISSN (Online) : 0975-4024 Dolly Indra et al. / International Journal of Engineering and Technology (IJET)

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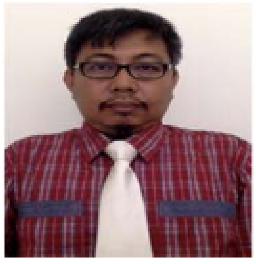

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