CMSC 465 Image Project

Part b:

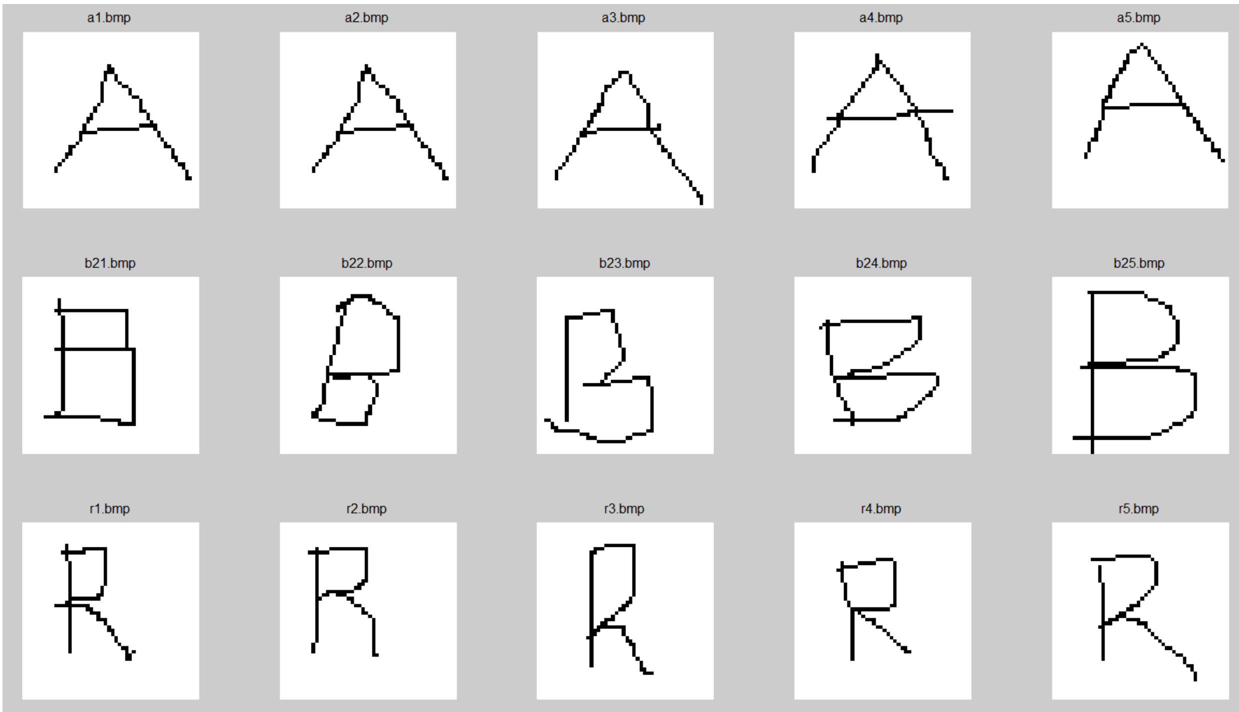

Figure 1. Plot of selected letters.

Part c:

The minimum perimeter polygon (MPP) for each image was calculated using `minperpoly()` function. As shown in Figures 2 and 4, the unbounded areas of the letters were excluded in the calculation, as expected. The unique characteristics of the letter 'B' produced the most accurate and recognizable MPPs as shown in Figure 3.

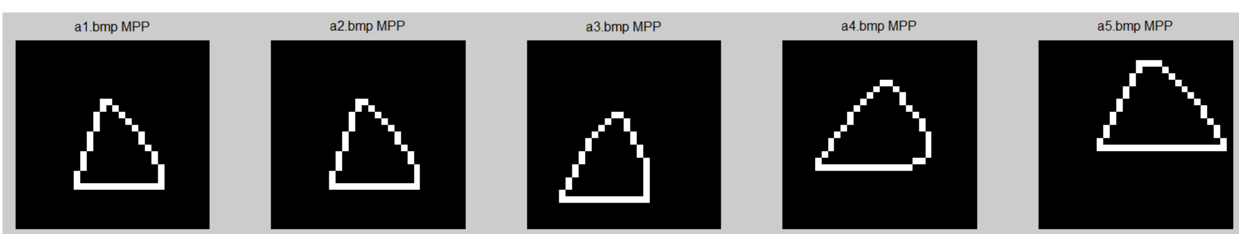

Figure 2. MPP images of selected letters belonging to class 'A'.

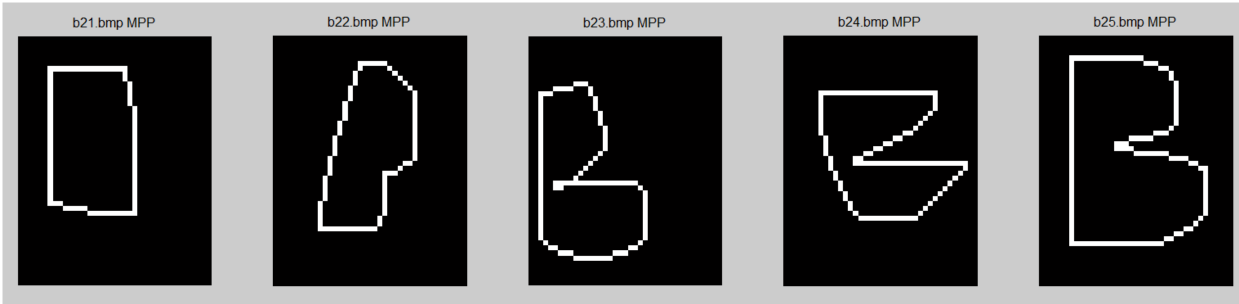

Figure 3. MPP images of selected letters belonging to class 'B'.

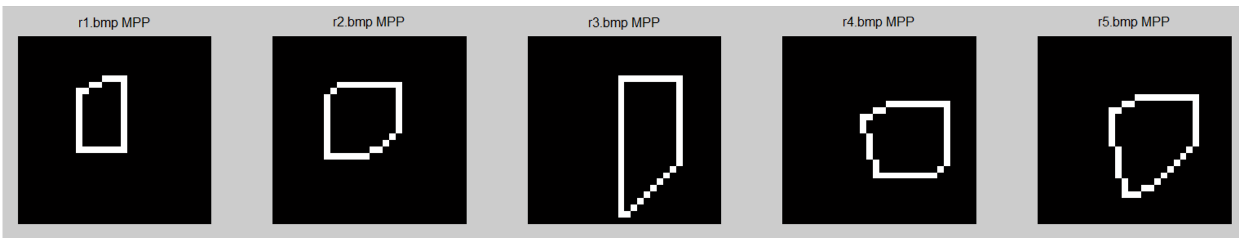

Figure 4. MPP images of selected letters belonging to class 'R'.

In studying the plots for the pattern vectors as shown in Figure 5, the variants of letters 'A' and 'R' appear to produce no easily distinguishable characteristics. The letter 'B' however, separates itself from the other letters by having longer boundary lengths. From this observation, it can be hypothesized that variants of the letter 'B' should be readily classifiable.

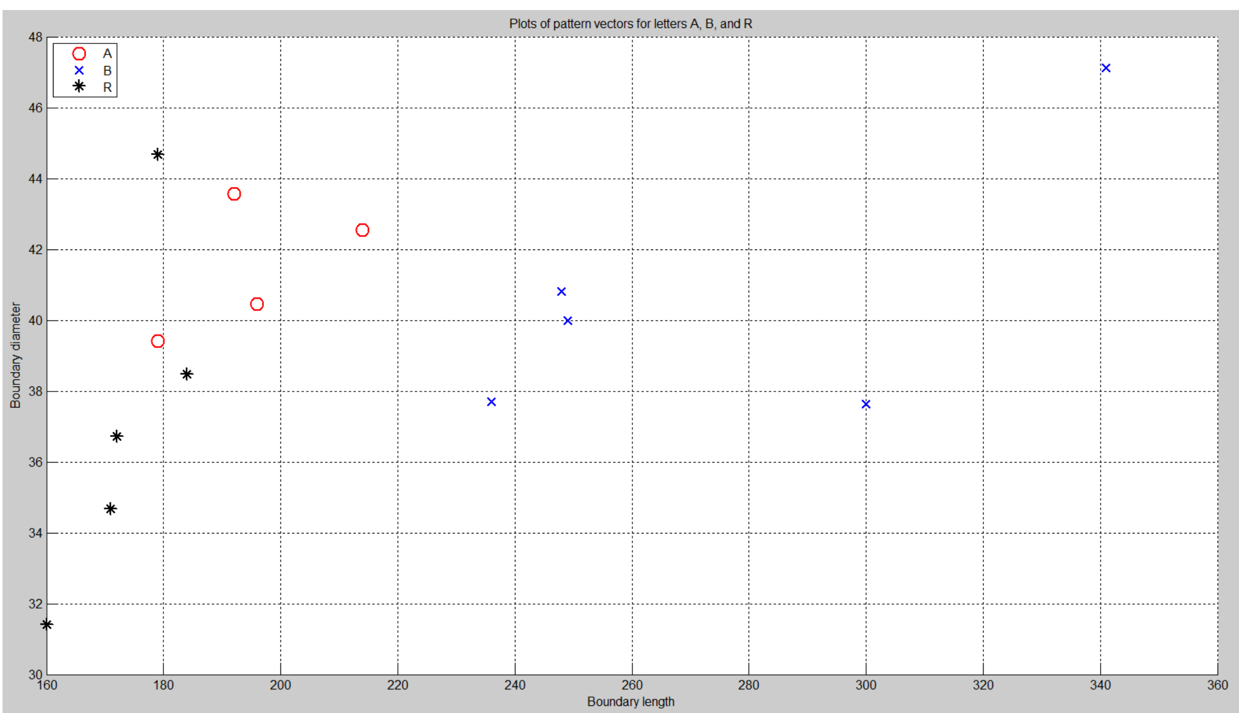

Figure 5. Plot of pattern vectors.

Figure 6 shows the pixel distances from the centroids per degree of rotation for each of the letters. Here it can be seen that some similarities exist between letters 'B' and 'R', with each having four distinct peaks in amplitude. It appears that images with long sequences of diagonally oriented pixels in groups of different sizes produce the noisiest signatures. This is clearly shown in a5 and b24. Based on this observation, it could be reasoned that the images of b22 and r4 would produce erratic signatures, however, these produced among the cleanest signatures. The longer straight line pixel segments appear to have an overall smoothing effect on the signatures.

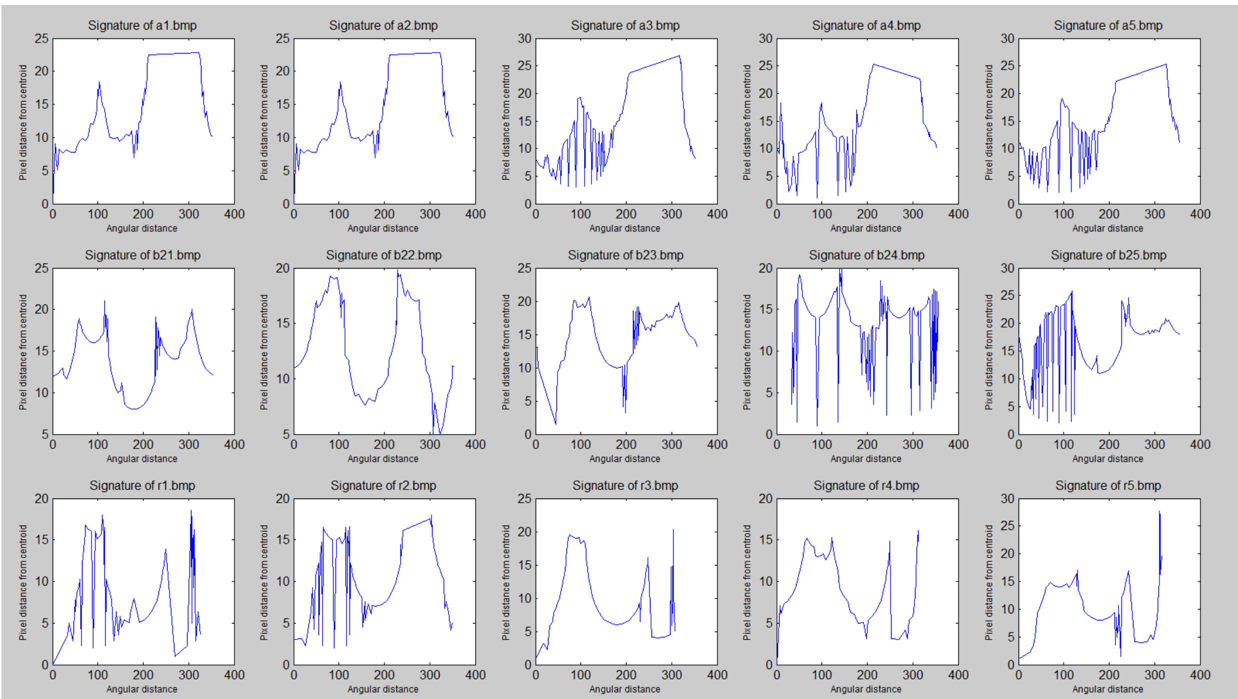

Figure 6. Plots of the signatures of the image boundaries.

Part f:

Two minimum distance classifiers were built for this project. The first uses a decision function built for each of the classes based upon the equation

$$d_j(x) = x^T m_j - \frac{1}{2} m_j^T m_j \tag{1}$$

where x represents the pattern vector of the letter to be classified and is assigned to a particular class when $d_j(x)$ produces the largest value. The results of this classifier are show in Table 1.

Table 1

Results of the first minimum distance classifier

Class	"A"	"B"	"R"
"A" (Count=5)	**3 (60%)**	0 (0%)	2 (40%)
"B" (Count=5)	0 (0%)	**5 (100%)**	0 (0%)
"R" (Count=5)	1 (20%)	0 (0%)	**4 (80%)**
Summary:	A total of 12 out of 15 images were classified correctly (80%)		

A second minimum distance classifier was built by incorporating each of the image amplitudes from the `signature()` function derived from each of the image boundaries. Unfortunately, this did not produce the desired results. As shown in Table, the correct classification of letters 'A' increased 20 percent; however, there was a significant decrease in the correct classification of letters 'B' and 'R'.

Table 2

Results of the second minimum distance classifier

Class	"A"	"B"	"R"
"A" (Count=5)	**4 (80%)**	0 (0%)	1 (20%)
"B" (Count=5)	2 (40%)	**3 (60%)**	0 (0%)
"R" (Count=5)	4 (80%)	0 (0%)	**1 (20%)**
Summary	A total of 8 out of 15 images were classified correctly (53.3%)		