# PERFORMANCE ANALYSIS OF OBJECT RECOGNITION SYSTEM USING DTMBWT AND KNN CLASSIFIER ON COLOUR IMAGES

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## ABSTRACT

Columbia Object Image Library (COIL) is a database of color images of 100 objects. The objects were placed on a motorized turntable against a black background. The turntable was rotated through 360 degrees to vary object pose with respect to a fixed color camera. Images of the objects were taken at pose intervals of 5 degrees. This corresponds to 72 poses per object. The images were size normalized.

## 1. Introduction-Performance Metric

As the object recognition system using DTMBWT and KNN classifier is considered as a pattern classification problem, the main performance metric used in this study is the classification accuracy. It is defined in eqn. 1.1 which is the ratio between the correct classification and recognition of a particular object to the total number of tested objects.

$$\text{classification accuracy}(\%) = \frac{\text{number of correctly classified objects}}{\text{total number of objets tested}} x100 \quad (1.1)$$

## 2. Simulation Results

The simulation results of object recognition system using DTMBWT and KNN classifier are discussed in this section. The performance of object recognition system using DTMBWT and KNN classifier is tested on colour of the images are considered.

**2.1 Performance on Colour Images**

To analyze the performance of the DTMBWT and KNN based object recognition system, two colour space models such as RGB and YCbCr are selected. Table 2.1 and 2.2 show the performance of object recognition system using DTMBWT and KNN classifier on RGB and YCbCr images respectively. As DTMBWT is a multi-resolution analysis, the performance is analyzed at various decomposition levels.

**Table 2.1 Performance on RGB colour images**

| Level of decomposition | Recognition accuracy (%) | | | | | |
|---|---|---|---|---|---|---|
| | $10^0$ | $20^0$ | $30^0$ | $40^0$ | $50^0$ | $60^0$ |
| 1 | 94.82 | 90.56 | 86.65 | 80.74 | 75.16 | 68.22 |
| 2 | 96.99 | 93.4 | 89.85 | 83.76 | 78.04 | 71.59 |
| 3 | 98.57 | 95.27 | 91.85 | 86.68 | 82.65 | 75 |
| 4 | 99.08 | 97.47 | 94.35 | 89.88 | 83.71 | 75.81 |
| 5 | 99.8 | 98.72 | 97.05 | 93.52 | 90.13 | 83.17 |

**Table 2.2 Performance on YCbCr colour images**

| Level of decomposition | Recognition accuracy (%) | | | | | |
|---|---|---|---|---|---|---|
| | $10^0$ | $20^0$ | $30^0$ | $40^0$ | $50^0$ | $60^0$ |
| 1 | 97.02 | 94.1 | 90.65 | 85.71 | 80.27 | 73.63 |
| 2 | 98.21 | 95.32 | 91.78 | 86.32 | 81.04 | 73.76 |
| 3 | 98.99 | 96.29 | 92.62 | 87.63 | 82.98 | 76.04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | 99.15 | 97.57 | 94.72 | 90.09 | 84.21 | 76.09 |
| 5 | 99.85 | 98.95 | 97.48 | 94.16 | 90.72 | 83.54 |

Table 2.3 shows the individual objects recognition accuracy by using YCbCr colour space at 5$^{th}$ level.

**Table 2.3 Individual object recognition accuracy at 5$^{th}$ DTMBWT level of YCbCr image**

| Obj. | Accuracy (%) | Obj. | Accuracy (%) | Obj. | Accuracy (%) | Obj. | Accuracy (%) |
|---|---|---|---|---|---|---|---|
| 1 | 100 | 26 | 100 | 51 | 100 | 76 | 100 |
| 2 | 100 | 27 | 100 | 52 | 100 | 77 | 100 |
| 3 | 100 | 28 | 100 | 53 | 100 | 78 | 100 |
| 4 | 100 | 29 | 100 | 54 | 100 | 79 | 100 |
| 5 | 100 | 30 | 100 | 55 | 100 | 80 | 100 |
| 6 | 100 | 31 | 96.94 | 56 | 100 | 81 | 100 |
| 7 | 100 | 32 | 100 | 57 | 100 | 82 | 100 |
| 8 | 100 | 33 | 100 | 58 | 100 | 83 | 100 |
| 9 | 100 | 34 | 100 | 59 | 100 | 84 | 100 |
| 10 | 100 | 35 | 100 | 60 | 100 | 85 | 100 |
| 11 | 100 | 36 | 100 | 61 | 100 | 86 | 100 |
| 12 | 100 | 37 | 100 | 62 | 100 | 87 | 100 |
| 13 | 100 | 38 | 100 | 63 | 100 | 88 | 100 |
| 14 | 100 | 39 | 100 | 64 | 100 | 89 | 100 |
| 15 | 100 | 40 | 100 | 65 | 100 | 90 | 100 |
| 16 | 100 | 41 | 100 | 66 | 100 | 91 | 100 |
| 17 | 100 | 42 | 100 | 67 | 100 | 92 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18 | 100 | 43 | 100 | 68 | 100 | 93 | 100 |
| 19 | 100 | 44 | 88 | 69 | 100 | 94 | 100 |
| 20 | 100 | 45 | 100 | 70 | 100 | 95 | 100 |
| 21 | 100 | 46 | 100 | 71 | 100 | 96 | 100 |
| 22 | 100 | 47 | 100 | 72 | 100 | 97 | 100 |
| 23 | 100 | 48 | 100 | 73 | 100 | 98 | 100 |
| 24 | 100 | 49 | 100 | 74 | 100 | 99 | 100 |
| 25 | 100 | 50 | 100 | 75 | 100 | 100 | 100 |
| **Average** | | | | | | | **98.18** |

It is observed from the Tables 2.2 and 2.3 that the overall performance of the proposed system while using the features extracted at YCbCr is higher than the features extracted at RGB colour space. The maximum recognition accuracy obtained by object recognition system using DTMBWT and KNN classifier is 99.85% and it is achieved at $10^0$ rotation and $5^{th}$ level of decomposition.

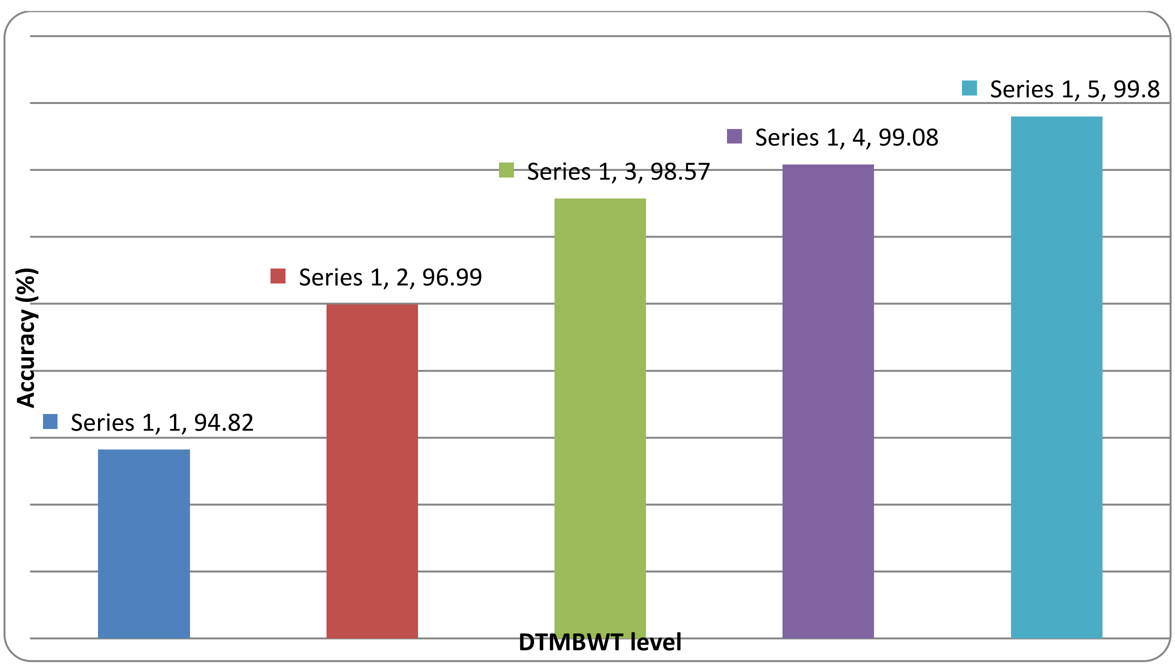


**Figure 2.1 Performance on RGB images ($10^0$ of training objects)**

Figure 2.1 to 2.4 shows the performance of object recognition system using DTMBWT and KNN classifier at different angles such as 10 degrees to 60 degrees by using RGB images.

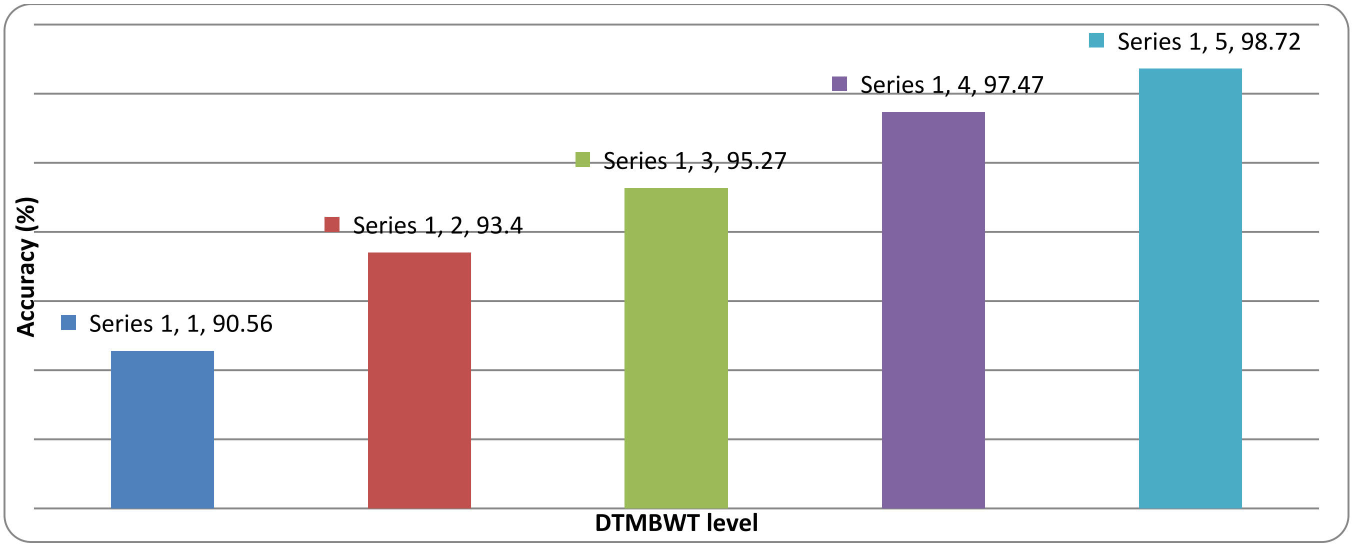


**Figure 2.2 Performance on RGB images ($20^0$ of training objects)**

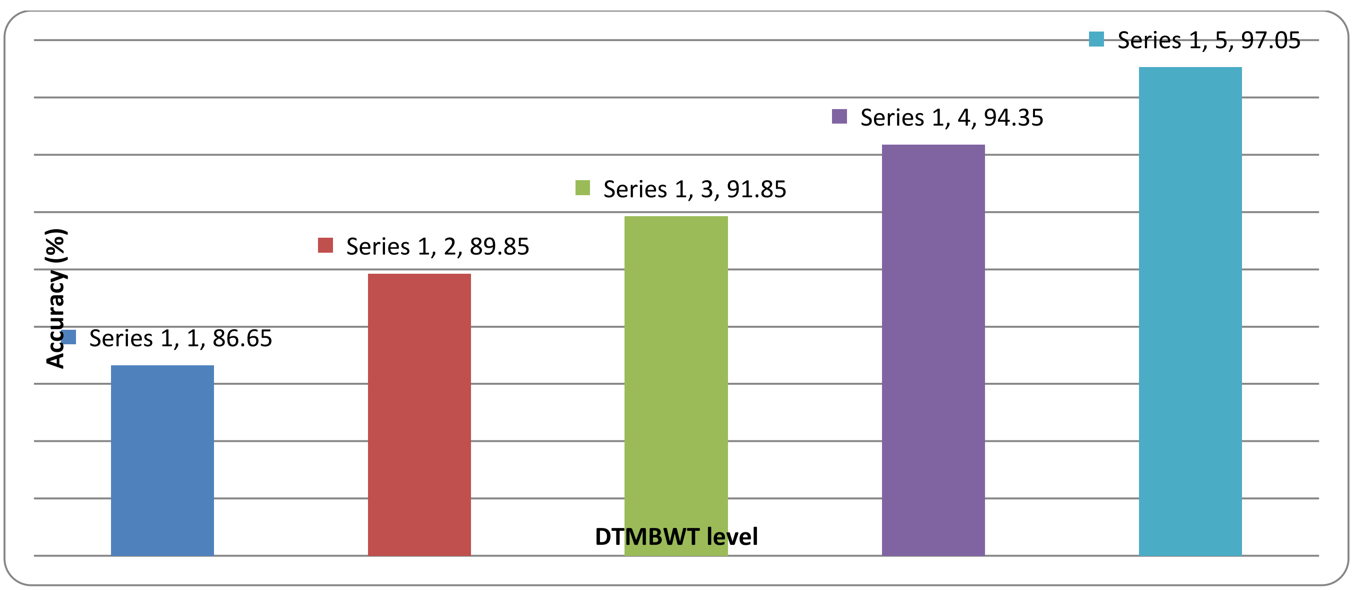


**Figure 2.3 Performance on RGB images ($30^0$ of training objects)**

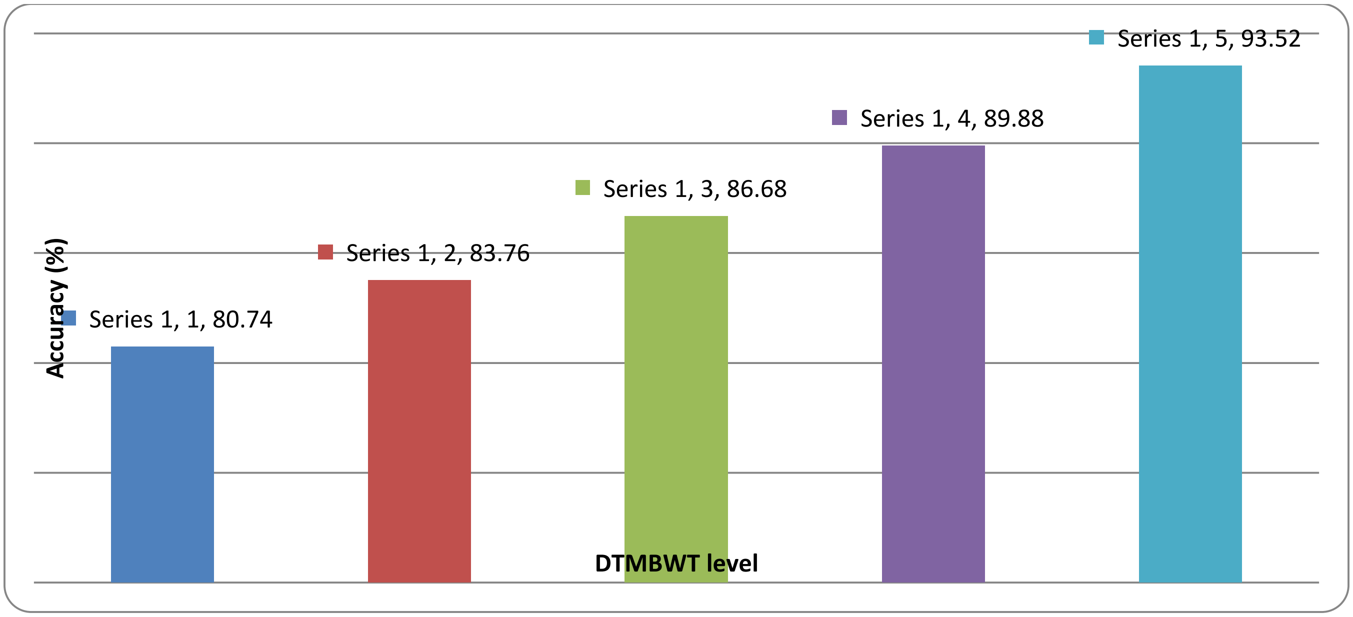


**Figure 2.4 Performance on RGB images ($40^0$ of training objects)**

## 3. Conclusion

The results of this work could be extended into many directions. Some of the possible ways are discussed below:

- In this study, the proposed object recognition system uses only DTMBWT energy features for the recognition. In addition to energy features, the other statistical features may improve the performance of the system at lower decomposition level.

- In this study, DTMBWT has been successfully applied for object recognition. In near future, investigations can be carried out using other multiresolution algorithms.

- In the recognition module, other powerful classifiers such as SVM and Adaboost can be used to increase the recognition accuracy instead of KNN classifier.

**References**

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