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## Performance Analysis of Object Shape Classification and Matching from Tactile Images using Wavelet Energy Features

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### Abstract

Tactile images while grasping objects are acquired and wavelet based features are extracted for matching and classification. The performance of matching and classification is evaluated in terms of matching rate and classification accuracy along with the computation times. This comparison will help in determining the applicability of classification or matching in future works including real time applications. Highest classification accuracy is found to be 86%, in 0.0619sec, while the best matching rate obtained is 96% in 0.0041 sec. Thus Image matching is suitable for real time applications taking less computation time while providing significant performance improvement at the same time.

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*Keywords:* Tactile image; image matching; object-shape classification; wavelet energy; k-nearest neighbour; linear discriminant analysis; Naïve Bayes; Euclidean distance.

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### 1. Introduction

Touch sensation is essential for acquiring knowledge about the surroundings of an individual. It is important to incorporate artificial touch sensation in human computer interactive devices to enhance their controllability and

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produce human-like functionality. Tactile sensing is rapidly finding its application in various areas of robotics and rehabilitation. To identify and distinguish the objects around us, artificial tactile sensing system should be able to recognize object shape, size, texture, surface etc. There have been various methods for object shape recognition based on different techniques like the use of neural networks [1], [2], regional descriptors [3], image gradient [4], reconstruction of 3D object shape by fusion of visual and tactile information [5], fuzzy classification and reconstruction of 2-D shapes [6], use of Markov models for 2-D shape recognition [7] etc.

In the present work tactile images of 10 different object shapes are acquired from 30 different subjects and processed followed by feature extraction for matching as well as classification. Wavelet based features have been extracted from the acquired images. Image matching is an important image analysis and recognition technique. Image matching has been implemented through the use of Euclidean distance as a similarity measure. Classification is performed in one-against-one (OVO) basis. Three different classifiers were used, namely k-nearest neighbor (kNN), Naïve Bayes classifier, and Linear Discriminant Analysis (LDA). The performance of matching and classification is evaluated in terms of matching rate and classification accuracy respectively along with the computation times for object shape recognition from tactile images. This comparison will help in determining the applicability of classification or matching in future works including real time applications without compromising with the efficiency of the whole system. Object shape recognition is performed using single grasping instead of dynamic exploration. This reduces the time of tactile image acquisition as well as the computational complexity of processing a very large number of tactile images resulting from dynamic exploration, thereby making it suitable for real time applications of object shape identification using tactile sensors. The overall approach is presented in Figure 1.

Experimental paradigm is explained in section 2, followed by the methodology in section 3. Experimental results are given in section 4. The concluding remarks are outlined in section 5.

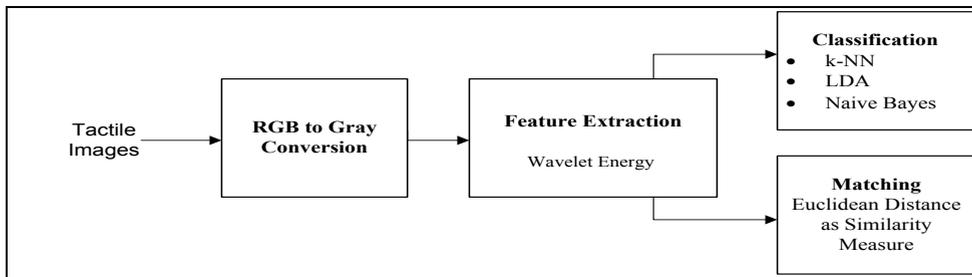


Figure 1. Flowchart depicting the course of work

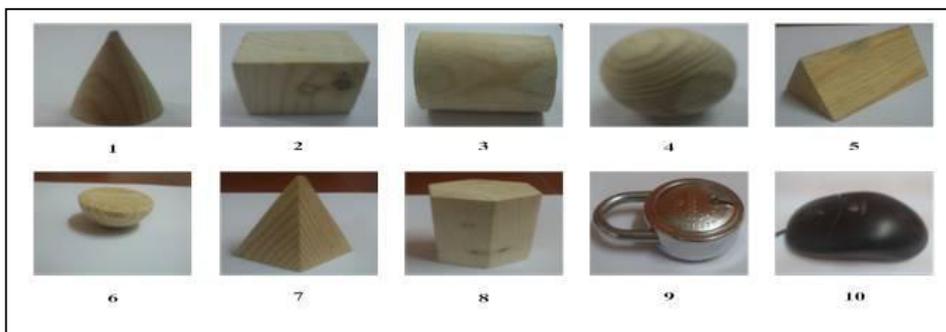


Figure 2. Objects used in the experiments

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