A review on feature based Object Recognition and study of multi class classification models

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Abstract

Object recognition is a vital tool for vision guided robotic system as its applications are plenty. In this project, an overview of the process of Object Recognition with the help of MS Azure Machine Learning toolbox has been analyzed. A brief comparative study of Learning algorithm and description of feature extraction study has also been done in the following section. Feature extraction parameters such as histogram spread, gabor magnitude, Harris Corners, Hough Circle detector, Viola-Jones object detector algorithm has been taken as feature extractors and their outputs have been parameterized in a tabulated form for better usability. This data was introduced to the MS Azure Platform and it has been found that we obtain the highest accuracy with the combination of aforesaid feature detectors and Multiclass Neural Network Classifier.

1 Introduction

In this research overview, a review on current feature extraction algorithm and the comparative analysis of Multiclass classifiers has been done. The primary motivation is to converge to a set of primary features which will be instrumental for being used as a robot vision tool in future. In this project, at first a database of pre-labelled images having 8 classes have been selected. A majority of them were selected for training via a multi class classifier after feature extraction and then they were evaluated with the test dataset [microsoft, 2012] subsequently providing us with a measure of performance. As expected, the accuracy varies with different classifier models. In the past Content based Image recognition technique [Choras, 2007] has been in use which characterizes image based on their extracted features and employs learning algorithm. The following section deals with a description of the image feature algorithms and the metric data used in order to train and classify different images for the purpose of object recognition. The classifiers show sufficient accuracy and currently work is undergoing in order to improve and obtain more accuracy for the given set of database.

Figure 1: Eight different classes of object used for the classification purpose. Some of them has a very high similarity among them.

1.1 Image dataset

The image dataset consists of 240 high resolution images from the Cambridge Microsoft Vision Research module [**?**]. This dataset consists of 8 distinct classes of objects which specifically includes farm, airplane, cow, human-face, cycles and other objects. These objects are placed in a vividly different environment having different illumination conditions, almost similar to what a robot will face while in a dynamic environment.

1.2 Feature detectors

We have used a series of feature detectors for better recognition of objects. The primary approach has been Content Based recognition. All the features have been accumulated and tabulated as a singular data with the help of further data processing.

- Colour Histogram
- Colour Spread and moment

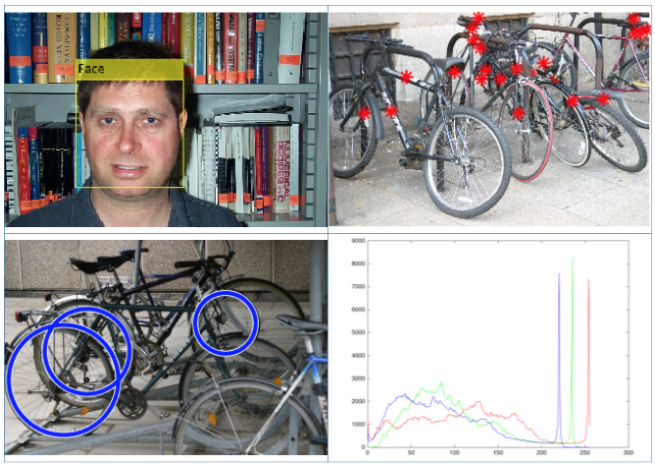

Figure 2: Feature set employed in current image dataset. Clockwise from top-left indicates the output from Viola-Jone face detector, Hariscorner, Histogram and Hough Circle detector.

- Gabor filter output
- Second order moment
- Corner points (Harris corner)
- Viola Jones face detector
- Hough Circle detector

First, the primary focus has been on color selection and its analysis. The histograms and spread of the particular color help us to distinguish many different backgrounds (especially in outdoor spaces such farms, etc.). This feature has been primarily used to distinguish two classes (related to cow and farm animals) from the rest of the set. Apart from this Viola Face detector [Viola and Jones, 2004] has been used in order to distinguish the class related to human face. Moreover, second order moment have been deployed to distinguish a class related to tree, due to the presence of very high concentration of similar pixel around the central axis allowing it to be easily detectable. Additionally, gabor phase and magnitude [Agarwal *et al.*, 2014], entropy, Harris Corner [Harris and Stephens, 1988] detector has been employed to provide further distinguishing feature to rest of the class of the dataset.

2 Methodology and Algorithm

Two vital platforms has been used in this process - image processing toolbox of Matlab and the Machine learning studio or MS Azure. MS Azure ML Studio uses a matrix format of the data (preferably .CSV) and this data matrix has been provided by MATLAB. At first, we obtain the dataset of images and extract its feature on a tabulated manner. This table is used for learning and processing in MS Azure studio and we can evaluate the score of the particular classifier model within the MS Azure platform itself. The detailed algorithm is shown in the following subsection. Figure 2 provides a general overview of the methodology used.

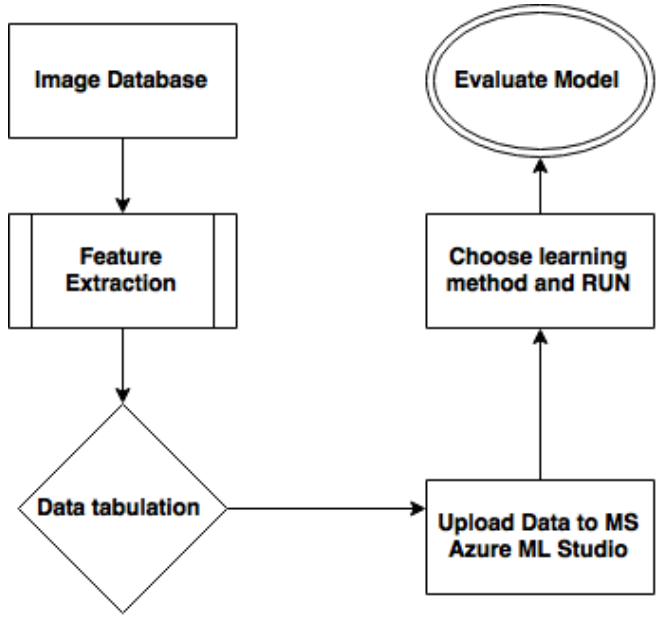

Figure 3: Block diagram of methodology used

2.1 Algorithm

The following algorithm has been deployed for the process:

- Acquisition of the labeled image dataset.
- Feature extraction algorithm employed on the image dataset.
- Feature metrics obtained for each dataset and tabulated in matrix form along with label.
- Conversion of the matrix data into a MS Azure recognisable format. (Preferably .CSV)
- Split the feature dataset into 70-30 model. 70 percent of the dataset will be used for learning and rest of it will be used for testing.
- Begin learning process and use Multiclass classifiers.
- Evaluate the model within the Azure toolbox.
- Repeat this process for every available classifiers.

3 Observation and Results

The classifiers distinguished the test dataset effectively aided by feature data. In particular, Multiclass Neural Network Classifier showed an overall efficiency of more than 76.2 percent. This result can be considered moderately efficient and we can conclude that we have definitive structure of distinguishing and classifying objects according to their feature. Further improvement can be done based on adding more feature and tuning certain parameters of the feature detectors themselves.

Adding to this, additional image feature output has also been displayed in order to have a better visualisation of the methodology used. As predicted before, due to the presence

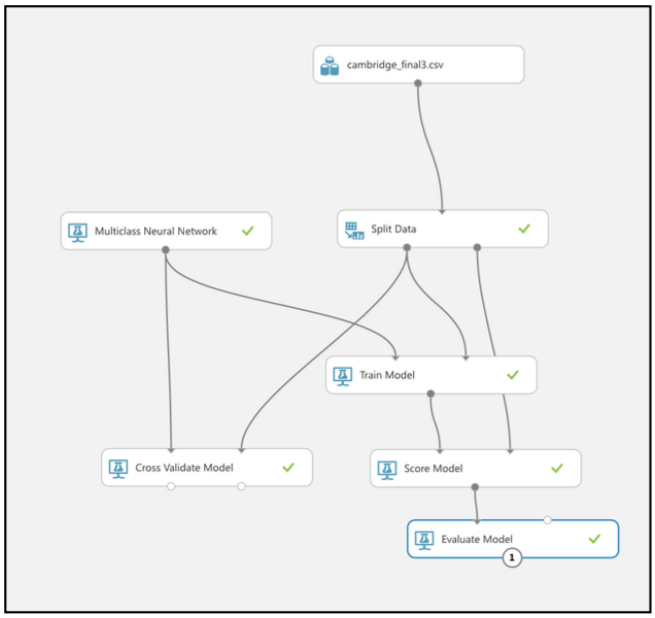

Figure 4: Azure Block position representing the methodology for classifier learning

of Viola Jones, Hough circle detector and second order moment we have a better recognition output and the overall accuracy related to these classes have increased significantly. The classes related to bicycle and face have been detected with an accuracy of 100 percent. But in case of classes denoting 1 and 5, they have been mislabeled with respect to each other. Due to very high characteristic similarity; although Class 1 has been labeled with significant success the class 5 has also been mislabeled as Class 1 in high volumes. Accuracy for rest of the classes are also appreciable.

4 Conclusion and future work

It can be safely concluded that a concrete structure is present for the object recognition module. Adding to this, the Multiclass Neural Network (MCNN) classifier along with the given set of classifiers provides a satisfactory classification output. MCNN proves to be better than Multiclass Jungle and Multiclass Forest Classifier in a noticeable way. Moreover the performance of the Image feature detector is highlighted since it is yet to improve in labeling certain classes-noticeably class 1 and 5, where the background information is very similar.

Classifier	**Overall Accuracy (percent)**	**Average Accuracy (percent)**
Multiclass Jungle	70	93
Multiclass Forest	74	93
Multiclas Neural Network	76	94

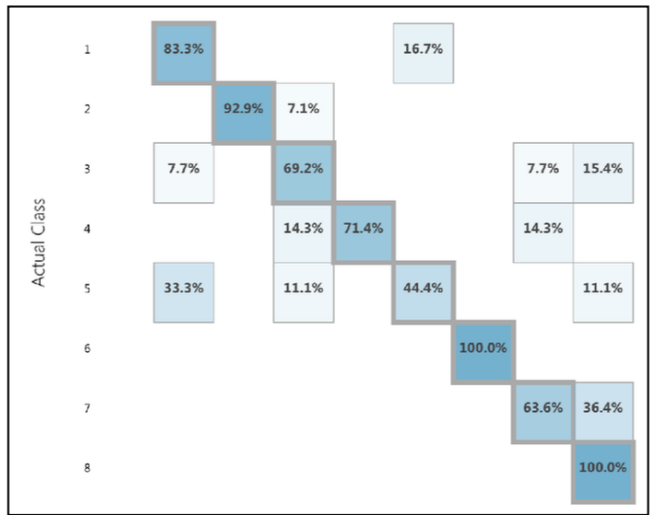

Figure 5: Performance matrix of the classifier. The horizontal rows number the actual class of the image dataset and the vertical column show the percentage efficiency with which the data has been labeled. There are several significant error blocks which are shown in darker blue color for better identification. It can be seen that 100 percent correct identification has been attained for two classes. This is considered as a significant development for a moderately identification model like this.

Hence, in future better feature detector sets are needed for accurate depiction of the background information. Adding to this, comparative analysis has been done only in case

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