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A Recent Survey on Multiclass Object Recognition and Classification based on Machine learning methods

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Abstract - **Multiclass object recognition and classification from the video stream is active research topic in computer vision due to its wide range of application in many emerging areas such as surveillance, medical, safety, vehicle detection. Object recognition and classification task are far more challenging because of image and video data are of heavy and highly variable in nature and harsh nature of real-world recognition and classification scenarios. The processing of image and video data is required to be in real-time. The objective of this paper presents a comprehensive qualitative and quantitative comparative study of several state-of-the-art object recognition and classification methods. We have also examined merits, demerits efficiency of pioneering machine learning methods being used for object recognition and classification.**

Keywords: Machine learning, image, video, surveillance, vehicle detection.

I. INTRODUCTION

Multiclass object recognition and classification are the most growing research area of pattern recognition and gaining popularity worldwide [2]. Computer vision applications are being developed using multiclass object classification for the applications of surveillance, navigation, medical diagnostic, automation, face detection, vehicle detection, and for the purpose of safety at airports and other facilities etc [3], [4], [5]. Object classification also used for the recognition of behavior and actions of a person [6] to find suspicious person. Multiclass objects recognition and classification involves extracting different features based on the temporal and spatial features and categorize each objects into their respective class. Manish Khare et al. [3] [14] classified various objects into various classes such as human, motorbike, aero plane, dog, bicycle and negative. Rest of the paper organized into 3 sections. Section II the literature review machine methods for object recognition and classification. Section III presents quantitative and qualitative analysis and conclusion is given in section IV.

II. MACHINE LEARNING METHODS FOR RECOGNITION AND CLASSIFICATION

Factors such as background noise, luminance, shape and size and reflection of light can affect the methods to recognize and classify different objects. The basic idea behind objects recognition and classification is extract the features and use these features to recognize various objects. Many methods have been proposed to recognize and classify objects from the images and video stream. This section is based on the work done on object recognition, classification from video stream.

SIFT based face and object detection method proposed by Shuji Zhao et al. [1] by representing the video object as a tube recognize similarity between object or character in same or other video data. Mohamed Elhoseiny et al. [2] presented an experiment study for multiclass outdoor surveillance system to recognize objects by their shapes and to generate information for feature extraction in the form of contour current and binary frame etc. Presented study compare the accuracy of methods such as appearance feature i.e. HOG and geometric feature and analyze the performance based on two classification methods SVM and AdaBoost. Manish Khare et al. [3] proposed multiclass object classification based on the DWT to recognize objects classify them into various classes using multiclass SVM. DWT satisfy the properties such as similarity and discontinuity. Further the result obtained this work; Manish Khare et al. [11] proposed Daubechies complex wavelet transforms (DCxWT) method. Features are extracted by decomposing the image data using complex wavelet transform and multiclass SVM is used to train classifier and classify test data. Adi Nurhadiyatna et al. [4] proposed a real time system using Gaussian Mixer Model with Hole Filling algorithm for multiple vehicle detection, Gabor kernel for feature extraction, and multiclass vehicle classification. Paper

used five different classifiers to compare classification process these classifiers are Learning Vector Quantification, Multilayer Perceptron, Random forest, Self Organize Map and Naïve Bayes. Authors implemented automatic classification system using single camera as a sensor. GMMHF detect the vehicle and Gabor kernel extract feature from the data and then features are classified by the five classifiers such as Naïve bayes, multilayer perceptron, random forest, LVQ and SOM. Proposed method doesn't work well with the heavy traffic and night condition.

LS-DDL based approach proposed by Hongcheng Wang et al. [5] to obtain high accuracy using small number of low dimensional dictionary atoms. Low dimensionality is used for storage and testing. For video based activity paper proposed Bag-of-Discriminative-Words model based on Bag-of-word and LS-DDL. Shiladitya Chowdhury et al. [6] proposed a novel elastic window based approach to locate the boundaries of the objects from video by elastically expanding the size of window using local image gradients. G-2DFLD used for facial feature extraction and a multiclass SVM is incorporates to recognize and classification. Method failed to detect objects due to collision of pixels of objects with the other objects moving in background.

Smart phone and cloud computing technology based approach presented by Anjan Kumar Paul and Jong Sou Park [7] that uses Smartphone as a client and computer as a cloud server. SIFT method used for feature extraction by calculating the difference of Gaussians (DoG) and based on DoG Naïve Bayes recognizes and classify the object from visual codebook created by clustering algorithm such as K-means clustering. Feimo Li et al. [8] categorized confusing subsets such as distinguish confusing orientations automatically by analyzing the correlation between specific orientation angles and location deviations at local detection window for vehicle detection and uses N-nary multiclass classifier. HOG, LBP and SIFT to build feature and then features are used by classifier for classification. Tripti Meena [9] proposed MKTL framework based transfer learning method to train classifier to learn and recognize new object classes for automatic surveillance. MKTL framework based on Naïve Bayes and SVM classifier are used to compare the performance of MKTL based on these classifiers. Pramod Sharma and Ramakant Nevatia [10] proposed unsupervised detector adaptation method focuses on performance and efficiency. Method selects discriminative random ferns for classification. Method neither requires training data used for training nor does it depend upon the training algorithm used for the training of generic detector. Proposed method only implemented for detection of human in video. Method can also be used for supervised and generic detector.

Table 1 presents the summary of various machine learning methods for multiclass object recognition and classification. The brief description and advantages of methods are highlighted.

III. QUANTITATIVE ANALYSIS

Focusing on machine learning models for object recognition and classification in images and videos, we found that various methods proposed so far vary by method, data input and training data.

Method with Adaboost (Mohamed Elhoseiny et al. [2]) based on feature selection performed better than SVM. LS-DDL (Hongcheng Wang et al. [5]) based on BoDW outperform methods such K-SVD-BoW, D-KSVD-BoDW and LC-KSVD-BoDW. Elastic window based approach (Shiladitya Chowdhury et al. [6]) perform better than LPCA, nearest neighbor methods.

Object recognition and classification performance analysis of recent methods based on accuracy reported by original work given in Table 1.

IV. CONCLUSION

This paper presented a qualitative analysis of various machine learning methodologies for the multiclass object recognition and classification. A successful multiclass objects recognition and classification from video and images not only needs to overcome variations such as noise from each video frame or image, cluttered background, luminous, reflection from the object, but also has to take care of how temporal and spatial dimensions can be incorporated into training model. Machine learning models overcome these problems by extracting features based on the edge orientation, geometric features, shapes etc.

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Table 1: Summary of various machine learning algorithms for object recognition and classification

S.No	Paper Title	Author	Description	Feature Extraction	Classifier	Advantage	Accuracy
1	MultiClass Object Classication in Video Surveillance Systems Experimental Study	Mohamed Elhoseiny et al. [2]	Recognize objects by using shapes to extract feature such as geometric and appearance feature by creating contour	HOG	SVM and AdaBoost	Geometric features performs better than	Adaboost-95.08%,
2	Sttk-Based Video Object Recognition	Shuji Zhao et al. [1]	SIFT based face and object detection method uses objects as STTK tubes of different colour to found same object	Spatio-Temporal Tubes kernel	Multi-class SVM	more robust than dictionary based, facial feature based and key-frame	
3	Using Advanced ML For Improving Surveillance Accuracy	Tripti Meena [9]	MKTL based on SVM and Naïve bayes used to train classifier to learn and classify new classes	MKTL framework	SVM , Naïve bayes	Better representation of image for prior knowledge	
4	Gabor Filtering for Feature Extraction in Real Time Vehicle Classification System	Adi Nurhadiyatna et al. [4]	GMMHF uses multilayer perceptron, random forest SOM and Naïve bayes to classify objects by extracting the features using gabor kernel by hole filling algorithm	GMMHF, Gabor Kernel	Naïve bayes, Random forest, Multilayer perceptr		93.3%
5	A Novel Elastic Window for Face Detection and Recognition from Video	Shiladitya Chowdhury et al. [6]	Elastic windows used to bound boundaries of the object and recognize object and faces from the video by using local gradient	G-2DFLD	SVM	The window locates the possible face boundaries by elastically expanding its	91.3%

S.No.	Paper Title	Author	Description	Feature Extraction	Classifier	Advantage	Accuracy
6	Multi Class Boosted Random Ferns for Adapting a Generic Object Detector to a Specific Video	Pramod Sharma and Ramakant Nevatia [10]	Using multiclass boosted random fern classifier for unsupervised detector adaptation method to improve the efficiency and		Multi Class Boosted Random Fern Adaptive	Doesn't require training data and algorithm for testing	
7	An approach towards Wavelet transform based Multiclass object classification	Manish Khare et al. [3]	DWT using DWT coefficient to classify objects into new classes based on the properties of similarity and	Discrete wavelet transform	Multiclass SVM	less confusion between different objects	
8	Discriminative Dictionary Learning via Shared Latent Structure for Object	Hongcheng Wang et al. [5]	Dictionary based latent approach based on dictionary based BoW is used to recognize objects	LS-DDL	LS-DDL	Low dimensionality improves	93.2%
9	Multiclass Object Recognition using Smart Phone and Cloud Computing for Augmented Reality	Anjan Kumar Paul, and Jong Sou Park [7]	Smart phone and cloud computing technology based method used to create library to recognize and classify objects from images	Visual based feature, SIFT	Naïve bayes		
10	Efficient Vehicle Detection and Orientation Estimation by Confusing Subsets Categorization	Feimo Li et al. [8]	Categorize confusing subsets such as distinguish confusing orientations automatically by analyzing the correlation between specific orientation angles and location deviations	LBP, HOG, SIFT	N-nary multiclass		
11	Daubechies Complex Wavelet Transform based approach for Multiclass Object Classification	Manish Khare et al. [11]	DCxWT with multiclass SVM used to recognize and classify objects by edge representation and decomposing image into discrete wavelet coefficients	DCxWT	Multiclass SVM	Easily classify various object into different classes using better edge representation	96.86%