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Visual Category Recognition for the Improved Storage and Retrieval Performance of the CCTV Camera System

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***Abstract*—In this paper, we propose a category level object recognition system for the efficient use of CCTV cameras in terms of storage and retrieval. We investigate the performance of the proposed approach by using four different classifiers. More specifically, we considered image sequences with cars, bikes and pedestrian as our three targeted object categories for classification and ultimately efficient storage and retrieval with reference to our CCTV cameras system. We utilized Linear Discriminant Analysis (LDA), Support Vector Machine (SVM), K-Nearest Neighbors (KNN) and Cartesian Genetic Programming (CGP) algorithms for the considered object categories classification. The Linear Discriminant Analysis (LDA), KNN and Support Vector Machine (SVM) are Statistical algorithms while Cartesian Genetic Programming (CGP) is Evolutionary Algorithm. More specifically, we utilized the standard "Caltech 101" dataset for investigating the performance of our proposed classifiers. Scale Invariant Feature Transform (SIFT) has been used to extract the scale, orientation and translational invariant features from the considered images which are input to the classifiers. Our empirical results show that in most of the cases, the results of LDA and SVM are relatively the same. To be specific, LDA gives an average accuracy of 85.3% and SVM 83.6%. Similarly, KNN gives an average accuracy of 74.6% while CGP outperforming the three gives accuracy rate of 89%.**

***Keywords*—Category Recognition, Feature Extraction, Scale Invariant Feature Transform, Linear Discriminant Analysis, Support Vector Machine, K-Nearest Neighbors, Cartesian Genetic programming**

I. Motivation and Background

Closed-circuit television (CCTV) cameras have long been used for surveillance and security purposes. They produce both still images and video recordings. These cameras continuously send the captured image signals to a storage device. Storage of each and everything produced by these cameras is sometimes not required and it waste enormous amount of hard drive space. Furthermore, in order to investigate past events through the stored data, analysis and retrieval of the whole long video sequence is sometimes very tedious and time consuming task. Therefore, in this paper we present an approach for the efficient use of these cameras through visual category recognition. The proposed systems preprocesses the input video sequence and after analyzing these images they are efficiently archived in the allocated storage space based on the analyzed object category. Consequently, the proposed system also results in the efficient retrieval of data from a large database. For example, consider a road side theft that has been recorded by CCTV camera. In order to retrieve the information from the large database, the performance of the system can greatly be increased by retrieving the concerned category data and analyzing specifically that category.

Category recognition has received considerable attention in the last few years. For example in [1], the results of visual categorization of two different classifiers Naïve bayes classifier and SVM (support vector machine) classifier have been compared. The results showed that SVM is superior to that of Naive Bayes classifier in performance, but is problematic in clutter background images. In [2], modified bag of keypoints with CGP and CGP-ANN has been used to classify different objects. Similarly in [3], David G. Lowe in his paper Object Recognition from Local Scale-Invariant Features gave a very useful approach to object recognition by selecting a new class of image features. The features extracted were invariant to local variations. Lowe recognize different object by matching their SIFT features. A new concept called Hierarchal Temporal Memory (HTM) has been used in [6], to retrieve image from a large database, both online and offline, based on the content of the image. In [7] T. Serre and others used a biology inspired methodology for object recognition. The algorithm is tested on variety of different recognition tasks, from simple object recognition to multiclass and cluttered recognition. This bio-inspired approach performs very well by using few training examples. The algorithm first established a feature set and then categorizes objects using a linear classifier.

Furthermore, new descriptors for object recognition which help in the performance of the classifier have been presented in [8]. The descriptor is an array of large number of week classifiers. The advantage of using these descriptors is that testing can be done very efficiently using the classifier and on a database of images it will generate good results in less time. The paper suggested that for any new image to the system, the classifier must be trained for that image and then this trained classifier will work efficiently for large databases.

II. Proposed Approach

Category recognition is the process to categorize different objects automatically. In this section, the process of object categorization is discussed. Initially we consider two categories Cars and Bikes and run the algorithm to note the classification results. Then we add pedestrian and note the effect on overall

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Performance Analysis of Overlapped Motion Compensated Temporal Interpolation using Open Multiprocessing

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Abstract— **Motion Compensation is an essential part of different video compression techniques. Video compression is always required especially for storage and transmission of videos. Motion Compensation is computationally complex and data intensive process. Overlapped Motion Compensated Temporal Interpolation (OMCTI) is a block based approach for the temporal interpolation of skipped frames. It generates interpolated frames with considerably improved quality. In this paper, Open Multiprocessing (OpenMP) based multithreaded solution is proposed to reduce the computation time of Overlapped Motion Compensated Temporal Interpolation. The OpenMP based solution is tested on multi-core processor for evaluation of performance. The paper is concluded with a discussion about the generated experimental results.**

Index terms *– Motion Compensated Temporal Interpolation (MCTI), Overlapped Motion Compensated Temporal Interpolation (OMCTI), Block based search, OpenMP, Multithreading.*

I. INTRODUCTION

Many modern multimedia applications require low bit rate transmission of the video sequences. This limitation of low bit rate transmission of video sequence is imposed by the limited bandwidth of the transmission channel. Video compression performs a very significant role in these multimedia applications. Every digitized video contains substantial amount of redundant data and compression can be achieved by taking advantage of these redundancies. The redundant data contained in a video is generally classified into two categories: statistical redundancy and subjective redundancy. The objective of video compression is to get rid of both spatial and temporal domain redundancies. Motion Compensation is widely used in video compression, because of its capability to exploit high temporal correlation between consecutive frames of a video sequence. To achieve low bit rate encoding requirement, temporal subsampling is a very valuable technique and it can also be combined with any video compression method to gain very high compression ratio. The skipped frames are required to be reconstructed at the receiver end in order to achieve high frame rate at the receiver end. Simple frame reconstruction methods such as frame repetition at the receiver end can produce undesirable results in the output video sequence.

Motion Compensated Temporal Interpolation [1] (MCTI) is a technique proposed by Chi-Kong Wong et al. for the generation of the skipped frames. MCTI is a block based Motion Compensation algorithm. In MCTI, block motions are compensated by tracking the blocks between successive received frames at the receiver end. The trajectory of each block is calculated and then these blocks are placed at appropriate locations according to the calculated trajectories in the interpolated frames. MCTI is a block based algorithm so the inserted frames tend to be blocky. In order to reduce this blocky effect an Overlapped Motion Compensated Temporal Interpolation [2] (OMCTI) technique is proposed by Chi-Kong Wong et al. The main disadvantage of these motion compensation algorithms is the massive computational requirements.

Parallel programming approaches can be used to overcome the massive computational requirements of motion compensation. Multithreading method is an efficient parallel programming model used for the improvement of the computing capability of underlying system. OpenMP (OMP) is a parallel programming API which is used to develop multithreaded applications for shared memory architecture systems. These systems can have one or multiple cores. In this paper, we discuss the OpenMP based multithreaded implementation of Overlapped Motion Compensated Temporal Interpolation for the construction of skipped frames.

The rest of the paper is organized as follow: In section-II we provide some discussion about the state-of-the-art literature review. Furthermore, an overview of some motion compensated algorithms and some OpenMP applications are provided in this section. Moreover MCTI, OMCTI and the parallel implementation is discussed in Section-III. The discussion about our generated experimental results is