Performance Evaluation of Different Cost Functions in Motion Vector Estimation

Suvojit Acharjee, Department of ETCE, Jadavpur University, Kolkata, India

Sayan Chakraborty, Department of CSE, JIS College of Engineering, Kalyani, India

Wahiba Ben Abdessalem Karaa, Department of CSE, High Institute of Management, Le Bardo, Tunisia

Ahmad Taher Azar, Benha University, Qalyubia, Egypt

Nilanjan Dey, Department of IT, JIS College of Engineering, Kalyani, India

ABSTRACT

Video is an important medium in terms of information sharing in this present era. The tremendous growth of video use can be seen in the traditional multimedia application as well as in many other applications like medical videos, surveillance video etc. Raw video data is usually large in size, which demands for video compression. In different video compressing schemes, motion vector is a very important step to remove the temporal redundancy. A frame is first divided into small blocks and then motion vector for each block is computed. The difference between two blocks is evaluated by different cost functions (i.e. mean absolute difference (MAD), mean square error (MSE) etc).In this paper the performance of different cost functions was evaluated and also the most suitable cost function for motion vector estimation was found.

Keywords: *Full Search, Mean Absolute Difference, Mean Square Error, Motion Vector, Similarity Measurement*

1. INTRODUCTION

Video refers to series of images or image frames, which suggests that a bigger storage or higher bandwidth is required to store or transfer the video through the network. The existence of high temporal redundancy in video can be removed using different international video compression standards. The most important part of every coding standard is motion compensation. Therefore in MPEG standard (Lameillieure & Schäfer, 1994) the frames are divided into three categories. First type is intra-coded frame (Gall, 1991) or I-Frame. I-Frame is a completely original frame which does not depend on the information of other frames, and the frame is

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sent once at the beginning and periodically after certain intervals to avoid the propagation of transmission error. Generally the interval is 12. For our study, the interval was pre-defined as 6 in the algorithm. The other two types of frames where MPEG achieves (Schwarz *et al.*, 2006) higher compression are predicted frames or P-Frame and bi-directional frame or B-frame. The frames are closely related. Hence, one frame can be predicted by translational model of the previous (Barjatya, 2004) frame. This prediction is done by using motion vector estimation and motion compensation. P-Frames are divided into m × n macro blocks and every macro block is predicted using previous I-Frame. The movement of the macro block in horizontal and vertical direction is referred as motion vectors. B-Frames never transmit error because they are not used for motion prediction. Previous I-Frame or P-Frame and the next P-Frame helps to measure the motion vector for B-Frames (See Figure 1).

Evaluation of motion vectors demand match between the block of current frame (P-Frame or B-Frame) and the block of reference frame (I-Frame or P-Frame).The matching operation of one block with another is completely dependent on the output of cost function (Acharjee & Chaudhuri, 2012). The cost functions (Wang *et al.*, 2014) evaluate similarity between two blocks (Nguyen *et al.*, 2010). During this evaluation, the best match between two blocks (Anantha *et al.*, 2013) refers to the block with the best output. In another scenario, if the cost function (Hussein *et al.*, 2011) evaluates dissimilarity, then the block (Takahashi *et al.*, 2012) with least output of cost function (Davies *et al.*, 2007) is the best match. The cost function (Acharjee *et al.*, 2012) with higher value and increasing dependency between two blocks finds the similarity among those blocks. Similarly, the cost function finds the dissimilarity between two blocks, only if the cost function has produced lower value and the dependency between those two blocks has increased. The popular cost functions like MAD, MSE etc. are the cost function which finds the dissimilarity. Minimum ratio, Spearman's rho, Kendall's tau etc finds the similarity between two blocks. Reducing computational complex-

Figure 1. Frame structure