ABSTRACT

The work presented in this thesis is based on camera motion estimation, characterization and its applications, primarily in the areas of video stabilization and moving region segmentation. The proposed methods can also have applications in video indexing, retrieval and summarization. The initial focus in the thesis was in exploring a region based feature namely MSER for the camera motion estimation problem and its application to video stabilization was investigated. Based on this study, it was observed that MSER feature based video stabilization technique was robust and efficient in comparison to the state-of-the-art stabilization methods. However, several shortcomings like computational time, image degradations affecting the camera motion estimation block in the form of outliers were observed which motivated in exploring the same problem in the block motion vector (compressed) domain. The motivation for exploring the motion vector domain was two-fold. Firstly, this domain offered computational savings as the motion estimation was already completed by the video encoding process. Secondly, this domain had outliers due to the video encoding process and any estimations of the camera motion handling outliers efficiently would also take care of imaging degradations. So the latter part of the thesis concentrated towards exploring the camera motion estimation problem in the block motion vector domain. A novel framework for video stabilization in the block motion vector domain was proposed and comparative analysis with its feature domain counterparts in the pixel domain was carried out. The framework was fast and able to stabilize challenging sequences which were not achieved by state-of-the-art stabilization methods. While estimating the camera motion parameters for the stabilization task it was observed that the entire block motion vector field was utilized. This led to the motivation that if the camera motion estimation can be carried out on a sub-sampled field then it would lead to faster estimations at the cost of drop in accuracy for the estimated parameters. The wavelet decomposition was chosen as a means for sub-sampling and applied on the block motion vector field which localized the average motion in the LL sub-band. The camera motion estimation was carried out using the LL sub-band wavelet coefficients and experimental results showed that by restricting the computations to the LL sub-band, significant gain in processing time was obtained at the cost of drop in estimation accuracy for the camera motion parameters. The other three sub-bands i.e. LH, HL and HH of the wavelet decomposed block motion vector field was utilized for fast inter-frame moving object segmentation which was a by-product of using wavelet analysis for the camera motion estimation problem. An extension of the proposed segmentation method for

moving cameras was also explored by performing global motion compensation. Finally, a novel learning based non-parametric camera motion characterization scheme using the polar magnitude and angle histogram in the block motion vector domain was proposed. The proposed scheme utilized discriminative and novel features like the coefficient of variation to characterize the six known camera motion patterns. A novel application of the proposed characterization scheme was explored for video stabilization and demonstrated that selective stabilization on video segments saves considerable amount of computational time as compared to running the stabilization algorithm on the entire video sequence.

Keywords: camera motion estimation; camera motion characterization; region features; video stabilization; video segmentation; outliers; block motion vector.