A statistical search range adaptation solution for effective frame rate up - conversion

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Abstract: The recent development of advanced television systems has demonstrated a need for an efficient video conversion technique. In this scenario, frame rate up conversion (FRUC) solutions play an important role due to their benefits in both increasing the viewing quality experience and reducing the cost of video transmission. However, with the recent increase in video resolution, notably from Standard Definition (SD) to High Definition (HD) and ultra HD, FRUC now requires not only better interpolated frame quality but also lower FRUC time processing. Considering this problem, this paper proposes a novel statistical learning based adaptive search range solution to enable an effective FRUC mechanism. In the proposed adaptive search range solution, a set of spatial-temporal features are carefully defined and exploited to adaptively assign an appropriate search range value to each considered block, notably by formulating the search range adaptation as a classification problem and using the well-known support vector machine framework for the classification task. Experimental results conducted for a rich set of common video test sequences shows the advantages of the proposed adaptive search range solution, notably in both interpolated frame quality improvement and time processing reduction.

1. Introduction

In recent years, frame rate up-conversion (FRUC) has become an important technique for various film/video conversions, and technology displays [1]. For example, old television is typically filmed at 30 or 60 frames/s, but high definition television (HDTV) has usually a refresh rate of 60 Hz or 120 Hz. To play the old videos on the new display devices, these videos must be converted to the higher frame rate. Moreover, in video transmission, due to the low bandwidth limits, instead of sending full frame rate video at the very high cost, alternatively, we could reduce the frame rate by half and then up-convert the frame rate later at the decoder side.

The early FRUC solutions involved frame repetition and temporal averaging but naturally these simple approaches to create the up-converted frames produce jerkiness and blurriness artefacts in the interpolated frame due to the movement of objects. To address these problems, motion compensated temporal interpolation (MCTI) has been introduced as one of the most efficient ways to create up-converted frames [2]. In MCTI, block based motion estimation (ME) is firstly performed to generate a motion vector field (MVF). Then, motion vectors together with reference frames are used to interpolate the up-converted frames using motion compensation (MC) step.

In order to improve the FRUC performance, a large number of solutions have been proposed [3-32]. Among the various FRUC techniques available, the block-based motion compensated interpolation (MCI) algorithm [2] is frequently used due to its low computation and ease of implementation. MCI typically includes two main components, the motion estimation (ME) and the motion compensation (MC). In ME, due to the absence of original frames at the receiver, two decoded adjacent frames are exploited to generate the motion vector field (MVF). From the MVF, a simple interpolation method is used to create the target interpolated frame. Generally, the more accurate the MVF, the better the quality of the interpolated frame; thus, ME plays a significant role in the MCI based FRUC approach.

In block-based motion estimation, a best matching block is typically searched for a square region where the co-located block of the reference frame is the centre and the size of the search region is determined by a so-called search range (SR) parameter as shown in Fig.1.

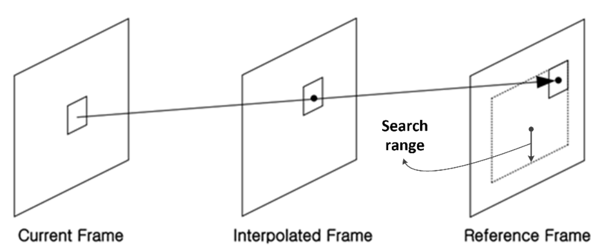

***Fig.1.** Unidirectional motion estimation*