Project Proposal:
Exploring the problem of optimization of Intra/Inter Prediction in H.264 standard

The Joint Video Team (JVT), comprising of the Video Coding Experts Group (VCEG) and the MPEG Video team, has come up with the relatively new H.264 (MPEG 4/ Part 10) codec. This low bit-rate codec has enabled representation of video in a highly compressed format, at the cost of increased complexity. Features like variable block sizes and multiple reference frames allow for accurate motion compensated prediction in H.264. Owing to these, the computational load for motion estimation increases significantly in H.264, sometimes occupying as much as 70% of the entire encoding time [5].

Some of the methods to reduce this complexity are enlisted in [1]. These include approaches such as simplifying the mode decision (intra/inter) before motion estimation; reducing the reference frame(s) complexity, especially in the case of multiple reference frames; reducing the number of search points during motion estimation, especially fractional pel estimation. While mode decisions are carried out on the basis of Rate Distortion Optimization (RDO) computations [2], some knowledge of uniformity or stationarity in the frames can greatly reduce the amount of calculations required. The authors in [4] have made use of this fact in their research.

Since motion estimation during inter-prediction results in lossy compression, it is necessary to have a lossless intra-coding, so that prediction can be as accurate as possible. The authors in [3] have proposed a novel DPCM based lossless intra-coding technique, which has been consequentiy adopted to be included in the standard. Since the DPCM technique makes use of previous pixel for prediction, it is always more accurate. Besides, the block-based structure is retained, to carry out the residual difference encoding process based on the DPCM intra-coded bit stream. The authors have shown that this reduces the bit rate by nearly 12% without major additional complexity.

It is evident from the above efforts that there is a lot of research going on to come up with minimal cost, maximum efficiency techniques to simplify the mode selection and motion estimation process in the H.264 encoder.[6][7] The aim of this project is on similar lines. The effort will be to come up with an efficient method that can considerably reduce the burden on a processor, without compromising on the quality of the bit stream. This would also provide a very good knowledge of the standard, the way it works and the direction that it is headed towards. Though this work will be mainly for Baseline and Main Profiles of H.264, there is also a lot of scope to extend any results obtained to the case of Residual Color Transform that has been recently proposed in the 4:4:4 High profile, as part of the FRExt [8]. Some of the areas of particular interest would include, trying to reduce the number of cases on which the Rate Distortion Optimization is performed and conceiving algorithms that can cut down on the motion estimation cost.

References
References:


