摘　要

随着人们对监控视频需求的扩大和分辨率要求的提升，监控视频数据量大幅增长。大规模监控视频给存储空间和传输带宽带来了很大的挑战，对视频的压缩效率提出了更高的要求。同时，监控视频编码实时性要求高，需要采用低复杂度的压缩算法对监控视频进行编码。监控视频具有场景稳定、背景区域静态及前景区域运动等特点。本文充分利用监控视频的性质，对监控视频编码复杂度和编码效率进行优化研究。本文的主要创新点如下。

第一，为降低监控视频编码复杂度，提出了一种基于前背景信息的运动估计优化算法。根据编码单元的前背景比例和尺寸自适应地选择编码单元划分模式，根据预测单元的前背景比例和尺寸自适应地选择搜索策略，优化整像素运动搜索和分像素运动搜索，从而降低背景区域的无意义的编码单元划分和运动搜索，同时提高前景区域的搜索精度。同时利用容错算法降低过度优化带来的性能损失。实验结果证明所提算法在监控视频上有较好的性能，在平均编码效率无明显下降的前提下（0.70%的码率增加），可以减少66.90%的搜索点数并节省46.69%的编码时间，大幅降低了编码复杂度。

第二，为提高监控视频编码效率，提出了一种基于编码信息的参考帧构建和管理算法。根据已有编码帧的残差、运动向量等编码信息，利用监控视频背景区域参考性能较好、残差和运动矢量相对较小，前景区域参考性能较差、残差和运动矢量相对较大等特点，将长期静态背景区域和短期运动前景区域像素有效更新到新构建的参考帧中，并用新构建的参考帧替换参考队列里的最远参考帧，使得新构建的参考帧可以为监控视频背景区域和前景区域同时提供有效参考。实验结果表明该算法对于监控视频，在编码复杂度无明显变化的情况下，可以提升7.30%的编码效率。

第三，基于HEVC编码标准，在参考软件HM-16.0的基础上，设计监控视频编码优化及信息分析平台HM-16.0+，不仅增加了对监控视频高效率低复杂编码的支持，还可以可视化并系统分析监控视频编码过程中的相关重要信息，为监控视频编码的进一步优化提供技术支持。

综上所述，本文利用监控视频前背景信息优化运动估计降低编码复杂度、利用监控视频编码信息优化参考帧技术提高编码效率，使得运动估计和参考帧技术更加适用于监控视频编码，监控视频编码在编码复杂度和编码效率上得到了优化。同时，编码过程中各类有用信息的可视化和统计分析，为进一步研究视频编码提供了技术支持。

关键词：监控视频编码，参考信息，运动搜索，参考帧构造，HEVC

Surveillance Video Coding Optimization Based on Reference Information

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ABSTRACT

With the expanding demand of surveillance video and the elevation of resolution ratio quality, the quantity of surveillance video data has increased a lot. The large scale of surveillance video has brought challenges to the storage space and transmission bandwidth and asks for a high quality of compression efficiency for surveillance video. Besides, the high requirement of compression in time requires a low complexity compression algorithm for surveillance video. The surveillance videos have their own characteristics, such as owning static views, static background regions and moving foreground regions, etc. This paper takes full advantage of these characteristics to optimize both coding complexity and efficiency. The main innovation points are illustrated as follows.

1. A low complexity surveillance video motion estimation algorithm (BFME) based on background-foreground information is proposed to accelerate the motion estimation procedure. In this algorithm, different CU depth are selected adaptively according to the background proportion and the size of the CU and different search strategies including integer-pixel motion search and sub-pixel motion search are selected adaptively according to the background proportion and the size of the PU, thus the motion estimation complexity of the background regions decreases and the search precision of the foreground regions increases. Besides, an error-tolerant algorithm is also performed to reduce the influence of over optimization. Experimental results demonstrate the advantage of BFME on surveillance videos. BFME can reduce the number of search points and the total encoding time averagely by 66.90% and 46.69% over HEVC reference software HM-16.0, while maintaining the coding efficiency (0.70% bitrate increase).
2. A high efficiency surveillance video reference frame construction and

management algorithm (CRCM) based on coding information is proposed to increase the coding efficiency. The algorithm utilizes coding information such as residual and MV of coded frames to construct a new frame called constructed frame for reference and replaces the forth reference frame in the reference frame list with the constructed frame to increase the reference efficiency. By making full use of the characteristics of surveillance video that background regions are more likely to have better reference performance with smaller residual value and MV and foreground regions are more likely to have worse reference performance with larger residual value and MV, the constructed frame can provide better reference for both background regions and foreground regions. Experimental results demonstrate the advantage of CRCM on surveillance videos. CRCM can achieve 7.30% bit-saving over HEVC reference software HM-16.0 with nearly no increase in coding complexity.

3. Based on HEVC and HEVC reference software HM-16.0, this paper develops the surveillance video coding optimizing and analysis platform, HM-16.0+. The platform not only has accepted the low complexity and high efficiency surveillance video coding algorithms proposed in the paper, but also can visualize and analyze the important coding information of surveillance video coding which can provide technical support for further optimizing of surveillance video coding.

In summary, the motion estimation and reference frame technology are more adaptive in surveillance videos and thus the surveillance video coding complexity and efficiency are optimized. Besides, the surveillance video coding optimizing and analysis platform on HEVC improves the surveillance coding efficiency and reduces the surveillance coding complexity on a large scale and provides a platform for the following researches on surveillance video coding optimization.

KEY WORDS: Surveillance Video Coding, Reference Information, Motion Search, Reference Frame Constructing, HEVC