VLSI Architectures of Perceptual Based Video Watermarking for Real-Time Copyright Protection

Saraju P. Mohanty, Elias Kougianos, Wei Cai, Manish Ratnani
VLSI Design and CAD Laboratory (VDCL)
University of North Texas, Denton, TX 76203.
Email-ID: saraju.mohanty@unt.edu.
Summary and Conclusions

- For effective digital rights management (DRM) of multimedia in the framework of embedded systems, we present a watermarking algorithm and VLSI architecture that can insert a broadcaster’s logo in video streams in real-time to facilitate copyrighted video broadcasting and internet protocol television (IP-TV).

- The watermarking process is performed in the frequency domain and the system’s maximum throughput is 43 frames/sec at a clock speed of 100MHz.

- Further research is under way to extend the real time performance of the system to HDTV and higher resolutions and to improve the PSNR. Advanced MPEG-4 features, such as N-bit resolution, advanced scalable textures, and video objects will be utilized.
Abstract

- For effective digital rights management (DRM) of multimedia in the framework of embedded systems, both watermarking and cryptography are necessary.
- We present a watermarking algorithm and VLSI architecture that can insert a broadcaster’s logo in video streams in real-time to facilitate copyrighted video broadcasting and internet protocol television (IP-TV) which when realized in silicon can be deployed in any multimedia producing appliance to enable DRM.
- The watermarking process is performed in the frequency domain and the system’s maximum throughput is 43 frames/sec at a clock speed of 100MHz which makes it suitable for real-time digital video broadcasting emerging applications such as IP-TV.

Introduction, Motivation, and Contributions

There is a need for real-time copyright logo insertion in emerging applications, such as internet protocol television (IP-TV). This is demonstrated in Fig. 1. The visible-transparent watermarking unit accepts broadcast uncompressed video and the broadcaster’s logo. The output is real-time compressed video with the logo embedded. This situation arises in IP-TV and digital TV broadcasting when video residing in a server has to be broadcast by different stations and under different broadcasting rights.

The Proposed Watermarking Algorithm

- Microsoft®, Real®, and Apple® support the MPEG4 standard and already have embedded MPEG-4 decoders into some of their products, and there are even free software implementations available, such as the Xvid codec. This motivated us to consider MPEG-4 as the target video compression framework in our research.
- Novel contributions of this paper are as follows:
  - A perceptual-based adaptive visible watermarking algorithm suitable for video broadcasting.
  - VLSI architectures for real-time watermarking in the context of compressed video (MPEG-4).
  - Simulink and FPGA prototyping of the VLSI architectures which can be integrated in multimedia producing appliances (e.g. digital camera, network processor).

We now present a watermarking algorithm that performs the broadcaster’s logo insertion as watermark in the DCT domain. The proposed watermarking algorithm is presented as a flow-chart in Fig. 2.

System Level Modeling and Prototyping

The proposed architectures of some data path components are shown below:

We performed exhaustive simulations to assess watermarking quality with a large variety of watermark images and video clips. For brevity we present selected examples of watermarked video in Figs. 7 and 8.

Testing of Watermarking Quality

- We present performance statistics with reference to existing hardware based watermarking for video in Table 4. We note that our implementation is the only one capable of achieving real-time video watermarking and compression at rates exceeding existing broadcast standards.
- In future, advanced MPEG-4 features, such as N-bit resolution, advanced scalable textures, and video objects will be utilized.

Summary, Conclusions, and Future Works

- We presented a visible watermarking algorithm using FPGA technology for MPEG4 video. The algorithm and its implementation are suitable for real-time applications such as video broadcasting, IP-TV and digital cinema.
- Further research is under way to extend the real time performance of the system to HDTV and higher resolutions and to improve the PSNR.

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