Fast and Effective AI Approaches for Video Quality Improvement

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ABSTRACT

In this work we present solutions based on AI techniques to the problem of real-time video quality improvement, addressing both video super resolution and compression artefact removal. These solutions can be used to revamp video archive materials allowing their reuse in modern video production and to improve the end user experience playing streaming videos in higher quality while requiring less bandwidth for their transmission. The proposed approaches can be used on a variety of devices as a post-processing step, without requiring any change in existing video encoding and transmission pipelines. Experiments on standard video datasets have shown that the proposed approaches improve video quality metrics considering either fixed bandwidth budgets or fixed quality goals.

CCS CONCEPTS

• **Computing methodologies** → *Learning from critiques*; **Image compression**; • **Computer systems organization** → *Neural networks.*

KEYWORDS

Video quality enhancement,GANs,video players,real-time video enhancement

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1 INTRODUCTION AND PROPOSED METHODS

Lossy video compression algorithms such as H.264, H.265, AV1, etc. are the foundation of video streaming but, in order to optimize available bandwidth and transmission costs, they introduce visual artefacts like blocking, mosquito noise, posterization, etc. that hamper user experience. In this work, we present a set of techniques based on AI that can be used to revamp video archive materials [5, 6] or increase the visual quality of streaming videos [1, 7]. The developed neural networks, trained using the Generative Adversarial Networks (GANs) framework [3] (Fig. 1 left), can be optimized to run in real-time [2, 4, 7] or faster than real-time even on mid-level GPUs, allowing their deployment for video restoration, and can be further optimized to run in real-time on mobile devices, exploiting CoreML and Neural Engine hardware on iOS devices [4], and exploiting WebGL and mobile GPU acceleration on Android and web browsers. The main scientific contributions of our work are:

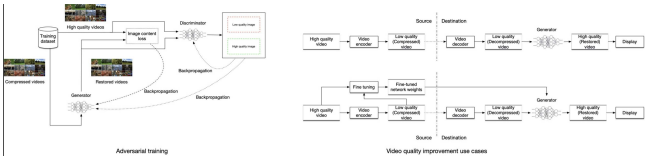

Figure 1: System overview: left) GAN-based training; right) use of the network to improve video quality of a generic video (top), use of a network specialized on a specific video (bottom)

(1) development of losses that combine perceptual and signal based metrics that help to reconstruct perceptually pleasant frames;
(2) development of neural network designs that allow to reduce their computational costs;
(3) development of GANs training regimes that generate realistic details.

Furthermore, we present a set of products, based on these contributions, that can be deployed on a variety of end user devices. These products can be embedded in video players, to process the frames immediately before showing them to the user (Fig. 1 right-top). They can upscale video frames, thus effectively reducing the bandwidth required to stream videos, and at the same time eliminate compression artefacts and add image details that were lost due to lossy compression. Our networks can be customized to specific video types (e.g. soccer, cartoons, documentaries) or on a per-title basis (Fig. 1 right-bottom), allowing to obtain a required video quality with a lower bitrate, even if this latter approach requires to send the weights of the network for each title; this is possible thanks to the compactness of the designed networks that require an extremely limited space. The proposed method can be adapted and effectively used also for video conferencing applications.

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