Fast Efficient Algorithm for Enhancement of Low Lighting Video

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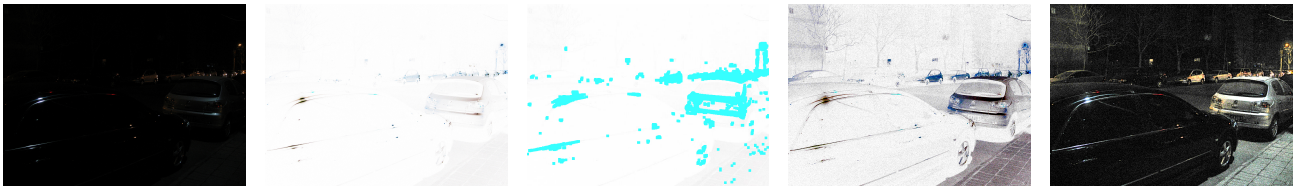

(a) (b) (c) (d) (e)

Figure 1: *(a) The input low lighting video frame I. (b) The inverted video frame R: R is obtained by inverting the input low-lighting video frame I. (c) The marked video frame: pixels with low intensity in at least one color (RGB) channel are marked in green. (d) The de-haze video frame J: J is obtained by applying the adapted de-haze algorithm on the inverted video frame R. (e) The final output video frame E: E is obtained by inverting the de-haze video frame J.*

Abstract

We describe a novel and effective video enhancement algorithm for low lighting video. The algorithm works by first inverting the input low-lighting video and then applying an image de-haze algorithm on the inverted input. To facilitate faster computation and improve temporal consistency, correlations between temporally neighboring frames are utilized. Simulations using naive implementations of the algorithm show good enhancement results and 2x speed-up as compared with frame-wise enhancement algorithms, with further improvements in both quality and speed possible.

Keywords: low lighting video enhancement, invert, de-hazing

1 Introduction

As video cameras become increasingly widely deployed, the problem of video enhancement for low lighting video has also become increasingly acute. This is because although camera and video surveillance systems are expected to work in all lighting and weather conditions, the majority of these cameras were not designed for low-lighting usage, and therefore the resulted poor capture quality often renders the video unusable for critical applications. Although infrared cameras are capable of enhancing visibility in low-lighting conditions [1] and [2], they suffer from the common limitation that objects must have a temperature higher than their surroundings to be visible. In many cases where the critical object has a temperature similar to the background, e.g. a big hole on the road, infrared cameras are not very useful. Conventional video enhancement techniques such as histogram equalization may not work well either in many cases, especially for real time processing of video sequences.

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In this paper, we propose a novel, simple and effective enhancement algorithm for low lighting video. We show that after inverting the input, pixels in the background regions of the inverted low-lighting video usually have high intensities in all color (RGB) channels while those of foreground regions usually have at least one color channel whose density is low. This is very similar to video captured in hazy weather conditions. Therefore, we can apply state-of-the-art image de-hazing algorithms to the frames in the inverted video sequence for enhancement. We show that the combination of inverting the input and then performing de-hazing on the inversion result is a simple but effective algorithm for low-lighting video enhancement. This process is conceptually illustrated in Figure 1.

To improve the efficiency of the algorithm and the temporal consistency of the output video, we utilize correlations between temporally neighboring video frames. In particular, we store the values of key algorithm parameters for each processed frame, and perform motion estimation between neighboring frames. If the pixels in the current frame are determined to be sufficiently similar to pixels in a previously processed frame, the stored values are used for the corresponding pixels in the current frame, thereby by-passing a significant portion of the computation. Simulation results using naive implementations of the algorithm show 2x speed-up as compared with the conventional frame-by-frame approach. By improving the implementation of the algorithm, especially by using fast motion search algorithms, further improvements in both quality and speed can be achieved. Please kindly find the demo video at http://media.cs.tsinghua.edu.cn/∼multimedia/siggraph2010.htm.

References

[1] Hau Ngo, Li Tao, Ming Zhang, Adam Livingston and Vijayan Asari. A Visibility Improvement System for Low Vision Drivers by Nonlinear Enhancement of Fused Visible and Infrared Video. Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2005, pp. 25

[2] Night Driver, Making Driving Safer at Night, Raytheon Company, available at: http://www.nightdriversystems.com/nightdriver.html

SIGGRAPH 2010, Los Angeles, California, July 25 – 29, 2010.
ISBN 978-1-4503-0210-4/10/0007