Application A8-080

作品名稱

高對比低雜訊虛擬高動態範圍影像合成之即時顯示系統

A Real-Time Display System for Generating High-Contrast, Low-Noise Virtual High Dynamic Range Images from Low Dynamic Range images

隊伍名稱

HDR魂!!! HDR Power!!!

隊　長

陳志榮 清華大學資訊工程學系

隊　員

柯瑋明、蔡昆哲、莊震宇

清華大學資訊工程學研究所

指導教授

邱瀞德 老師 清華大學資訊工程學系

作品摘要

自然世界的亮度範圍能夠達到100,000,000:1，但由於多數螢幕顯示裝置皆只能夠表示100～1000：1的範圍，這樣的差異造成要在螢幕顯示真實世界的景象是很困難的。為了解決這類問題，現今已開發一些能夠藉由低動態範圍影像的偵測器來取得高動態範圍影像的技術。其中最顯而易見的方法是從利用不同的曝光條件連續獲得同樣場景的多張影像，然而這類的方法只適用於靜態景象，能夠應用的範圍不廣。另外，針對多重影像偵測器或是具有單一相素多重感應器元件的部分，現今也有許多研究者在做研究，用這種方法能使物件可以在擷取及處理過程中任意移動，然而此技術無法普及的主要原因是其製造成本非常昂貴。

至於高動態範圍影像產生後，如何能夠在LCD或CRT等傳統顯示器上維持高動態範圍的品質變成一個很重要的議題。色調對應即是解決如何將高動態範圍影像在維持人類視覺所見內容的前提下顯示至低動態範圍顯示器中的一種影像處理演算法，但是一個設計良好的色調對應演算法其計算複雜度相當高，很難即時處理。

在我們設計之系統中，我們使用單一張低動態範圍影像來產生多張具有不同平均亮度、曝光程度不同的低動態範圍影像，接著利用權重平均的方法虛擬地建造高動態範圍影像，建造完之後會有一些雜訊產生，因此我們發展了一套適應性演算法去偵測自動的定義雜訊程度，並藉其決定雙邊過濾器的參數後，將雜訊影像送進雙邊過濾器處理。最後我們採用區域性對比增強演算法來得到最終之近似高動態範圍影像、低雜訊、與細部增強之影像。

我們設計的系統是fully pipelined並在ARM926EJ-S Versatile平台做測試。由於沒有複雜的色調對應演算法，我們能夠即時地處理720x480解析度、30MHz的影片，能夠直接應用在現今的監視器系統中。

Abstract

The luminance range of natural world can reach 100,000,000:1 but that of displayed luminance is about 100~1000:1 for most screen devices. This discrepancy makes the accurate display of real world scenes difficult. Therefore, technologies for capturing a high dynamic range (HDR) image with a low dynamic range (LDR) detector have been developed. The most obvious approach is to sequentially capture multiple images of the same scene using different exposures. The above methods are suitable only to static scenes. Using multiple image detectors or HDR sensors for scene capture has been investigated. Under this approach, the scene objects and the imaging system are free to move during the capture process. However, the HDR detectors or sensors are very expensive and not popular in the market.

After the HDR images are produced, to maintain the quality of high dynamic range on the display of conventional LCD or CRT devices becomes an important issue. Tone mapping is an image processing algorithm to resolve the issue of rendering HDR images on LDR displays while preserving the visual contents. But the complexity of a delicate tone mapping algorithm is too high to achieve real-time processing.

In our work, we make use of a LDR photograph to generate multiple LDR images with different average luminance, and then we construct the HDR photograph with weighting average method. After the HDR photograph has been created, some noise has been also generated. Therefore we develop an adaptive algorithm to estimate the parameters of the bilateral filter so that the noise level can be determined automatically. Finally, we adopt the local contrast enhancement algorithm to get the final HDR-like, low-noise, and detail-enhanced image.

Our design is fully pipelined and has been tested on ARM926EJ-S Versatile Platform. Without complex tone mapping algorithms, we could process a image with 720×480 resolution, 30MHz in real-time.