

Design of a Real Time System for Nonlinear Enhancement of Video Streams by an Integrated Neighborhood Dependent Approach

Adam Livingston, Hau Ngo, Ming Zhang, Li Tao, and Vijayan K. Asari
Department of Electrical and Computer Engineering
Old Dominion University, Norfolk, VA 23529
{alivi001, hngo001, mzhan002, ltaox001, and vasari}@odu.edu

Abstract

In this paper, we propose an efficient VLSI architecture for real time enhancement of video containing non-uniform and low light conditions. The nonlinear transfer function is determined by the cumulative distribution function of the previous frame. A dataflow design technique is used to construct a pipelined multi-module architecture. The design is capable of processing 73 102 × 102 video frames per second.

1. Introduction

Image enhancement is a very important pre-processing step in many computer vision applications. Researchers around the world have proposed various techniques to improve visual perception in images captured in poor visibility environment such as Multi-Scale Retinex MSR, Luma-Dependent Nonlinear Enhancement LDNE, and Adaptive Histogram Equalization AHE [1-3]. Adaptive and Integrated Neighborhood Dependent Approach for Nonlinear Enhancement AINDANE is another nonlinear technique which improves the visual quality of digital images captured under low or non-uniform illumination conditions. AINDANE incorporates neighborhood information to better control the

luminance and contrast enhancement processes [4]. A pipelined architecture design for AINDANE is proposed in this paper. The architectural design also utilizes a simple approximation method for fast computation of some mathematical operations. We implemented the architecture design on an FPGA due to its flexibility and cost considerations [5-6].

2. Architecture Design

AINDANE can be broken down into the three distinctive parts, adaptive luminance enhancement, adaptive contrast enhancement, and color restoration. This paper presents an implementation for the adaptive luminance enhancement portion of this algorithm. The nonlinear transfer function used in the luminance enhancement procedure is defined as

$$I'_n = \frac{1}{2} (I_n^{0.75z+0.25} + 0.4(1-z)(1-I_n) + I_n^{2-z}) \quad 1$$

where I_n is the normalized input luminance and z is defined as

$$z = \begin{cases} 0 & \text{for } L \leq 64 \\ \frac{L-64}{128} & \text{for } 64 < L < 192 \\ 1 & \text{for } L \geq 192 \end{cases} \quad 2$$

and L is the intensity level corresponding to

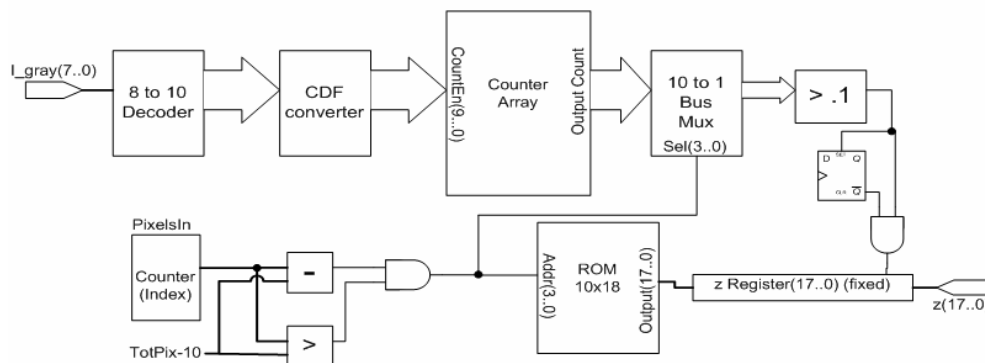


Figure 1: Block diagram of the module to compute tuning parameter z

