A.ZH. KHACHATRYAN, H.R. MELKONYAN

A GEOMETRIC METHOD FOR FINDING THE DERIVATIVE OF TRIGONOMETRIC FUNCTIONS. CONNECTION OF HARMONIC AND EXPONENTIAL FUNCTIONS

A new method based on geometric considerations for determining the known relationships between trigonometric functions and their derivatives is proposed. On the basis of the developed approach, the classical result of Euler concerning the connection between elementary trigonometric functions and the exponential function is also reproduced.

Keywords: derivative, sine, cosine, Euler's formula.

UDC 621.391

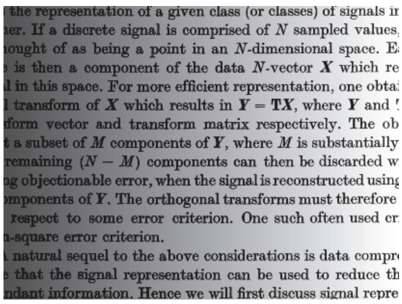
S.H. KHACHATRYAN, L.G. MINASYAN

ONE IMAGE ILLUMINATION COMPENSATION ALGORITHM

An algorithm for compensating for uneven distribution of illumination on digital images and, in particular, on digitized text images, is described to improve the image quality and text legibility.

Keywords: algorithm, compensation, uneven distribution of illumination.

Images obtained by photographing, depending on the lighting, do not always have a satisfactory quality. Nowadays, photosensitive film cameras have given way to digital cameras. Photos taken by a digital camera save photos in a digital format, which makes it possible to digitally process images to improve their quality [1-9].



the representation of a given class (or classes) of signals ir
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is then a component of the data N-vector $\boldsymbol{X}$ which re
l in this space. For more efficient representation, one obta
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t a subset of M components of $\boldsymbol{Y}$, where M is substantially
remaining $(N - M)$ components can then be discarded w
ng objectionable error, when the signal is reconstructed using
omponents of $\boldsymbol{Y}$. The orthogonal transforms must therefore
respect to some error criterion. One such often used cr
n-square error criterion.
A natural sequel to the above considerations is data compr
e that the signal representation can be used to reduce th
ndant information. Hence we will first discuss signal repre

Fig 1. Image of text with uneven lighting

Currently, the task of digitizing images and documents is very relevant. Digital cameras and scanners are commonly used to digitize documents. As a result of digitization, images with an uneven distribution of illumination are often obtained, which degrades the quality of images, distorts and complicates their perception. Figure 1 shows an image of text with uneven lighting.

There are many algorithms that compensate for the uneven distribution of illumination in images [1-9]. One of the simplest is an algorithm that applies Gaussian blur to an image, with a blur kernel

$$h_1(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}. \quad (1)$$

This article describes an algorithm for compensating uneven distribution of illumination on digital images and, in particular, on digitized text images to improve image quality and text legibility.

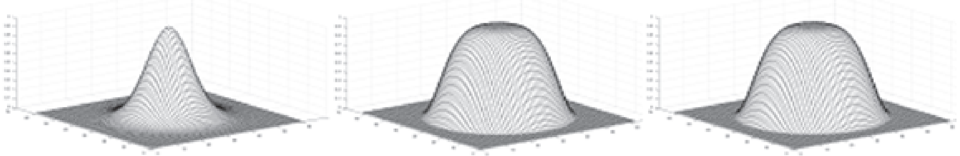
Let

$$h_2(x, y) = \begin{cases} \cos^2(x^2 + y^2), x^2 + y^2 \le \frac{\pi}{2}, \\ 0, \ x^2 + y^2 > \frac{\pi}{2}. \end{cases} \quad (2)$$

$$h_3(x, y) = \begin{cases} \log_2(x^2 + y^2 + r), x^2 + y^2 \le R^2, \\ 0, \ x^2 + y^2 > R^2, \end{cases} \quad (3)$$

where R is a certain positive number that determines the carrier of the h_2 function, r is some positive number on which the quality of the reconstructed image depends, The value of r is chosen empirically (in our case, R=1,r=0.65).

Figures 2 a), 2 b) and 2 c) show the surfaces described by the functions $h_1(x, y), h_2(x, y)$ and $h_3(x, y)$ defined by formulas (1) - (3).



a) b) c)

Fig. 2

Here is an algorithm for compensating the illumination of an image. The functions $h_1(x, y)$, $h_2(x, y)$, and $h_3(x, y)$ are sampled uniformly (with a constant sampling rate), resulting in a kernel matrix of image blur. Then, a two-dimensional discrete convolution of the brightness matrix of the original noisy image with a blur kernel is calculated. The brightness matrix of the blurred image coincides with the central part of the resulting convolution, the dimension of the original image. The reconstructed image is obtained as a result of term-by-term dividing the brightness matrix of the low-quality original image by the brightness of the blurred image and subsequent filtering of the image [7 - 9]. Here we restrict ourselves to no additional processing and image filtering.

Figure 3 shows a block diagram of the image processing algorithm.

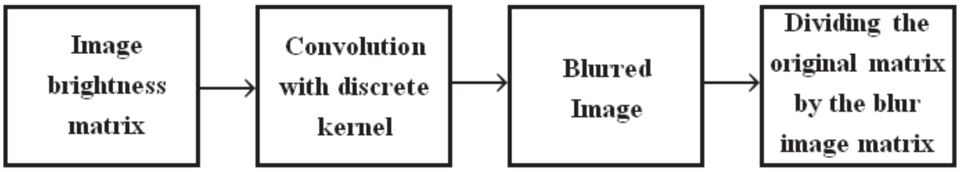
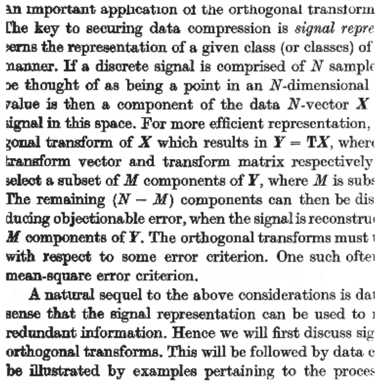


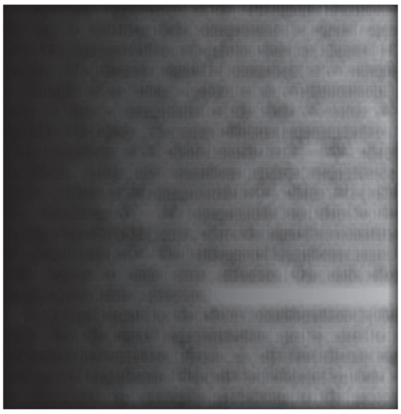
Fig. 3. The block diagram of the image processing algorithm

Figures 4 a), b), c), d), e) and f) show a blurry image and the result of the implementation of the proposed algorithm for compensating for uneven distribution of illumination in a digital image.

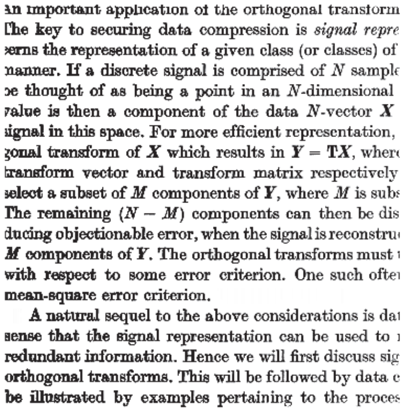
a) Blurred image with kernel h_1


an important application of the orthogonal transform
The key to securing data compression is *signal repre*
cerns the representation of a given class (or classes) of
manner. If a discrete signal is comprised of N sampl
be thought of as being a point in an N-dimensional
value is then a component of the data N-vector X
signal in this space. For more efficient representation,
gonal transform of X which results in $Y = TX$, wher
transform vector and transform matrix respectively
select a subset of M components of Y, where M is sub
The remaining $(N - M)$ components can then be dis
ducing objectionable error, when the signal is reconstru
M components of Y. The orthogonal transforms must
with respect to some error criterion. One such ofte
mean-square error criterion.
A natural sequel to the above considerations is da
sense that the signal representation can be used to
redundant information. Hence we will first discuss sig
orthogonal transforms. This will be followed by data c
be illustrated by examples pertaining to the proces

b) The result of the algorithm with the kernel h_1



c) Blurred image with kernel h_2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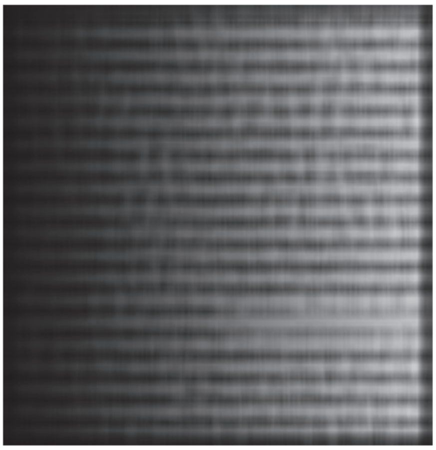
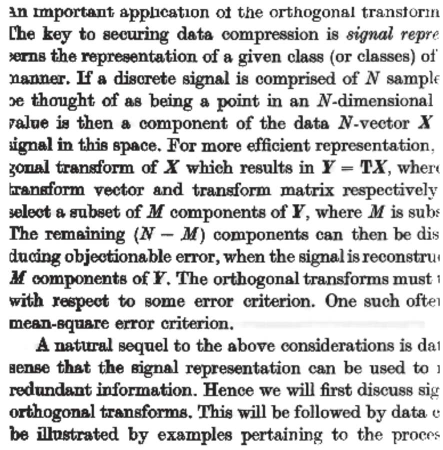
d) The result of the algorithm with the kernel h_2



e) Blurred image with kernel h_3



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f) The result of the algorithm with the kernel h_3

Fig. 4.

Note also that similar results are obtained when convolving the original image with kernels of the form $h = \{h(i,j), h(i,l) = 1, i, j = 1, 2, \cdots, n\}$, where n is chosen depending on the image (n≥20).

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Ս.Հ. ԽԱՉԱՏՐՅԱՆ, Լ.Գ. ՄԻՆԱՍՅԱՆ

ՊԱՏԿԵՐԻ ԼՈՒՍԱՎՈՐՈՒԹՅԱՆ ՓՈԽՀԱՏՈՒՑՄԱՆ ՄԻ ԱԼԳՈՐԻԹՄ

Նկարագրված է թվային պատկերներում լուսավորության անհավասարաչափ բաշխումը փոխհատուցելու ալգորիթմ, մասնավորապես՝ թվայնացված տեքստային պատկերների վրա՝ պատկերի որակը և տեքստի ընթեռնելիությունը բարելավելու համար:

Առանցքային բառեր. ալգորիթմ, փոխհատուցում, լուսավորության անհավասար բաշխում:

С.Г. ХАЧАТРЯН, Л.Г. МИНАСЯН

ОБ ОДНОМ АЛГОРИТМЕ КОМПЕНСАЦИИ ОСВЕЩЕННОСТИ ИЗОБРАЖЕНИЯ

Описан алгоритм компенсации неравномерного распределения освещения на цифровых изображениях, в частности на оцифрованных текстовых изображениях, для улучшения качества изображения и разборчивости текста.

Ключевые слова: алгоритм, компенсация, неравномерное распределение освещения.

UDC 517. 948

S.A. YEPISKOPOSYAN

THE UNIFORMLY UNIVERSAL GREEDY PROPERTY BY THE CHRESTENSON-LEVY SYSTEM

In the present paper, we will build a function $U(x) \in L^1[0,1)$, by strictly decreasing the Fourier Chrestenson-Levy coefficients $\{c_k(U)\}$ which have the uniformly universal greedy property.

***Keywords*:** Chrestenson-Levy system, function, universal.

Now, we present the definitions of the Chrestenson-Levy system (see [1, 2]).

Let a denote a fixed integer, $a \geq 2$ and put $\omega_a = e^{\frac{2\pi}{a}i}$.