Comparison of Original and Cartoon images with Edge and Background Detection

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Abstract—*In this paper, the image is decomposed into two parts which are the smooth components (cartoon) and the oscillatory components (texture) using a linear model which reduces to a low-pass /high-pass filter .The paper also involves the one of the applications of decomposed image i.e., edge detection,background detection and pixel value observation . The edge detection of images using canny mask and background detection comparison is done with histogram of background of both cartoon and original image of original image and cartoon at same position have been* discussed in the paper.

I. INTRODUCTION

A gray level or color image will be denoted by f:(x,y) € Ω→R (respectively R^3) whereΩ is an open subset of R^2, typically a rectangle or a square.

An image f is defined on a continuous domain by interpolating a digital image defined on a finite set of pixels.We are interested in decomposing f into two components $f=u+v$, such that u represents a cartoon or geometric (piecewise-smooth) component of f , while v represents the oscillatory or textured component of f . The oscillatory part v should contain essentially the noise and the texture.The general variational framework for decomposing f into $u+v$ is given in Meyer's models as an energy minimization problem.

$$\inf_{(u,v) \in X1 \times X2} \{F1(u) + \lambda F2(v) : f = u+v\}$$

Where F1,F2 ≥0 are functionals and X1, X2 are spaces of functions or distributions such that $F1(u) < \infty$ and $F2(v) < \infty$ if and only if (u,v) € X1 x X2.

The constant λ>0 is a tuning parameter. A good model for the above equation is given by a choice of X1 and X2 so that if is $u$cartoon and if vis texture, then $F1(u) << F2(v)$ and $F1(v) << F2(u)$ (such conditions would insure a clear cartoon+texture separation; in other words, if v is only cartoon, without texture, then texture components must be
penalized by F1, but not by F2 , and vice-versa).

In fact, the choice for $F1(u)$ has quickly converged to the total variation of , that excludes strong oscillations but permits sharp edges.

One of the first nonlinear cartoon+texture models is the Mumford and Shah model for image segmentation, where f € L^2 (Ω)is decomposed into a piecewise-smooth function with its discontinuity set included in a union of curves whose overall length is finite, and $v = f - u$ represents the noise or the texture.

There has been an extensive line of papers modifying and interpreting Meyer's models, and proposing minimization schemes There have also been extensions intending to decompose u into *three* components, namely BV, texture, and a residual (e.g., noise).

The rest of the paper is organized as follows: in Section II we formulate the linear cartoon + texture model inspired from Y. Meyer, which can be easily and rapidly solved in the Fourier domain and Section III comparison of original and cartoon image using the edge Section IV comparison of background detected using histogram of original and cartoon images .Section V is the conclusion of the paper and the results we got in the comparison of the original and cartoon image

.II. LINEAR VERSION OF MEYER'S MODEL

In view of the multiplicity and complexity of nonlinear models, it seems reasonable to first fix as a reference the best linear model. Separation of scales in images is classically obtained by applying a complementary pair of low-pass and high-pass filters to the data f , namely u = LPF(f), and then $v = u + v = HPF(f)$. The TV-H^1 model is easily linearized by replacing the total variation $\int|Du|$ by the Dirichlet integral $\int|Du|^2$. Then the most natural variational linear model associated with Meyer's ideas is $H^1 - H^{-1}$. Indeed, is H^{-1} dual to H^1 , in the same way as G is dual to BV . The low-pass filter $f \rightarrow u$ is obtained by the minimization

$$\min_u \{ \sigma^4 \int|Du|^2 + \| f - u \|^2_{H^{-1}} \} \quad (1)$$

This model can be compared with the classical Tikhonov quadratic $H^1 - L^2$
Minimization

$$\min_u \{ \sigma^2 \int Du^2 + \int (f - u)^2 \}$$

which is equivalent in the Fourier domain to the low-pass filter $u\hat{}=1/(1+(|2\pi\sigma\xi|)^2))f\hat{}$. This Wiener filter is known to remove high -frequency components due to the edges of , and not only those due to oscillations

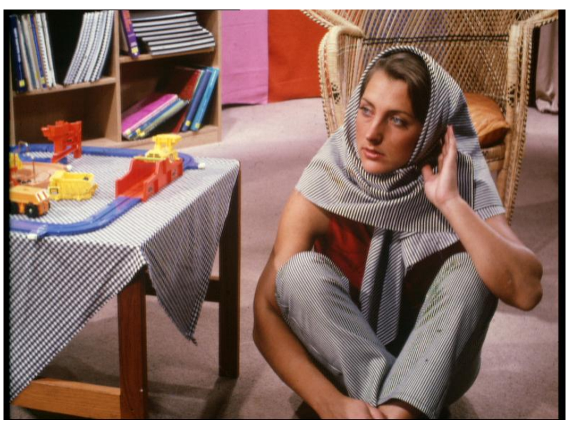


Fig.1 : jpeg image

Fig.2 grayscale image of fig1

Using the Fourier transform in (1), the H^1seminorm of u is and the H^{-1} seminorm of v is $\int Du^2 = \int (2\pi\sigma\xi)^2 u\hat{}(\xi)^2$. This implies in particular that $u - f = v$ has zero mean, since feasible solutions satisfy $v\hat{}(0)=0$. Minimizing
this quadratic functional (1) in u yields in Fourier the unique solution $u\hat{}=L\hat{}_\sigma f\hat{}$, where

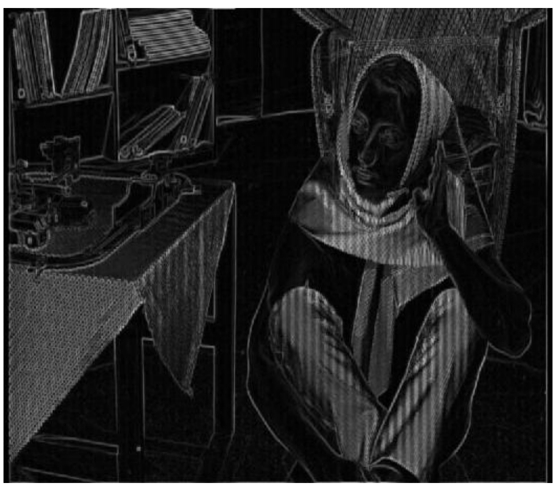
$$L\hat{}_\sigma (\xi) = 1/(1+((2\pi\sigma\xi)^4)$$

The meaning of the parameter σ is now easily explained: if the frequency ξ is significantly smaller than $1/2\pi\sigma$, then the ξ frequency is kept in u , while if ξ is significantly larger than $1/2\pi\sigma$, then the frequency ξ is considered as a textural frequency and attributed to v. Thus,the solution $(u,v) = (L_{\sigma*}f,(Id- L_\sigma)*f$
is nothing but a pair of complementary low-pass and high-pass filters. Note that as $\sigma \rightarrow 0$, $L_\sigma \rightarrow Id$, . We will also consider
the filter K_σ, where $K\hat{}_\sigma (\xi) = e^{-((2\pi\sigma\xi)4)}$, which behaves still more like the characteristic function of the ball centered at zero with radius $1/2\pi\sigma$.

It is worth mentioning that related linear and nonlinear three-term decompositions $f = u + v + w$ based upon the H^1 - H^{-1} duality the linear case is the (H^1 , H^0, H^{-1}) decomposition, while the nonlinear decomposition uses piecewise (where piecewise H^1 is the SBV space for the cartoon, combined with piecewise H^{-1} for the texture).

The cartoon and texture of decomposed image is shown below :

(a)



(b)

Fig 3 (a & b) are the cartoon and the texture of image in fig.2.

The cartoon and the texture images are obtained from the linear Meyer's model with the sigma value of 1.5 different authors in different papers.

III. EDGE DETECTION

Edge detection is one of the applications of the decomposed images. The edge detection of the original image *f* is done using the canny edge detection and similarly the edge detection was done for the cartoon image *u*. *T*he edge detected image of original and cartoon are shown below.

Fig5. canny edge detection of original image

Fig.6. canny edge detected images of cartoon images of jpeg images. The cartoon is with sigma 1.5.

If we observe the canny edge detected orginal and the

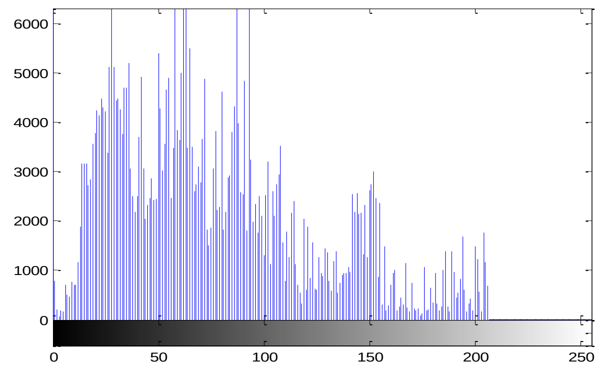
cartoon image the number of edges in the cartoon detected image are less compared with the original edge detected image .

The reason is that the edge due to the texture or the oscillatory components of the image are not seen in the decomposed cartoon image.

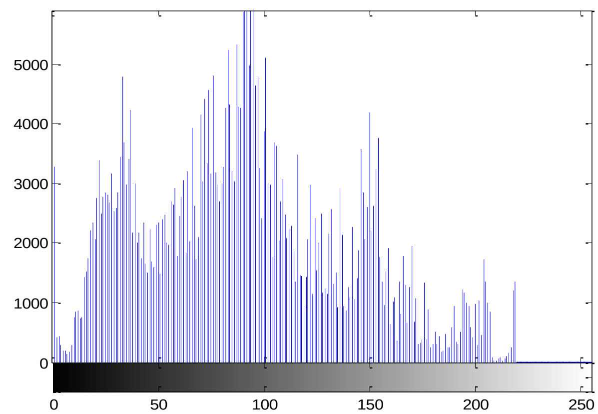
Therefore the number of edges are reduced in the cartoon image.

IV. BACKGROUND DETECTION

The background is detected for the original and cartoon images and the histogram of the background of original and cartoon images are used for the comparison of the images.



7(a).histogram of original image background



7(b). histogram of cartoon image background

From the above histogram we can observe that the contrast of the original image is less compared with the contrast level of the cartoon image.

V. CONCLUSION

We can conclude that the image can be decomposed into two parts the smooth and the oscillatory components called cartoon and the texture. In this the Meyer's model linear lowpass/highpass model is used for the decomposition of the image. The disadvantage with this model is if we increase the sigma value of the lowpass filter L(σ) the cartoon undergoes blurring. This has been overcomed by using the nonlinear filter model . we also discussed the edge and background detection of the original and the cartoon image of a particular image. From the images we can say that the edge in the cartoon edge detected image are less when compared with the edge detected image of the original image as the edges occurring due to the texture components have been filtered in the cartoon edge detected image. Here the edge detection is done using canny mask the detection is also done using prewitt and the sobel masks which improves the edge detection further.

The background detection for the original and cartoon image are analysed using the histogram of the background . From the histogram we can observe that the contrast of the original image is less compared with the cartoon image because the gray level is extended greater than 200. In addition to the edge detection and background detection the pixel values are also observed in our experiment and we observed that the pixel value of original image at a particular region is higher in value compared with the cartoon image pixel value at the same region as that of the original value.

REFERENCES

[1]Fast Cartoon + Texture image filters
[1] W. K. Allard, "Total variation regularization for image denoising, I.
Geometric theory," SIAM J. Math. Anal., vol. 39, no. 4, pp. 1150–1190,
2008.
[2] L. Ambrosio, "Variational problems in SBV and image segmentation,"
Acta Appl. Math., vol. 17, no. 1, pp. 1–40, 1989.
[3] L. Ambrosio, N. Fusco, and D. Pallara, Functions of Bounded Variation
and Free Discontinuity Problems. London, U.K.: Oxford Univ. Press,
2000.
[4] F. Andreu-Vaillo, V. Caselles, and J. M. Mazón, Parabolic Quasilinear
Equations Minimizing Linear Growth Functionals. Cambridge, MA:
Birkhauser, 2004.
[5] G. Aubert and J. F. Aujol, "Modeling very oscillating signals. Application
to image processing," Appl. Math. Optim., vol. 51, no. 2, pp.
163–182, 2005.
[6] G. Aubert and L.Vese, "A variational method in image recovery," SIAM
J. Numer. Anal., vol. 34, pp. 1948–1979, 1997.
[7] J. F. Aujol, G. Aubert, L. Blanc-Féraud, and A. Chambolle, "Image
decomposition. Application to SAR images," Lecture Notes Comput.
Sci., vol. 2695, pp. 297–312, 2003.
[8] J. F. Aujol, G. Aubert, L. Blanc-Féraud, and A. Chambolle, "Image

decomposition into a bounded variation component and an oscillating
component," J. Math. Imag. Vis., vol. 22, no. 1, pp. 71–88, 2005.
[9] J. F. Aujol and A. Chambolle, "Dual norms and image decomposition
models," Int. J. Comput. Vis., vol. 63, no. 1, pp. 85–104, 2005.
[10] J. F. Aujol and G. Gilboa, "Constrained and SNR-based solutions for
TV-Hilbert space image denoising," J. Math. Imag. Vis., vol. 26, no.
1–2, pp. 217–237, 2006.
[11] J. F. Aujol, G. Gilboa, T. Chan, and S. Osher, "Structure-texture image
decomposition—Modeling, algorithms and parameter selection," Int.
J. Comput. Vis., vol. 67, no. 1, pp. 111–136, 2006.
[12] A. Blake and A. Zisserman, Visual Reconstruction. Cambridge, MA:
MIT Press, 1987.
[13] A. Buades, B. Coll, and J. M. Morel, "A review of image denoising
algorithms, with a new one," Multiscale Model. Sim., vol. 4, no. 2, pp.
490–530, 2005.

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