Resolution Enhancement of Images Taken by a Mobile Phone Camera

Article *in* ELECTRONICS WORLD · February 2012

CITATIONS
0

READS
197

3 authors:

Gholamreza Anbarjafari
University of Tartu
151 PUBLICATIONS **1,775** CITATIONS
SEE PROFILE

Hasan Demirel
Eastern Mediterranean University
177 PUBLICATIONS **2,926** CITATIONS
SEE PROFILE

Erbug Celebi
Cyprus International University
29 PUBLICATIONS **84** CITATIONS
SEE PROFILE

RESOLUTION ENHANCEMENT OF IMAGES TAKEN BY A MOBILE PHONE CAMERA

DR GHOLAMREZA ANBARJAFARI FROM GAZIKENT UNIVERSITY, **DR HASAN DEMIREL** FROM THE EASTERN MEDITERRANEAN UNIVERSITY AND **DR ERBUG CELEBI** FROM CYPRUS INTERNATIONAL UNIVERSITY IN TURKEY PROPOSE A SUPER RESOLUTION TECHNIQUE BASED ON INTERPOLATION OF THE HIGH FREQUENCY SUBBAND IMAGES OBTAINED BY DISCRETE WAVELET TRANSFORM (DWT)

Interpolation in image processing is a method to increase the number of pixels in a digital image. Interpolation has been widely used in many image processing applications such as super resolution.

The interpolation-based super resolution has been used for a long time and many interpolation techniques have been developed to increase the quality of this process. There are three well-known interpolation techniques: nearest neighbour interpolation, bilinear interpolation and bicubic interpolation. Bicubic interpolation is more sophisticated than the other two techniques but produces smoother edges than bilinear interpolation.

> Carey et al have estimated the unknown details of wavelet coefficients in an effort to improve the sharpness of the reconstructed images

Image Resolution Enhancement

Image resolution enhancement in the wavelet domain is a relatively new research addition and recently many new algorithms have been proposed. Carey et al have estimated the unknown details of wavelet coefficients in an effort to improve the sharpness of the reconstructed images. Their estimation was carried out by investigating the evolution of wavelet transform extrema among the same type of subbands.

Edges identified by an edge detection algorithm in lower frequency subbands were used to prepare a model for estimating edges in higher frequency subbands; and only the coefficients with

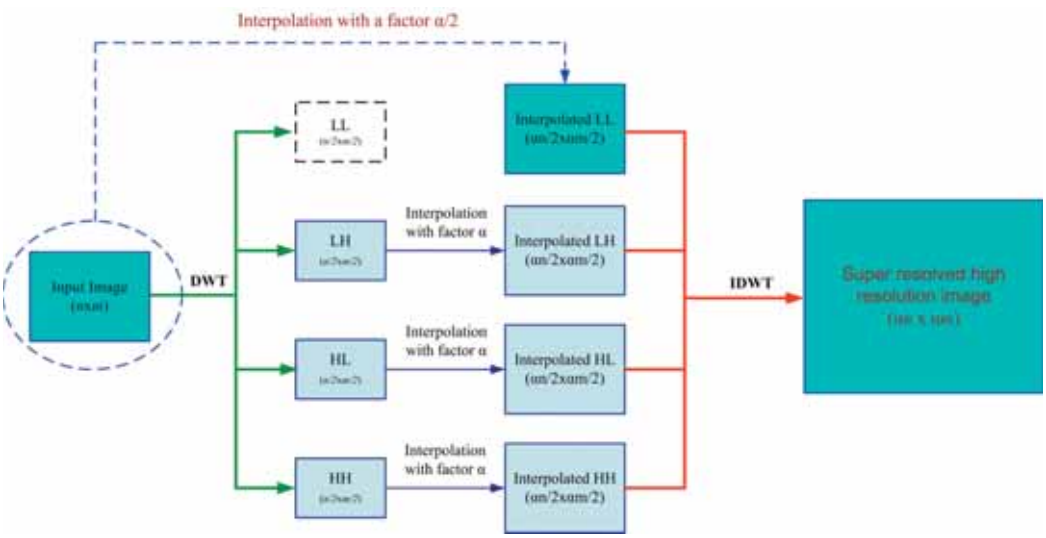

Figure 1: The block diagram of the super resolution algorithm

significant values were estimated as the evolution of the wavelet coefficients. As these significant coefficients correspond to salient image discontinuities and consequently only the portrayal of those can be targeted with this approach.

In this article, we are proposing a technique which generates sharper super-resolved images. The proposed technique, which is based on Demirel-Anbarjafari Super Resolution (DA SR) technique, uses the discrete wavelet transform (DWT) to decompose a low resolution image into different subband images. Then, the high frequency subband images are interpolated using bicubic interpolation. In parallel, the input image is also interpolated separately. Finally, interpolated high-frequency subband images and the interpolated input image are combined by using IDWT to achieve a high resolution output image.

The technique has been implemented in Java language in order to be installed on the mobile phones. The experimental results show the superiority of the DA SR technique over the available techniques.

The Proposed Image Resolution Enhancement Technique

The main loss of an image after being super resolved by applying interpolation is on its high frequency components (i.e. edges), which is due to the smoothing caused by interpolation.

Hence, in order to increase the quality of the super resolved image, preserving the edges is essential. In this work, discrete wavelet transform (DWT) has been employed in order to preserve the high frequency components of the image. DWT decomposes an image into different subband images, namely Low-Low (LL), Low-High (LH), High-Low (HL), and High-High (HH).

In the DA SR technique, DWT is used to decompose an input image into subband images. LH, HL and HH subband images contain the high frequency components of the input image. In DA SR technique the interpolation is applied to high frequency subband images. Instead of using LL, which contains less information than original input image, the input image is used for interpolation. Hence, using input image instead of LL subband image increases the quality of the super resolved image. Note that input image is interpolated with the half of the interpolation factor, α, used to interpolate the high frequency subbands, as illustrated in Figure 1.

By interpolating the input image by $\alpha/2$, and HH, HL and LH by α, and then by applying inverse DWT (IDWT), the output image will contain sharper edges than the interpolated image obtained by interpolation of the input image directly.

This is due to the fact that, the interpolation of isolated high-frequency components in HH, HL and LH will preserve more high frequency components after the interpolation of the respective subbands separately than interpolating Ξ directly.

User-Affected

Figure 2 shows the actual graphical user interface (GUI) window which is generated by JFrame in Java and is the main interface window on the mobile phone application; there is a location in which the user enters the enlargement factor. Also the user has the opportunity of super resolving the image by using either of DA SR technique, which is discussed in the work or bicubic interpolation.

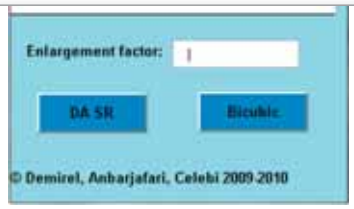

Figure 2: Part of the GUI of the programme for a mobile phone

Double clicking on the empty space opens a new window where the user can choose the low resolution image. Illustration 1 is showing the required class written in the MIDLet for the super resolution technique on the mobile phone.

Figure 3 shows the image has been uploaded into the software. As it is shown the image has some blocky effects which are not desired. In Figure 4 the uploaded image has been enlarged twice and super resolved by using the DA SR technique.

Due to the fact that the high

ILLUSTRATION 1: THE REQUIRED CODE SEGMENTS IN THE MIDLET WHICH IS USED IN ORDER TO SIMULATE THE DA SR TECHNIQUE

```
public class SuperRes {
 public void paint(Graphics g)
 // Load an image from the MIDlet resources
 if (image == null) {
 try {
            image = Image.createImage("/myimage.png");
 } catch (IOException ex) {
            g.drawString("Failed to load image!", 0, 0, Graphics.TOP | Graphics.LEFT);
 return;
 }
 }
 try{
 alpha = Integer.parseInt( textfield.getString() );
            }
 catch( Exception e ){
 Alert error = new Alert("Invalid alpha", "Please enter a valid enlarment factor", null,
AlertType.ERROR);
 }
 DWT dwt = new DWT( image, 1 ) ;
 Image LL = ImProcessing.resize( image, alpha/2 );
 Image LH = ImProcessing.resize( dwt.LH, alpha );
 Image HL = ImProcessing.resize( dwt.HL, alpha );
 Image HH = ImProcessing.resize( dwt.HH, alpha );
 IDWT idwt = new IDWT( LL, LH, HL, HH, 1 );
 g.drawImage(idtw.getImage(), 0, 0, Graphics.TOP | Graphics.LEFT);
            }
}
```

Figure 3: The software on a mobile phone with an uploaded low resolution image

Figure 4: The software on a mobile phone with the high resolution image

frequency subbands contain directional frequencies, embedding the interpolated high-frequency components (i.e. edges) into the reconstruction process by using IDWT introduces aliasing effects on the super resolved image as shown in Figure 4. However, the achieved gain on the quality of the image is much higher than the loss caused by distortion, and the super resolved image is sharper and less blurred.

New Technique

This article proposes a new super resolution technique based on the interpolation of the high-frequency subband images obtained by DWT and the input image. DA SR technique is using DWT to decompose an image into different subband images, and then the high frequency subband images are interpolated.

An original image is interpolated with half of the interpolation factor used for interpolating the high frequency subband images. Afterwards all these images are combined using IDWT to generate a super-resolved imaged.

The DA SR technique has been tested on well-known benchmark images, where their PSNR and visual results show the superiority of DA SR technique over the conventional and state-of-art image resolution enhancement techniques. ●