Image Denoising Analysis over Wireless Networks

Hamidreza Yazdizadeh Alborz

Department of Electrical Engineering, Amirkabir University of Technology, Tehran, Iran

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Abstract - *Image denoising is one of the most challenging issue in image processing. It further amplifies when an image send through a wireless network. Many reasons can affect the image such as rain, fog, snow, sensors. This paper investigate aforesaid effects and the potential solutions are used in order to denoising.*

***Key Words*: Wireless, Network, Image, Denoising**

1. INTRODUCTION

Wireless networks have many applications in order to send the data. The type of networks are different which are included satellite communication, different wireless communication and integrated wireless networks. The integrated wireless networks have a combined architecture. It is a combination of two or more networks which can be different from each other such as WLAN, WiMAX and Adhoc [1]-[4]. Figure 1 shows these types of networks.

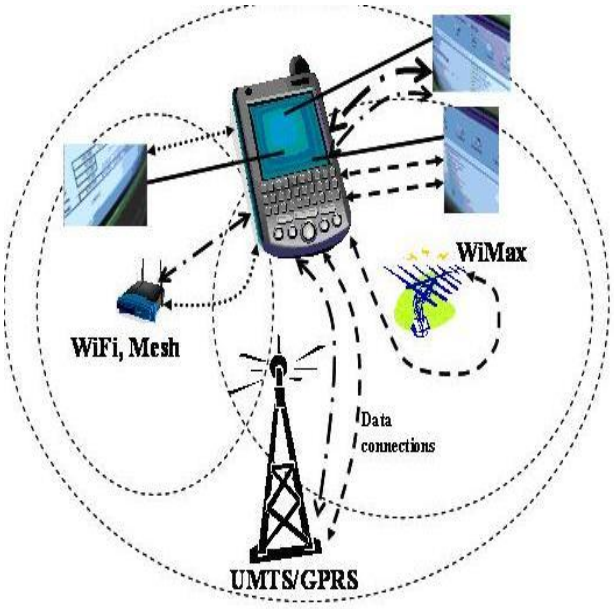

Fig -1: Integrated wireless

The other type of network can be satellite communication which is used for different purposes [5][6]. One of its usage is disaster management [7][8], In this case the data can be interpreted in order to help the people or evaluate the area in which the disaster is happened. The most important data is image which can be used in this process. Figure 2 shows the satellite communication architecture.

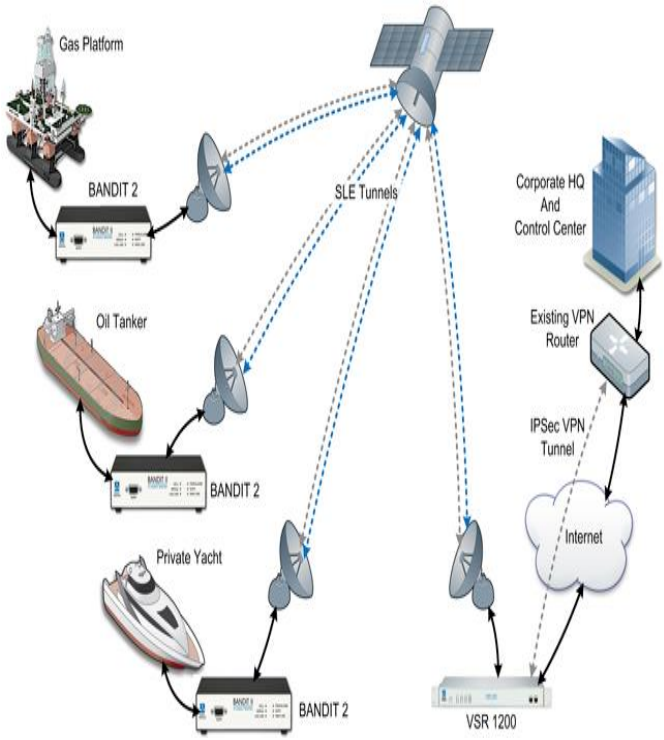

Fig -2: Satellite network architecture

Also, satellite communication can be GPS which is used frequently in communication systems [9] [10]. The data which are sent over these types of networks are different. They can be text, voice, video and image. One of these data is images. When image is sent over the wireless networks, some noise can affect it. These noise caused by channel noise, sensor noise or any other types of noise source. There are some works on image denoising through wireless networks [11] [12]. Therefore, at the receiver side, the degraded noise is obtained. Type of noise is depend on the channel condition. The channel has different effects which creates different random distributions for noise. Also there are some denoising methods in order to restore the image. These methods are based on the type of noise as well as its mathematical distribution [13]. The methods also based on the wireless channel condition in which the image is sent. The denoising and the conditions are discussed later in this paper. The bock diagram of the process is shown in figure 3. The input image data goes through a wireless channel and the degraded image is obtained on the other side, then, the image is restored by the different techniques based on aforesaid conditions.

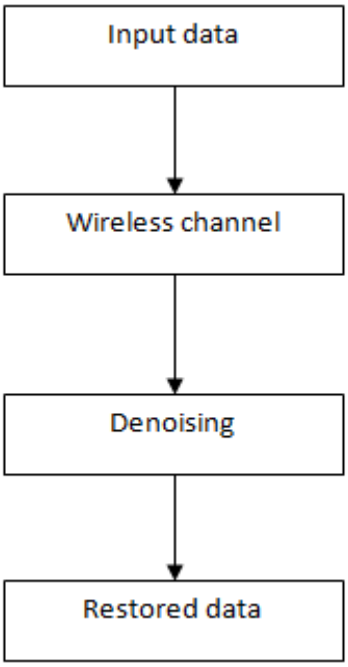

Fig -3: Block diagram

2. CHANNEL

2.1 Natural noise

The channel in the wireless networks is the air. When the data is transmitted through the channel, some noise affect the channel. These types of noise are due to air conditions. One of these types of noise is atmospheric noise which is due to natural process. The lightening, rain, fog, snow and other natural events can be a reason. They are radio noise and can be observed as a combination of white noise and impulse noise. Also, it is dominant in low frequencies. Figure 4 shows the atmospheric noise relationship [14]. One of the important data which can be degraded is the image.

The image data can be affected due to these types of noise when it is received at the receiver side. In this condition, two common types of noise that may appear in the image are impulse and periodic noise [15]. These types of noise randomly affect the image. Then, the image can be restored properly after acquisition based on the related denoising techniques.

2.2 Transmission error

This kind of noise is based on errors which appear during the transmission. These errors can be caused by thermal

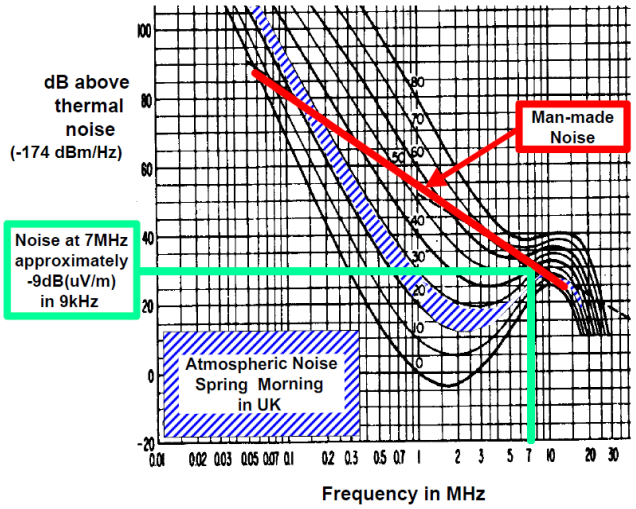

Fig -4: Atmospheric noise relationship

noise [16], signal distortion, cross talk [17], companding which is voice amplitude signal compression, interference, PCM(pulse code modulation) [18], jitter which is variation in signal timings [19] and synchronization. It can be detected and corrected. There are several techniques for error detection and correction.

The image data can be affected due to these types of noise when it is received at the receiver side. In this condition, a common type of noise that may appear in the image is impulse noise. This noise randomly affect the image. Then, the image can be restored properly after acquisition based on related denoising techniques. This is an important problem in ICT [20] issues.

3. SENSOR

Camera sensor is one of major problem which is produced many types of noise. It causes random variation of color in the image. The common type of that is a charged couple device (CCD) [21] and complementary metal oxide semiconductor (CMOS) [22]. The newer one is Foveon X3 sensor which is based on CMOS technology. All of them are based on RF technology [23].

The image data can be affected due to these noise when it is received at the receiver side. In this condition, many common types of noise that may appear in the image are 1) impulse noise [15] 2) Gaussian noise [24] which is additive and independent and the amplifier is a major source of that. At higher frequency, it changes to shot noise which is not independent. Shot noise [15] can be defined as a variation in the number of photons which are sensed at a given exposure level. It has Poisson distribution and also, can appear as dark shot noise [25] in which additional shot noise from the dark leakage in the sensor is produced 3) quantization noise [26] [27] which caused by quantizing the pixels of an image to a number of discrete levels. Its distribution is normal. It is independent, if other noise

sources are big enough. 4) Film grain noise [28] which is dependent and has distribution similar to shot noise. Also, it is called isotropic (non-oriented) source. 5) Anisotropic noise [28] which has significant orientation in the image. These noise randomly affect the image. Then, the image can be restored properly after acquisition based on related denoising techniques.

4. DENOISING

In the denoising block, the image will be denoised based on various denoising methods. It should be done in the receiver side after receiving the data. All noise types have their own denoising process. Impulse noise which appears as black and white pixels [30] [31]. Gaussian noise appears as Gaussian distribution in the image histogram [32]. Shot noise which appears as Poisson distribution in the image histogram. Also, other types of noise have their own distribution and consequently their own denoising method.

There are some algorithms which is used as preprocessing in order to denoising through wireless networks. These algorithms are included Dual-tree complex wavelet transform (DT-CWT) in wireless multimedia sensor networks (WMSN) [11]. It is based on wavelet coefficient estimation and apply an optimal hard threshold function using MAD strategy. It claims that has better performance than 2D-DWT to enhance the WMSN images.

Another denoising is clustering-based sparse denoising in wireless multimedia sensor networks (WMSN)[33] [34]. In this algorithm, the WMSN images are clustered and based on pixel intensity of regions of interest (Bayesian), then, non-local self similarity is used and a new sparse denoising model is created by clustering based sparse representation. It uses both non-local self similarity and sparsity. Finally, in order to solve the l_1 norm optimization problem, a surrogate shrinkage function is used iteratively.

This paper suggests a denoising block as a post-processing method. After the image receives by the receiver, a post-processing is applied on the image and the denoised image is obtained. This can be done by regular denoising methods based on the type of noise. Also, it is possible to add extra steps in order to improve the restored image, for example, multiple denoising steps.

5. CONCLUSIONS

This paper reviewed the previous processes and showed a new procedure for the image denoising through wireless networks. It exploited several blocks including: input data block, a wireless channel, denoising block as a post-processing, an output data block. These blocks have their own process and methods. Then a new procedure proposed as denoising with regard to wireless channel condition. Also, its flexible nature can be improved in the future to add and improve extra blocks.

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