ISSN 1512-1232

AN ADAPTIVE, OPTIMAL AND LOW COMPLEXITY (AOL) SYSTEM FOR THE IMAGE TRANSMISSION OVER POINT-TO-POINT WIRELESS NETWORKS

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Abstract
This paper focuses on image transmission over wireless networks and propose an efficient system to minimize the overall processing-and transmission energy consumption given the expected end-to end distortion constraint. In the proposed system, an image is first encoded as a scalable bit stream with multiple quality layers that is optimal in the rate-distortion (RD) sense. Given the estimated channel condition, the characteristics of the image content, and the distortion constraint, the proposed system can adaptively determine the number of layers to be transmitted and adjust the source coding rate, the source level error resilience scheme, the channel coding rate for each layer through the proposed low-complexity joint source channel coding and power control algorithm. The advantages of the proposed system lie in three aspects: adaptivity, optimality and low complexity.

Keywords*: JPEG 2000, QoS, source coding schemes, channel coding rates*

1. Introduction

Wireless network refers to any type of computer network that is wireless, and is commonly associated with a telecommunications network whose interconnections between nodes is implemented without the use of wires. Wireless networks have had a significant impact on the world as far back as World War II. Through the use of wireless networks, information could be sent overseas or behind enemy lines easily, efficiently and more reliably. Since then, wireless networks have continued to develop and their uses have grown significantly. Cellular phones are part of huge wireless network systems. People use these phones daily to communicate with one another. Sending information overseas is possible through wireless network systems using satellites and other signals to communicate across the world. Emergency (services such as the police department utilize wireless networks to communicate important information quickly)[1][2][3].

1.1 Characteristics of a Wireless Channel

Due to severe wireless channel conditions, such as path loss, fading, co-channel interference, and noise disturbances, the capacity of wireless channels is much lower than wired channels, and the bit error rate (BER) is much higher. A wireless network offers advantages and disadvantages compared to a wired network. Advantages of wireless include mobility and elimination of unsightly cables. Disadvantages of wireless include the potential for radio interference due to weather, other wireless devices, or obstructions like walls. Meanwhile, the throughput may fluctuate due to the time varying characteristics of wireless channels. The severe channel conditions have placed another major obstruction when designing efficient image communication systems over wireless networks [4][5]

1.2 Image Transmission over Wireless Networks

To design an efficient image communication system over wireless networks, there still exist many challenges, of which some are caused by resource limitations, such as power supply and

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processing capability, some from wireless channel conditions, some due to the special characteristics of compressed image data [6][7][8]. Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The reduction in file size allows more images to be stored in a given amount of disk or memory space. It also reduces the time required for images to be sent over the Internet or downloaded from Web pages. There are several different ways in which image files can be compressed. For Internet use, the two most common compressed graphic image formats are the JPEG format and the GIF Format. The JPEG method is more often used for photographs, while the GIF method is commonly used for line art and other images in which geometric shapes are relatively simple. A text file or program can be compressed without the introduction of errors, but only up to a certain extent. This is called lossless compression. Beyond this point, errors are introduced [9][10]. In text and program files, it is crucial that compression be lossless because a single error can seriously damage the meaning of a text file, or cause a program not to run. In image compression, a small loss in quality is usually not noticeable. There is no "critical point" up to which compression works perfectly, but beyond which it becomes impossible. When there is some tolerance for loss, the compression factor can be greater than it can when there is no loss tolerance. For this reason, graphic images can be compressed more than text files or programs. Since image data contains a lot of redundancy, to efficiently utilize limited resources, source compression is always necessary. Compared with general data, the compressed image data has some special characteristics, such as unequal importance, error tolerance, and constrained error propagation [11][12].

2. Limitations of the Existing System

When an image is being transmitted from the source to the destination on occurrence of a corrupted bit the neighboring bits are also likely to become corrupted. This stops the Image Transmission process and the whole process has to be repeated again and again until there is no bit loss. This results in incomplete image transmission. An efficient image communication system over wireless sensor networks is faced by many challenges, of which some are caused by resource limitations such as

- Power supply and processing capability
- Wireless channel conditions
- Special characteristics of compressed image data etc.

Maintaining a good quality of service (QoS) and minimizing average Energy consumption are contradictory.

3. Proposed System

The advantages of the proposed system and lies in the following aspects:

(i) Adaptively (ii) Optimality (iii) Low complexity

These are the key properties for efficient multimedia transmission systems. Adaptively says that the proposed system is adaptive to the channel condition, the characteristics of image content, and the QoS constraint. Optimality says that it can approximate the optimal solution with a tight bound. Low complexity says that the JSCCPC algorithms can be executed with negligible time, which is very suitable for online processing.

Another advantage of the proposed system is that it exploits the error resilient coding schemes at the source coding stage. Most existing systems focus on reducing the channel BER, while here it shows that restricting the error propagation range by applying source error resilient coding schemes can improve the system performance dramatically in many situations. In the proposed system, JPEG is adopted as the source coding standard, which has the following desirable properties:

- state-of-the-art compression performance,
- quality scalability
- strong error resilience

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These three properties are of importance for image transmission over error prone channels, where high compression performance can be used to save limited resources, quality scalability to facilitate the unequal error protection (UEP), and error resilient coding to restrict the error propagation range.

3.1 Description of the Proposed System

The proposed system has been designed with the help of five modules as follows

(i). System Design Module, (ii) Image Compression and Transmission Module, (iii) Missing Block Module, (iv) Image Receiving Module, (v) Error Resilient Module.

3.1.1 System Design Module

Java Swing contains a number of GUI components intended for the System Design. The Controls are declared (i.e. components).If necessary the controls are sub classed in need of a special behavior. When the actions occur- In order for the controls to perform the desired behavior the event-handling interfaces are implemented and registered. The Controls are added to the Container which is again sub classed if necessary. The Sender and the Receiver windows are designed using the GUI components. Frames and Applets use Content Pane. Most Components support Borders and Icons hence used in the System Design. Here the Client gives the URL of the image to be transmitted and the destination address to which the Image has to be transmitted.

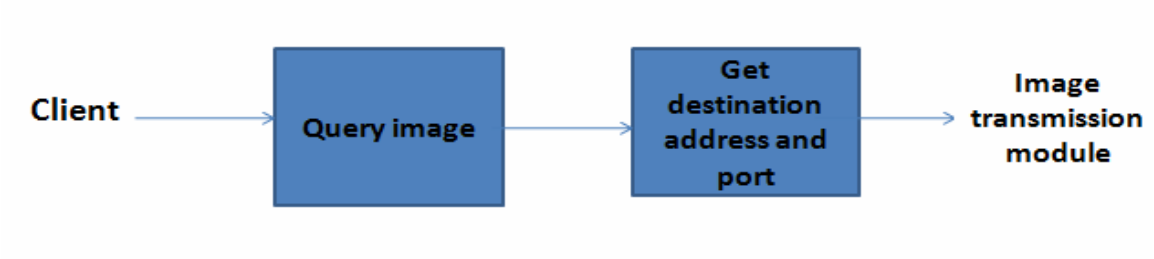

Figure 1. Client entering the query image to be transmitted

3.1.2 Image Compression and Transmission Module

In order to store and transmit an Image in an efficient form image compression is done. This also reduces the redundancy. Image Compression is the application of Data compression on digital images. In effect, the objective is to reduce redundancy of the image data in order to be able to store or transmit data in an efficient form Compression is useful because it helps reduce the consumption of expensive resources, such as hard disk space or transmission bandwidth.

Figure 2. Compressing and transmitting an image

Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image to a unacceptable level. JPEG2000 is a wavelet-based image compression standard. One of the newest photo formats in the technology world today is JPEG2000. This is a more advanced version of the JPEG format that most people are very familiar with and comfortable using. JPEG2000 is able to compress photos to 1:50 or one-fiftieth the size of the original file, without sacrificing quality.

Lossless and lossy compression: the standard provides lossy compression with a superior performance at low bit-rates. It also provides lossless compression with progressive decoding. Applications such as digital libraries/databases and medical imagery can benefit from this feature.

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Protective image security: the open architecture of the JPEG2000 standard makes easy the use of protection techniques of digital images such as watermarking, labeling, stamping or encryption.

Region-of-interest coding: in this mode, regions of interest (ROI's) can be defined. These ROI's can be encoded and transmitted with better quality than the rest of the image.

Robustness to bit errors: the standard incorporates a set of error resilient tools to make the bit-stream more robust to transmission errors.

JPEG 2000 gains up to about 20% compression performance for medium compression rates in comparison to the first JPEG standard.

The usual steps involved in compressing an image are:

1. Specifying the Rate (bits available) and Distortion (tolerable error) parameters for the target image.
2. Dividing the image data into various classes, based on their importance.
3. Dividing the available bit budget among these classes, such that the distortion is a minimum.
4. Quantize each class separately using the bit allocation information derived in step 3.
5. Encode each class separately using an entropy coder and write to the file.
6.

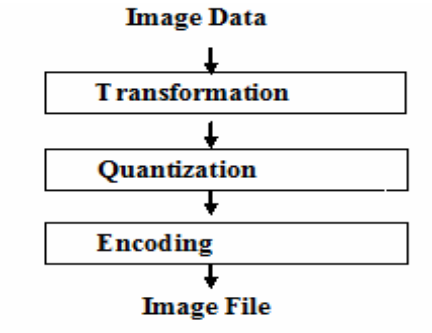

Figure 3. Image Compression

Once the Image is compressed using the jpeg2000 compression standard the Image file is then transmitted over the wireless network. The state-of-art compression performance, quality scalability and strong error resilience-These these properties are of importance for image transmission over error prone channels, where high compression performance can be used to save limited resources, Quality scalability to facilitate the unequal error protection and error resilient coding to restrict the error propagation range.

3.1.3 Missing Block Module

While transmitting an Image there may be the occurrence of some error in the bits as a result the neighboring bits become corrupted. Thus herein we see the usual phenomenon of what happens when a bit is missed.

Figure 4. Missing Block: Bit Corruption Assessment

In computer science, a channel code is a broadly used term mostly referring to the forward error correction code and bit interleaving in communication and storage where the communication media or storage media is viewed as a channel.

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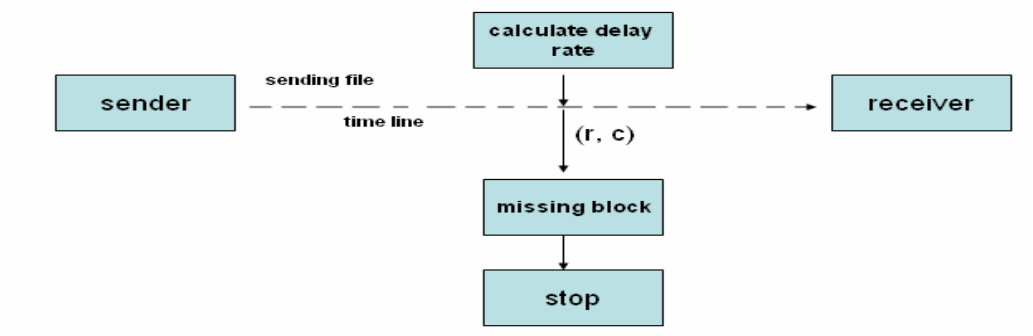

Figure 5. Image sending failed

The channel code is used to protect data sent over it for storage or retrieval even in the presence of noise. In case of the occurrence of a corrupted bit the image is not received further in an attempt to send the Image.

3.1.4 Image Receiving Module

The compressed encoded image data is decompressed and received in the receiver. The Digitized signal is analyzed once again and received by the receiver. Image files are composed of either pixels or vector data. The pixels that compose an Image are ordered as Grid (rows and cols). Each pixel consists of numbers representing magnitudes of brightness and colors. Image file size is expressed as the number of bytes. It increases with the number of pixels composing an image and color depth of the pixels. Each pixel of an image increases in size when its color depth increases. In comparison to the RGB color value the image is received at the receivers end.

3.1.5 Error Resilient Module

Error concealment is a technique to mask the effects of bit loss in transmitting an Image. Because the image signal is sent as compressed bits on a Wireless network, there may be losses or bits being corrupted on getting to the destination. Generally the Image data has to be transmitted again and again on occurrence of a bit loss or corruption. Herein we use error resilient coding schemes to resilience the occurring errors. Error propagation denotes the phenomenon that if some bits are corrupted, the neighboring bits are likely to become useless as well, especially in the case when variable-length coding is applied. Meanwhile, the affected bits can be restricted inside a certain range by applying error resilient coding schemes, thus receiving the reconstructed image.

Figure 6. Error Resilient

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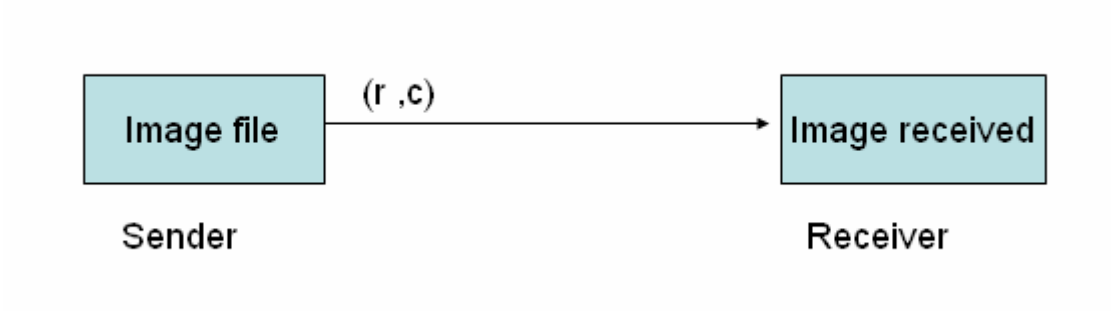

Figure 7. Receiving the complete image

4. Experimental Results

Implementation literally means to put into effect or to carry out. The system implementation phase of the software deals with the translation of the design specifications into the source code. The ultimate goal of the implementation is to write the source code in Java Swing and the internal documentation so that it can be verified easily. The code and documentation should be written in a manner that eases debugging, testing and modification. System flowcharts, sample run on packages, sample output etc. is part of the implementation. An effort was made to satisfy the following goals in order specified.

(i) Minimization of Response Time, (ii) Clarity and Simplicity of the Code, (iii) Minimization of Hard-Coding, (iv) Minimization of the Amount of Memory Used The experimental results of each and every module are as follows.

4.1 Output of Sender and Receiver

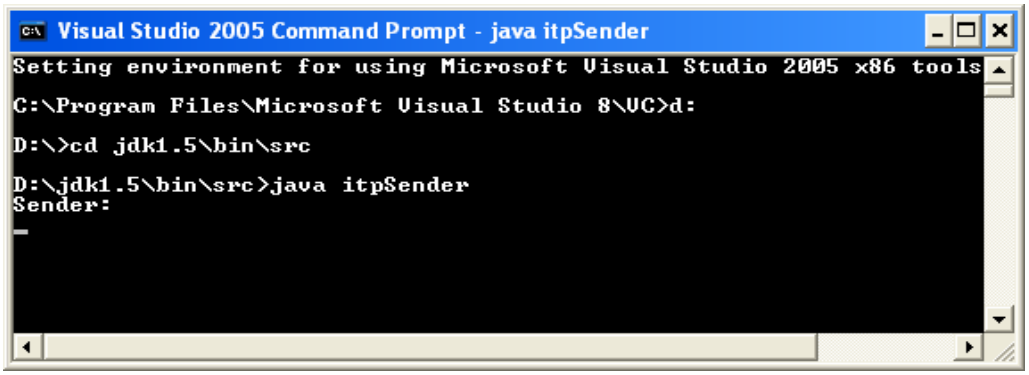

Figure 8. Running the Sender Java File

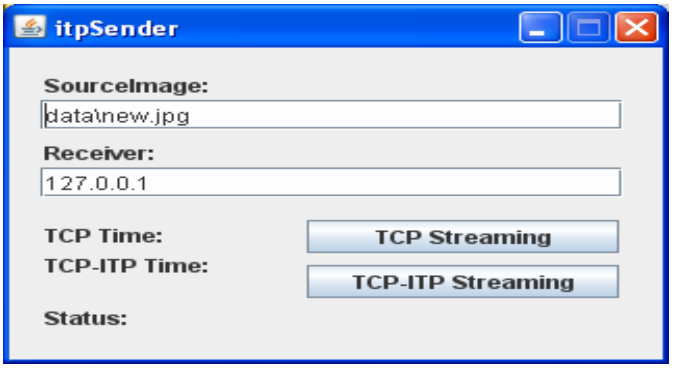

Figure 9. Sender Window

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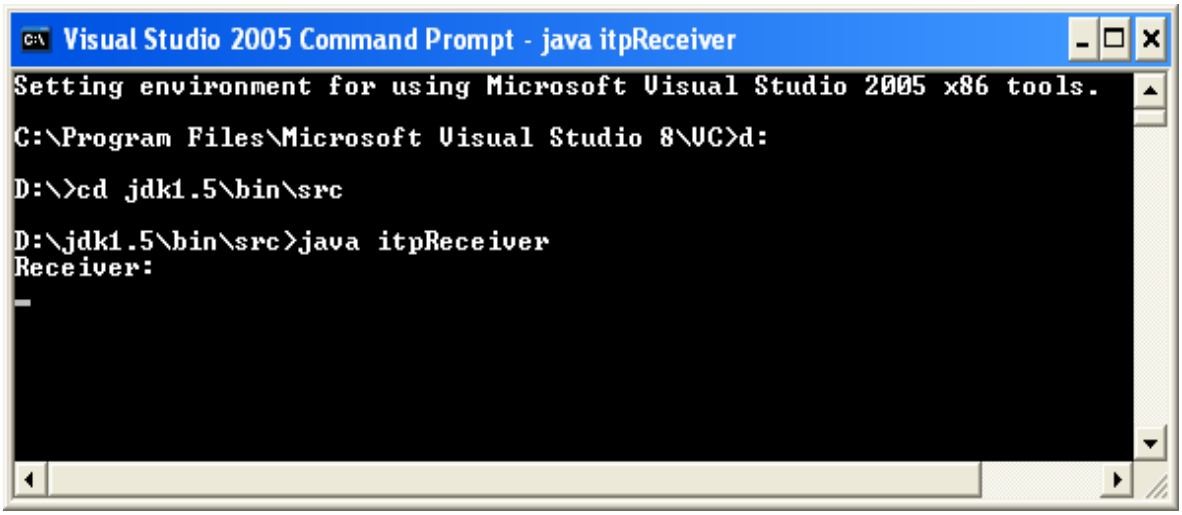

Figure 10. Running the Receiver Java File

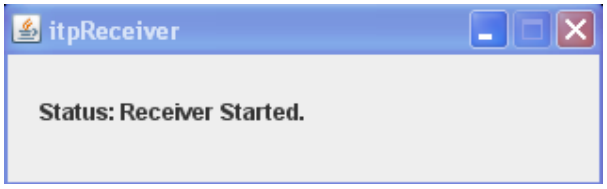

Figure 11. Receiver is started

Figure 12. Receiver is listening to the Sender

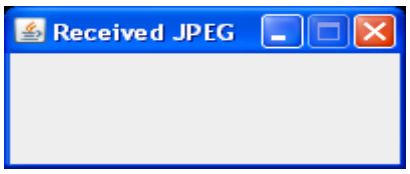

Figure 13. Window for receiving the Image

4.2 Output of Transmitting an Image

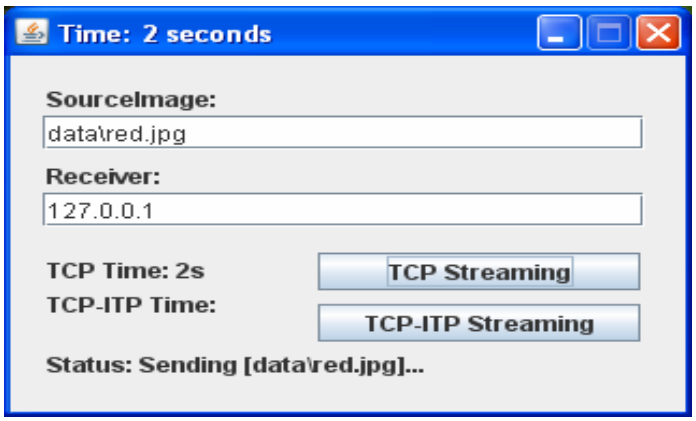

Figure 14. Transmitting a compressed Image File

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4.3 Output of an Error Resiliencing

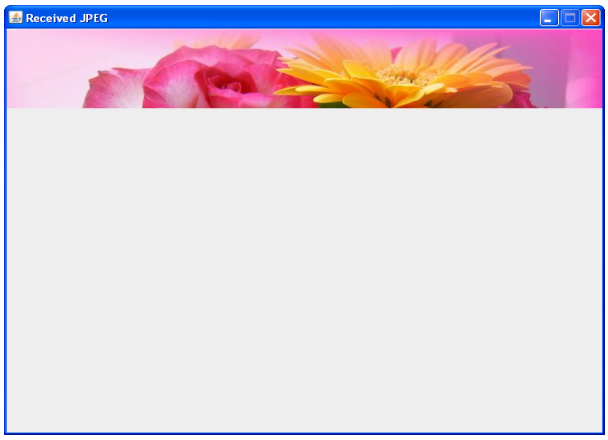

Figure 15. State of the Image before applying the Error Resilient Coding Schemes

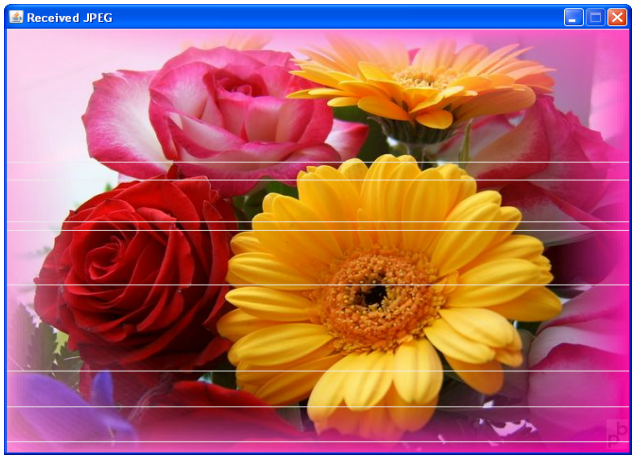

Figure 16. State of the Image after applying the Error Resilient Coding Schemes
Occurrence of errors-Error is Resilienced

5. Conclusion

In this proposed system, JPEG 2000 is adopted as the source coding standard, which has the following desirable properties: state-of-the-art compression performance, quality scalability, and strong error resilience. These three properties are of importance for image transmission over error prone channels, where high compression performance can be used to save limited resources, quality scalability to facilitate the unequal error protection, and error resilient coding to restrict the error propagation range. The proposed Algorithm is adaptable, optimal and has low-complexity, which overcomes the drawbacks of previous approaches, such as high complexity, not adaptive to image content and channel conditions. Simulations have been conducted and Error resilience is analyzed.

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Article received: 2011-11-09