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EFFICIENT VIDEO TRANSMISSION FOR WIRELESS COMMUNICATION NETWORKS USING ZIGBEE PROTOCOL

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ABSTRACT

The rapid growth of digital communication systems causes higher traffic in proliferating wireless networks that causes the need to get higher end videos for communication. The transmission of videos in wireless networks experiences intolerable delays that lead to inconsistent perception of videos. To overcome the above stated problem the efficient zigbee protocol (IEEE 802.15.4) is used efficiently. Consequently it provides a low bit rate and low cost communications for short distances respectively. First a method is proposed in which, the variable delays (i.e. jitter) can be reduced, by virtuously lowering the resolution of video frames from a complete video sequence. The video frames are then mixed with high resolution and low resolution frames of a sequential video. It therefore involves the efficient usage of existing bandwidths which is adopted by the behaviour of 4G networks. A further advancement hereinafter uses cryptographic techniques to provide security to the transmitted video effectively. It involves the encryption mechanism done using elliptic curve cryptography to accomplish a secure video transmission over the WPAN (wireless personal area network) network. The final aim is to show experimental results that prove the achievement of better PSNR (peek-to-peek signal to noise ratio) and VQM (video quality metric) values for enhanced video perception.

KEYWORDS
Internet Protocol (IP) Packet Delay Variation (IPDV) measurement, Wireless Networks, Mean Square Error (MSE), Video Streaming.

1. INTRODUCTION

In the current trends, wireless communication networks based on the International Organization for Standardization/Open Systems Interconnection (ISO/OSI) layers are widely used worldwide in many applications such as colleges, factories, industries, research fields and university campuses. They help in providing a wired access to the network or Internet connections for the home personal computers (PCs), Laptops, and other electronic connectivity devices. The proper working of these applications involve social, medical, manufacturing, scientific and financial [1].

In Some applications the traditional conception of communication networks involves features that are similar to the computing environment. In this scenario, the conjecture is to find the difference between the communicating networks environment and the computer networks environment because of the typical use of communication network such as video broadcasting, television broadcasting (TV), conferencing of video calls, telesurgery and many more. Communication in networks is either wired or wireless for any transmission of data. The data which is transmitted can be any of the following forms: signals, text, image, voice and video. The association of IEEE mainly defines the physical (PHY) and medium access control (MAC) layers for the communication in wireless channels such as 10-100 meters [2].

On the other hand the usage of these services for transmitting the data over proliferating wireless networks causes a higher cost for communication. To meet the requirements of the above stated problem, a low cost and low bit rate zigbee protocol is used. This protocol is stated internationally as IEEE 802.15.4 which is mainly used for the short distance communications. The Efficient zigbee protocol has been very much useful in reducing the cost of communication and helps providing a low bit rate for the transmission of videos is vital. Since humans are the excellent way for the interaction of images/videos the renowned psychometric tests were conducted on humans, which lead to the invention of the JPEG (Joint Photographic Experts Group) algorithm for image compression. JPEG is an ISO/IEC group of experts that develops and maintains standards for a suite of compression algorithms for computer image files.

In this framework, Delay, Latency, Jitter, packet loss and compromised data throughput along with round-trip times are often realized on the Internet protocol (IP) networks will lead to voice and video quality degradation. Consequently an appropriate solution is to be provided to overcome the inconsistent perception of videos by users. In the same way the measurement of delay and jitter plays a fundamental issue which is to be recognized. Specifically, this measurement activity involves the evaluation of the following metrics: throughput, available bandwidth, delay measurements, one-way delay, round-trip delay, variable delay (jitter), and packet loss. These metrics that are related directly to the perception of video-streaming services have been studied. Consequently, these metrics are evaluated at the application layer of the ISO/OSI protocol stack, which requires the comparison of the originally transmitted video and the received one.

2. PRELIMINARY NOTES

Considering the literature studies that are able to study the video quality perceived by the users takes into account the classification of two main categories: subjective tests, in which case the humans are allowed to view, perceive and assess the data (i.e. video) and objective tests, which are completely involved in analyzing and measuring the computational models of the original video and the distorted video sequences [3]. Some of the objective quality metrics which are mentioned in the literature survey reveals that the undistorted or undamaged video signal is fully available. This is called as full-reference (FR) video quality assessment. In practical the reference images or video sequences are quite often not easily perceptible. Hence the measurement approaches for image or video quality are somewhat blind. This blind or no-reference assessment of images or video quality sequences are highly difficult for the humans, as they play an important role in the assessment of the distorted image or videos without using any reference. Another type of the video quality assessment is the reduced-reference video quality assessment in which certain features are extracted from the original signal and then transmitted to the video quality assessment procedure as partial information for the analysis of the distorted video signals [3].

Recently, the most widely used FR objective video distortion/quality metrics are *peek-to-peek signal-to-noise ratio* (PSNR) and *video quality metric* (VQM); consequently these are the factors that are considered here.

The metric used in the computation of the image and video processing is reliable and efficient to compute. This metric is the most popularly used for image and video quality assessment. It measures the image fidelity using the following relation:

$$PSNR = 10.\ Log_{10} \frac{MaxErr^2}{MSE} \quad (1)$$

where MaxErr is the maximum possible absolute value of the color component difference. Simultaneously, MSE is the *mean square error* and can be calculated using the relation:

$$MSE = \frac{1}{w\ .\ h} \sum_{i=1}^{w} \sum_{j=1}^{h} (x_{i,j} - y_{i,j})^2 \quad (2)$$

where w and h are video width and height, respectively, and the corresponding $x_{i,j}$ and $y_{i,j}$ are the pixels in positions i and j of the original received video. However the measurement of MSE does not correlate with the human perception of quality as discussed in [3].

In literature work, the algorithm for the VQM has been mentioned. It provides the analysis of video quality with the help of two input video streams: the original video, which is taken as reference, and the one that is displayed efficiently, which is to be analyzed. The algorithm is based on the *discrete cosine transform* (DCT) [4]. It applies an 8x8 DCT transform to the reference video frame and the corresponding received video frame, respectively. Its objective is to separate the incoming frames into unique spatial frequency components. It later measures the local contrast and converts them in *just-noticeable differences* which apply temporal *contrast sensitivity function* (CSF) filtering. Consequently, the CSF computes the variation of the sensitivity of the *human visual system* (HVS) to distinct spatial and temporal frequencies that are available in the visual stimulus [5].

As mentioned above, the efficient VQMs are mostly evaluated at the application layer of the ISO/OSI protocol stack and imply the requirement of the original transmitted video to be available. On the other hand, in [6], it has been stated that *Quality of Service* (QoS) indexes, especially IPDV, affects the performance of video-streaming services. Additionally, these QoS indexes mentioned above can also be computed at the network layer of the ISO/OSI protocol stack. Thus the relationship between a quality related to the IPDV and the evaluated VQMs are found to be correct. Furthermore, the analysis of the metrics at the network layer and the inconsistent information of the originally transmitted video could be vanquished [7]. This estimator plays a major role for the technicians, to use the video streaming resources efficiently in a WAN network. Next session deals with the proposed work and conclusion.

3. PROPOSED WORK

With regards to the above discussed QoS measurements in compliance with the IPDV estimators, the efficient video-streaming services have been considered in this paper. It includes the consideration of the work is split up into Text Transfer method, Image Transfer method, Video Transfer method, Reduced Resolution Video Transmission, Encryption using Elliptic Curve Cryptography and finally Measurement Analysis. These are explained in the forthcoming sessions respectively.

A. TEXT TRANSMISSION

The transmission of text messages in the real time scenario plays a major role in wireless communications. Eventually, it states that the text which is transmitted travels either in wired or wireless networks. But this paper concentrates mainly on the wireless mode of transmission. The transmission and reception of the text data via internet avails the facility of a certain type of protocol in the network. For this purpose, the efficient zigbee protocol (IEEE 802.15.4) is used here. The relationship between IEEE 802.15.4 and Zigbee is in accordance between IEEE 802.11 and the Wi-Fi Alliance technology. Zigbee is a specification for a suite of high level communication protocols using small, low cost, low bit rate, low-power digital radios for wireless personal area networks (WPAN). The technology implied by the zigbee protocol mechanism is simpler and less expensive compared to other WPANs, such as Bluetooth mechanisms.

B. IMAGE TRANSMISSION

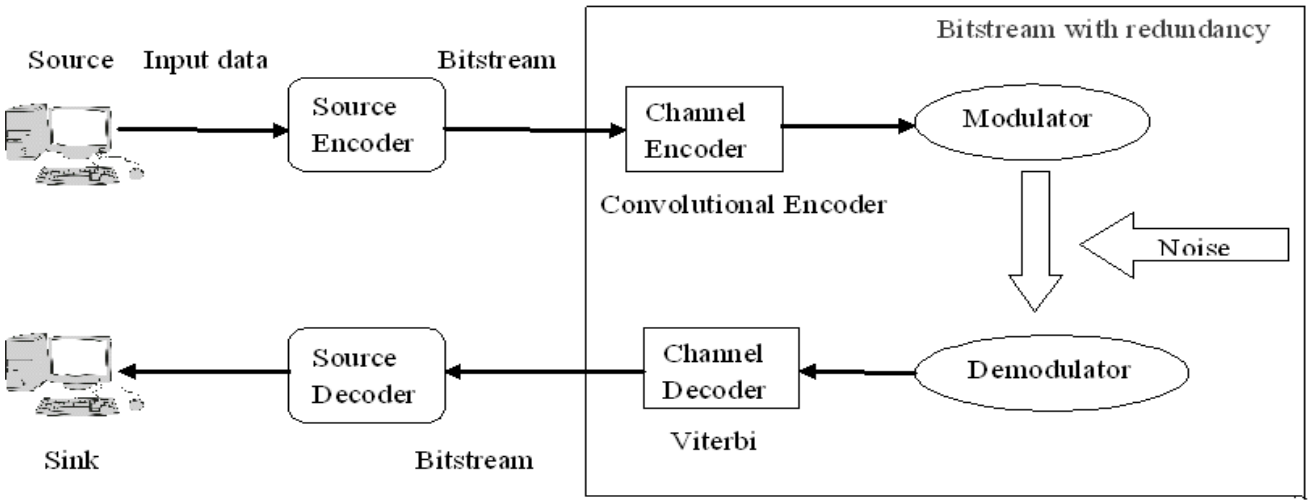
Subsequently, images are also considered as input for the transmission of messages over the wireless media. Since the size of the image is somewhat larger than the text data, the resizing of the image is required to be implemented. This technique specifies the reshaping of the input message (i.e., image) to fit into the corresponding input data format. The difference between the text and the image data is the size of the file which differs in only a few kilobytes (KB) of memory storage. According to the scientists, humans perceive more information from images rather than the text data in real world applications. The format of the images can be jpeg, jpg, gif, tif, png, dicom, and bmp can be provided as input data for wireless communication.

C. VIDEO TRANSMISSION

Consequently, the real time videos along with its features are also transmitted in the wireless network for communication. The technology used for online video transmission is video-streaming services. These services typically include the basic features of the video and its associated properties. Various tests are conducted by emulating a real time video-streaming service from source to the end user.

In this paper, a short term video is transmitted from the source to destination via a wireless channel.

FIGURE-1: SIMPLIFIED MODEL OF PROPOSED WORK



Source: The source output data is based on the input information such as the output of a digital communication machine.

The architecture of the proposed work has the source encoder block which accepts the input data information in the form of text, image, and video respectively.

Source Encoder: The mechanism of converting the output of either an analog or digital source message into a sequence of binary digits is called source encoding or data compression.

Channel Encoder: The sequence of binary digits information from the source encoder block, which is often referred to as the information sequence, is transmitted to the channel encoder block in the simplified model. The main goal of the channel encoder is to present, the binary information sequence with

some amount of information in an controlled manner that can be used at the receiver to overcome the effects of noise and interference encountered in the transmission of the signal via wireless channels. Hence, the introduced redundancy values serves with greater reliability of the received data and improves the fidelity of the received output signal information. Accordingly, the redundant information sequence message aids the receiver in decoding the desired information sequence.

Modulator: The binary sequence at the output of the channel encoder is given to the digital modulation block, which acts as the interface to the wireless communication channels. Since nearly all of the communication channels encountered in practice are capable of transmitting electrical signals (waveforms), the primary purpose of the digital modulator is to map the binary information sequence into signal waveforms.

Channel: The communication channel is the physical medium that is used to send the signal from source to the destination. In wireless communication environment, the channel used can be the atmosphere (free space or air). Furthermore, telephone communication medium, personal computers (PCs) and laptops usually employ a variety of physical media, including wired links, optical fibers, and wireless (microwave radio, Bluetooth, etc.,). Whatever the physical medium used for transmission of the data for communication, the necessary property is that the transferred signal is corrupted in a random manner by a variety of possible mechanisms, such as the additive thermal noise generated by digital electronic devices, human noise, e.g., vehicle engine noise, Environmental noise, e.g., noise during thunderstorms.

Demodulator: At the receiving end of a digital communication system, the digital demodulator processes the channel-corrupted transmitted waveform and reduces the waveforms to a sequence of numbers that represent estimates of the transferred data blocks. The corresponding sequence of data is given to the channel decoder respectively.

Channel Decoder: The channel decoder attempts to reconstruct the original information sequence from knowledge of the code used by the channel encoder and the redundancy contained in the received data. This is where the error correcting Convolutional codes are applied like the hard decision or the soft decision Viterbi decoding algorithm, Maximum A Posteriori decoding algorithm (MAP) and so on.

A measure of how well the demodulator and decoder performs is the frequency with which errors occur in the decoded sequence. More precisely, the average possibility of a bit-error at the output of the decoder is a measure of the performance of the demodulator-decoder combination. In general, the probability of error occurrence is a function of the code characteristics and properties, the different type of waveforms (signals) used for the transmission of information over the wireless channel, the amount of power transmission, the unique characteristics of the medium, i.e., the total value of noise, the nature of the interference mechanism, etc., and the system of demodulation and decoding.

Source Decoder: As a final step when an analog output sequence is considered, the source decoding block accepts the output sequence data from the channel decoding block and, from the knowledge of the source encoding sequence methodology and attempts to reconstruct the original signal from the source. Due to the channel decoding errors and possible distortion introduced by the source encoder block and hence, the source decoding block, the signal occurring at the output of the source decoder is an approximation to the original source output sequence. The difference function between the original signal and the reconstructed signal is a measure of the distortion introduced by the digital communication system.

Sink: The sink is the final received information sequence, the transmitted input which may be text, image, audio or a video. Thus the final information sequence is obtained.

D. REDUCED RESOLUTION VIDEO TRANSMISSION

In general, a video is a collection of frame sequences. When a video is transmitted across the internet its features along with the frames are also transmitted. While transmitting a high resolution video via wireless channel certain type of delay occurs in the communication link. This turns out to be a problem for video-streaming services. The occurrence of delay are due to the factors such as rain, storm, power cut, less memory space available at the receiving end and traffic in the network. To overcome this problem, a technique called reduced resolution video transmission is used here. It involves the mixing of the video frames with low resolution and high resolution frames in a complete video sequence. Afterwards, the obtained video is transmitted across the internet to the corresponding receiver. The system is unicast and describes the transmission from single sender to a single receiver. Thus, this technique reduces the transmission delay and aids perceptible videos for users.

E. ENCRYPTION USING ELLIPTIC CURVE CRYPTOGRAPHY

Security constraints are significant at present scenario in the real world applications. To ensure a secure video transmission the services of cryptographic techniques are used here. It involves the usage of the Elliptic Curve Cryptography (ECC) method which revolves around public-key cryptographic techniques. The performance criteria are based on the algebraic structure of the elliptic curves over finite fields. The input data is first encrypted for security purposes and then transmitted to the receiving end user where decryption takes place. Hence, the overall system is secured.

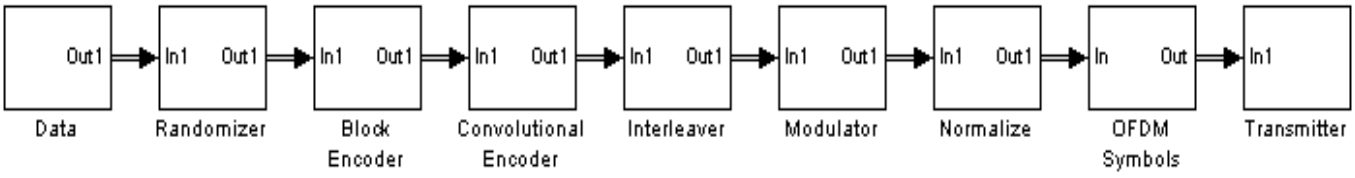
F. MEASUREMENT ANALYSIS

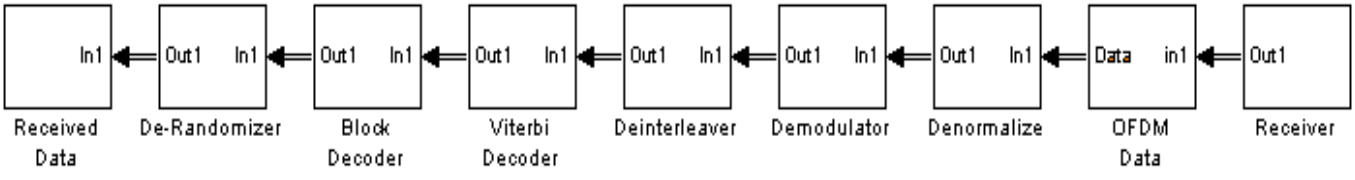
The overall performance of the system with its existing system is analyzed using various metrics. These measurements include the calculation of parameters such as MSE, IPDV estimators at the network layer, PSNR and VQM at the application layer.

4. RESULTS

Initially, the input to the system is given as the text message and transmitted across the wireless medium. This input data is passed as the seven bit ASCII code (American Standard Code for Information Interchange) and then received at the sink node. It is depicted with the help of the simulation results shown in MATLAB (MATrix LABoratory).

For the input text message “Hello” the corresponding ASCII code is 48 65 6C 6C 6F which is given as input and the output is received at the destination. The results of the simulation are given below as follows:





5. CONCLUSION

A reliable and efficient analysis of the WAN supporting video-streaming services has been performed from the service source to the end user respectively. Specifically, the problem of delay is vanquished by the technique of reduced resolution video transmission over the wireless network to enable the users for better perception of videos without any inconsistencies. This mode of communication is achieved in unicast systems successfully. The future work of this paper can be done in multicast systems for efficient video-streaming services.

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