Video Transmission in WMSN Environment using Compressed Sensing Technique

Chetan S. Deshmukh[1], Prof. S.V.Dhopte[2]

Department of Information technology, Sant Gadge Baba Amravati University
PRMIT&R, Badnera, Amravati, India

[1]chetan.deshmukh00@gmail.com

[2]sanjaydhopte@gmail.com

Abstract— **This article presents the design of a networked system for compression with rate control of video in Wireless Multimedia Sensor Network Environment on the theory of compressed sensing. The objective of this work is to detect key frame from video and send onto wireless link with controls the video compression rate, the transmission rate, and the channel coding rate to maximize the received video quality. It is shown that compressed sensing can overcome many problems of video over WMSNs including encoder complexity and low resiliency to channel errors. It is shown that the rate of compressed sensed video can be controlled by sampling rate.**

Keywords— **Compressed Sensing, Wireless Sensor Network, Video Compression. Shot boundary detection.**

I. INTRODUCTION

A Wireless Sensor Network is a network of devices known as nodes having sensing and communication capability. The nodes can sense the environment and send the information gathered from the monitored field using wireless links. The data is forwarded to a sink also called as controller. The sink can use the data locally or send it to other connect networks through a gateway. The nodes can be stationary or moving depends on application. Wireless sensor networks (WSNs) can be used to gather scalar information from nodes acting as sensors in a monitored field such as humidity, pressure, temperature, etc. Nodes in WSNs are electronic devices that can be equipped with a transreceiver, a limited energy supply, a sensing unit, memory chip, processor and a Global Positioning System (GPS). When low-resolution CMOS cameras and microphones are embedded in wireless sensors the nodes are able to communicate multimedia and scalar data. Then the resulting network becomes Wireless Multimedia Sensor Networks (WMSNs) which enhance applications like surveillance, disaster monitoring, wildlife observation, traffic avoidance, industrial process control and localization services [1].

The wireless sensor network consist of node and sink in which, the video data capture by source nodes have to be digitalized and transmitted to the sink wireless links. The energy and processing capability of the sensor nodes is limited and the natures of the wireless links that interconnect them restrict the bandwidth of the communication path. Multimedia coding techniques provides solution over that which are used to compress the original data, reducing the transmission rate and saving energy of the source node over the entire path toward the sink. Some multimedia coding provides error resilience that is ability to correct the error, which may provide acceptable end-to-end quality of the application, even when some packets are lost while transmitted over error-prone wireless links [1] [2].

A new cross layer wireless system based on Compressed Sensing (CS) can offer a convincing solution to various video streaming problems. It is an alternative to traditional video encoders that sense and compress data simultaneously at very low computational complexity for the encoder. Image coding and decoding based on CS has recently been explored [3]. A single-pixel camera can operate efficiently across a much broader spectral range than conventional silicon-based cameras. For transmission of CS images and video streaming in wireless networks, we have to use the Compressive Distortion- Minimizing Rate Control (C-DMRC), a new distributed cross-layer control algorithm that jointly regulates the CS sampling rate, the data rate injected in the network and the rate of a simple parity-based channel encoder to maximize the received video quality over a multihop wireless network [4] [5].

II.RELETED WORK

Video coding standards has drowned a lot of research interest and number of techniques. The basic design of all major video coding standards follows the same block-based hybrid video coding approach. Each block of a picture is either intra-picture coded, with-out referring to other pictures of the video sequence, or it is inter-picture coded, where the prediction signal is formed by a displaced block of an already coded picture. The latter technique is also referred to as motion-compensated prediction and represents the key concept for utilizing the large amount of temporal redundancy in video sequences [5] [6].

In a Research Article by ISO/IEC JTC 1, “Coding of Audio-Visual Objects”(2000), The next generation of MPEG i.e. MPEG-4, is based upon the same technique as its previous techniques. The most important new features of MPEG-4, concerning video compression are the support of even lower bandwidth consuming applications, e.g. mobile devices like cell phones and on the other hand applications with extremely high quality and almost unlimited bandwidth. In general the

MPEG-4 standard is a lot wider than the previous standards. It also allows for any frame rate, while MPEG- 2 was locked to 25 to 30 frames per second. This is the classic MPEG-4 video streaming standard, MPEG-4 Visual [7].

In research article, The H.264 is the new generation standard for video encoding. It can provide good video quality at lower bit rates than previous standards as well as better error robustness or better video quality. The standard is designed to give lower latency and better quality for higher latency. All these improvements compared to previous standards are without increasing the complexity of design so much. The additional goal was to provide flexibility to allow a wide variety of applications like for both low and high bit rates, for low and high resolution video and with high and low demands on latency[8][9].

A number of applications with different requirements have been identified for H.264:

- Entertainment video including broadcast, satellite, cable, DVD, etc (1-10 Mbps, high latency)
- Telecom services (<1Mbps, low latency)
- Streaming services (low bit-rate, high latency)

In research article, The most common rate control scheme is the well-known Transmission Control Protocol (TCP), because of algorithm used in TCP. The variation in the rate determined by TCP can be very distracting for an end user which results in poor end user perception of the video quality. TCP assumes that the main cause of packet loss is congestion and thus misinterprets losses caused by channel errors as signs of congestion. The equation-based rate control schemes regulate the transmission rate of a node based on measured parameters such as the number of lost packets and the round trip time of the data packets[10] [11]. The effects of packet loss and compression on video quality as well as the video distortion over lossy channels of MPEG encoded video with both inter-frame coding and intra-frame coding is studied [12].

III. COMPRESSED SENSING

Compressed Sensing (CS) is a technique that can overcome many problems like encoder complexity and low resiliency to channel error regarding to video over WMSNs. The rate of Compressed Sensed Video (CSV) can be control by varying the compressed sensing sampling rate. CS can offer an alternative to traditional video encoders by enabling imaging systems that sense and compress data simultaneously at very low computational complexity for the encoder. In conventional digital image or video capturing the large amount of raw data acquired which need immediate compression in order to store or transmit. This process has two main disadvantages. First, acquiring large amount of raw image or video data can be expensive particularly at wavelength where CMOS/CCD technology is limited. Second compressing raw data can be computationally complex in case of video. The process of sample, process, keep important information, and throw away the rest, is known as Compressed Sensing (CS). In other applications, such as multi-image capture in camera networks, implementing a compression algorithm may In other applications, such as multi-image capture in camera networks, implementing a compression algorithm may itself be a challenge. These burdens may be reduced by using compressive imaging hardware such as the single-pixel camera where random measurements are collected independently from each frame and no additional compression protocol is needed[3][12].

IV. C-DMRC

The overall architecture of compressive distortion-minimizing rate controller (C-DMRC) is shown in figure 1. The system takes a sequence of images at a user-defined number of frames per second where the encoding is done using compressed sensing and transmits an encoded video in wireless environment. The end-to-end Round Trip Time (RTT) is measured to perform congestion control for the video within the network, and the Bit Error Rate (BER) is measured to provide protection against channel losses. This system combines functionalities of the application layer, the transport layer and the physical layer to deliver video through a wireless network to maximize the received video quality while accounting for network congestion and lossy channels[4][13].

A. CS Video Encoder: - The CS video encoder accept raw samples from the single pixel camera and generates compressed video frames. The compression is based on the correlation between frames.

B.Rate Controller: - The Rate Controller in C-DMRC block takes the end-to-end RTT of the previous packets and the calculate sample loss rate as input to determine the optimal sampling rate for the video encoder.

C.Adaptive Parity:- The Adaptive Parity block uses the Bit error rate of the channel to determine a parity scheme for encoding the samples ,which are input directly from the video encoder and also calculate sample loss.

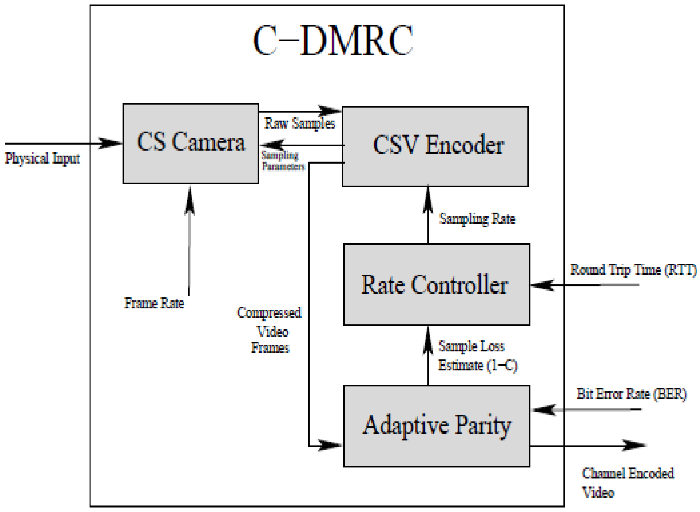

Fig 1 Architecture of the C-DMRC video rate control system.

V. PROPOSED SYSTEM DESIGN

A.Shot Boundary Detection

The CS single-pixel camera can be modelled as two stage process of sampling followed by recovery. We can built a MATLAB implementation of both stages of this process to carry out various test. In shot boundary detection method, A shot consists of continuous frame sequences in video captured by a single camera. Shot boundary detection is the process of identifying changes in the frames of a video sequence so that alternate representations may be used, e.g. key-frames may be extracted from video sequence. An example of a key-frame representation for a 10000-frame sequence, such video storyboards can be obtained by a shot-detection process running on stored or live incoming video. This representation can be used as a video summary to browse the content of the whole sequence and if desired to quickly pick the shots of interest and view them. The definition of a shot change is difficult to make when object or camera motions may change the content of the view frame drastically. To be consistent we define a shot to be a sequence of frames that was continuously captured from the same camera[14].

In the proposed system, rather than capturing the video by actual camera we are taking the video file as a input from video source. The input video file is first processed by shot boundary detection technique which partitioned each frame into number of blocks. Now SBD calculate the block difference between adjacent frame and select key-frames on the basis of block difference. So the frame having block difference large enough are encoded by CSV encoder and transmit towards source.

B. Orthogonal Frequency Division Multiplexing

The rate control scheme can be implemented using Orthogonal Frequency Division Multiplexing (OFDM) which is a multi-carrier transmission technique. OFDM divides the available spectrum into many carriers, each one being modulated by a low rate data stream. OFDM uses the spectrum more efficiently this is achieved by making all the carriers orthogonal to one another which prevent interference between the closely spaced carriers. It provide logical channel in which we can decide signal to noise ratio. The white noise can be introduced in the channel. the frames are transmitted with OFDM transmitter through channel and received by OFDM receiver. After that the compressed frame are forwarded to CSV decoder to get video output.

The transmission is done with the help of OFDM which allow rate controller to take decision. As the frame transmitted towards source node, the quality of video is continuously monitored as the quality of video is higher than required the transmission rate is increased by system. When the transmission rate is higher the quality of video is much high the various error are introduced in transmission which reduce the quality of video. Once the quality of video is lagging the system decrease the transmission rate. In this way the transmission rate is continuously rotate depending on the congestion in network. In OFDM the rate controller takes decision on the basis of two input i.e. RTT (round trip time) and sample loss which is calculated on the basis of Bit Error rate. On the basis of this two input the rate controller decide optimum sampling rate for the CSV encoder.

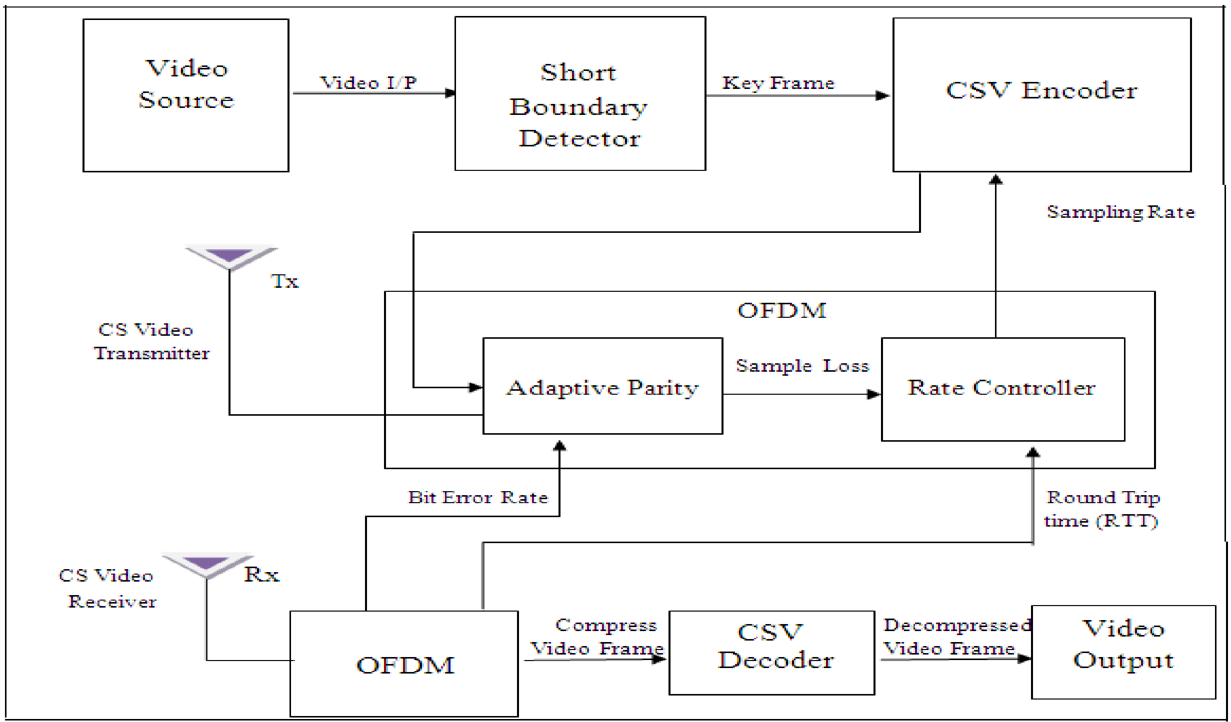

Fig 2 System implementation in WMSN

VI. RESULT AND ANALYSIS

We proposed system, based on Compressed Sensing (CS) for joint compression, rate control and error correction of video. The objective of this work is to design a system that jointly control video encoding rate, transmission rate and channel coding rate to maximize the received video quality [13]. This can achieve with the help of distributed video coding approach and the Compressive Distortion Minimizing Rate Control (C-DMRC). The new distributed cross layer control algorithm C-DMRC jointly regulates the CS sampling rate, data rate injected in network and the rate of simple parity based channel encoder to maximize the received video quality [4].

The proposed work is different in the following sense

- Use information that can be obtained from Short Boundary Detection and do not use the original image in the encoding process at the transmitter. Hence, C-DMRC has the ability to compress images during the detection process, avoiding the need to store the entire image before it is compressed.
- Look at the problem from a networking perspective, and consider the effect of joint rate control at the transport layer, video encoding, and channel coding to design an integrated system that maximizes the quality of wirelessly transmitted CS video.

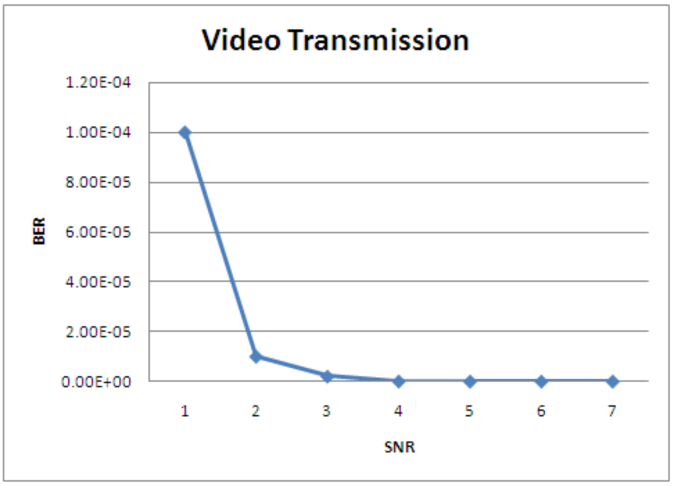

Fig 3 Bit Error Rate

VII. CONCLUSION

We have proposed a wireless video transmission system based on compress sensing. The system consist of video encoder, distributed rate controller and adaptive parity channel encoding scheme to take the advantage of compressed sensed video to provide high quality video to the receiver. Compressed Sensing can overcome many problem like encoder complexity and low resiliency to channel error regarding to video over WMSNs. System use C-DMRC is a new distributed cross-layer control algorithm that jointly regulates the CS sampling rate, the data rate in the network, and the rate of a simple parity-based channel encoder to maximize the received video quality over a multi-hop wireless network.

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