RESEARCH ARTICLE OPEN ACCESS

# Implementation of Automatic Recovery In Packet Loss For Wireless Sensor Network

[1]Mr. Devaraya Vijay Kumar Arjun, [2]Mr. Jammi Ashok
[1]M.Tech, Department of Computer Science and Engineering, Guru Nanak Institute of Technology, Hyderabad, AP-INDIA,
[2]Professor and Head,Department of CSE, Guru Nanak Institute of Technology, Hyderabad,AP-INDIA

**Abstract**
This paper describes with an idea of how the automatic recovery paradigm will work for audio/video streaming data packets in Wireless Sensor Networks. In recent works observed that compressed sensing theory can obtain all the signal information from far fewer measurements by means of non-adaptive linear projection, and can recover the signal information using non-linear reconstruction technique. In this paper according to the compressive sensing theory, a new video codec system has been developed. In the encoding process, the audio/video frame sequences are divided into groups, each group include intra and inter frames. A random measurement matrix is constructed to measure different frames. Then the measurements are quantized, the quantization codes are transmitted on the channel. In decoding process, each frame sequence is reconstructed using the St OMP algorithm and processed in the present system then experimental results shown that the proposed method exhibits better results over the traditional video codec with keeping the same quality of the video image, and it can reduce sampling number significantly, realize easily, encode/decode more efficiently.
**Keywords**:Automatic Recovery, compressed sensing, video codec and measurement reconstruction

## I. Introduction

The demand of information for people increase so fast with the development of formation Technology. The video signals at the most intuitive form of expression, always are paid much attention. A video signal which can be seen as a series of static images formed, each image is called for one frame in a video sequence. Not only intra-pixel image and its neighbors are closely linked, and also between adjacent frames have a very strong correlation. These correlations will result data redundancy, removal of these redundancy will reduce the amount of data, so as to realize the video compression. In current years the appearance of a new theory - is called compressive sensing (compressive sampling). Compressive sensing theory is dissimilar from the traditional Nyquist sampling theory, it has been pointed out that as long as the signal is compressible or sparse in a transform domain, the signal can project from high-dimensional onto low dimensional space by the way of measurement matrix. Then the original signal can be reconstructed from the low dimensional signal by solving an optimization problem. The projection signals contain enough information to reconstruct can be proved.

In theoretical approach, the sampling rate is not determined by the signal bandwidth, but depends on the information structure and content in the signal.In the compressive sensing theory, image/signal both sampling and compression are processed in the low rate, so that the sensor sampling and costing are substantially reduced, and signals are recovered by optimization process. Therefore, the theory shows that it is an effective and directive way transforms the analog signal to digital compression signal, it has direct information sample characteristics. As the theory any signal can be compressed, if sparse representation space could be found, signal can effectively be compressed sample. So the compressive sensing theory will bring a new revolution in the field of signal sampling.

In the proposed work, the compression measurement and reconstruction of the video sequence sparse signal was taken as main line, introduced the theory of compressive sensing framework and the traditional video codec model, proposed video codec scheme based on the theory of compressive sensing, illustrated the concrete methods about the encoding process of the measurements matrix and the decoding process of reconstruction algorithm, analyzed experimental results, which shows that this scheme of video codec has a good prospect.

## II. Comparative Study With Some Prominent Techniques

- **Video Transmission Using Compressed Sensing.** It contains video encoder based on compressed sensing. Where it is shown that by using the difference between the compressed sensing samples of two frames it can capture and compress the frames based on the temporal correlation at low complexity without using motion vectors.

• **Distortion-based Rate Control.** C-DMRC leverages the estimated received video quality based on rate control decision. The transmitting node which controls the quality of the transmitted video. Since the data rate of the video signal is linearly dependent on the video quality, and this effectively controls the data rate. We can maintain short-term fairness in the quality of the received videos by controlling congestion.

• **Rate Change Aggressiveness Based on Video Quality.** In the proposed controller, nodes adapt the rate of change of their transmitted video quality based on an estimate of the impact that a change in the transmission rate will have on the received video quality. The rate controller uses the information regarding the estimated received video quality directly in the rate control decision. If the sending node estimates that the received video quality is high, and round trip time measurements indicate that current network congestion condition would allow a rate increase, the node will increase the rate less aggressively than a node estimating lower video quality and the same round trip time. Conversely, if a node is sending low quality video, it will gracefully decrease its data rate, even if the RT T indicates a congested network. This is obtained by basing the rate control decision on the marginal distortion factor, i.e., a measure of the effect of a rate change on video distortion.

• **Optimality of Rate Control Algorithm.** We conclude that the proposed rate control algorithm can be interpreted as an iterative solution to the optimal rate allocation problem (i.e., finding the rates that maximize the sum of video qualities).

To evaluate the system presented in this paper, the video quality is measured as it is perceived at the receiving node. For most measurements and simulations, structural similarity (SSIM) [22] is used to evaluate the quality. The SSIM index is preferred to the more widespread peak signal to noise ratio (PSNR), which has been recently shown to be inconsistent with human eye perception [22] [23] [24].[2]

The remainder of this paper is structured as follows. In Section II, It is discussed about Comparative Study with Prominent techniques; In Section III will introduce the Automatic-recovery system architecture. The Section IV describes the proposed video encoder based on compressed sensing (CSV). In Section V, It shows the Experimental Results and Analysis. Section VI gives the main conclusions and discusses future work.

## III. RELATED WORK

One of the most common rate control scheme is the well-known transmission control protocol[26]. Because of the additive increase/multiplicative-decrease algorithm used in TCP, the variation in the rate determined by TCP can be very distracting for an end user, resulting in poor end user perception of the video quality [21]. In addition, TCP assumes that the main cause of packet loss is congestion [22], and thus misinterprets losses caused by channel errors as signs of congestion. These considerations have led to a number of equation-based rate control schemes, which analytically regulate the transmission rate of a node based on measured parameters such as the number of lost packets and the round trip time (RT T) of the data packets. Two examples of this are the TCP-Friendly Rate Control [26], which use the throughput equation of TCP Reno [25], and the Analytical Rate Control (ARC) [19] [20]. Both of these schemes attempt to determine a source rate that is fair to TCP streams. However, in a WMSN, priority must be given to the delay-sensitive flows at the expense of other delay-tolerant data. Therefore, both TCP and ARC result in a transmission rate that is more conservative than the optimal rate. For this reason, in an effort to optimize resource utilization in resource-constrained WMSNs, our scheme does not take TCP fairness into account. Recent work has investigated the effects of packet loss and compression on video quality. In reference[23], the authors analyze the video distortion over lossy channels of MPEG-encoded video with both inter-frame coding and intra-frame coding. A factor $\beta$ is defined as the percentage of frames that are an intra frame, or I frame, i.e., a frame that is independently coded. The authors then derive the value $\beta$ that minimizes distortion at the receiver. The authors of [24] investigate optimal strategies to transmit video with minimal distortion. However, the authors assume that the I frames are received correctly, and that the only loss is caused by the inter-coded frames. In this paper, we assume that any packet can be lost, and rely on properties of CS video and on an adaptive parity mechanism to combat channel impairments and increase the received video quality. Quality of service (QoS) for video over the Internet has been studied in [23] and [24]. Both of these works deal with QoS of video over the Internet using TCP or a TCP-Friendly rate controller. In general, a WMSN will not be directly connected to the Internet, so requiring fairness to TCP may result in significant underestimation of the achievable video quality. Several recent papers take a preliminary look at video encoding using compressed sensing. The work is different in the following sense:

(i) It only uses information that can be obtained from a single-pixel camera [21] and do not use the original image in the encoding process at the transmitter. Hence, C-DMRC is compatible with direct detection of infrared or terahertz wavelength images, along with the ability to compress images during the detection process, avoiding the need to store the entire image before it is compressed; (ii) It looks 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.

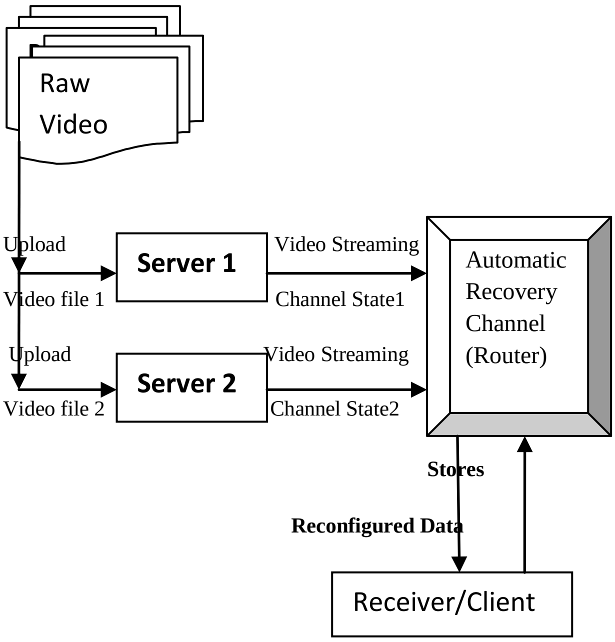


**Figure1. Architecture of Automatic Recovery System**

Finally, several recent papers take a preliminary look at video encoding using compressed sensing. Our work is different in the following sense: (i) Implemented work only use information that can be obtained from a single-pixel camera [18] and do not use the original image in the encoding process at the transmitter. Hence, Automatic Recovery system is compatible with direct detection of infrared or terahertz wavelength images, along with the ability to compress images during the detection process, avoiding the need to store the entire image before it is compressed; (ii) more importantly, 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 CS video transmitted over wireless links.

## IV. Compressive Sensing For Video Codec

In the video signal inter frame coding; residual frame signal represents the corresponding pixels difference that between two adjacent frames. When the objects of video are no movement or the scene of video is no frequently switching, the residual frame signal matrix often has a large number of zero value, is compressible and sparse. The characteristic of residual frame signal fit for the requirements of compressive sensing theory, if apply the compressive sensing theory for inter-frame video signal coding, the video coding will be represented using far fewer measurements, also has strong robustness. Using the compressive sensing methods, the efficiency of video encoding will enable greater while reducing the loss of data and achieving the decoding process in noisy environments. According to Figure 2, design the video codec scheme based on compressive sensing.

### A. Compressive sensing Encoder

The compressive sensing encoder is shown in Figure 2. First the video sequence is divided into image groups before encoding. In encoding process, if the current frame using intra frame coding mode (denoted as I-frame), the frame is directly pre-processed and measured coding, in which the preprocess is an optional step; if the current frame using the inter frame coding mode (denoted as P-frame), the method is previously reconstructed decoded frames as reference frames, and the current frame is subtracted by reference frames to produce the residual frame, then the residual frame is preprocessed and measurement encoded. As the residual image more sparse requires for less measurement samples. Two coding modes measurements are quantized; entropy coded and produces the coded stream.


**Figure2 Compressive sensing Encoder**

B. Compressive sensing decoder

The compressive sensing decoder is shown in Figure 3. In the decoding process, the received coded stream is entropy decoded, inverse quantized, reconstructed by solving the underdetermined linear equations. If get I-frame, the reconstructed image is desired; if get the P-frame, the image is the residual image, and then it is added to the reference frame in the memory to obtain the desired frame. In the two modes, the reconstructed image should be stored into the memory, it will use as the reference frame for next one.


**Figure3 Compressive sensing decoder**

## V. Experimental Results And Analysis

This system experiments, the primary consideration is to solve three key problems which discussed in the section IV of compressive sensing. In this paper, automatic recovery for video signals is chosen at the DCT transformation, in order to increase its recovery level. This measurement matrix is used the Gauss Random measurement matrix [9]. Regarding the reconstruction algorithm, Donoho, proposed a stage wise orthogonal matching pursuit (St OMP [8], Stage wise OMP) algorithm. It has simplified orthogonal matching pursuit (OMP) algorithm in order to approximate the accuracy to further improve the calculation speed (computational complexity is O(N)), is more suitable for solving large-scale problems. This paper utilizes St OMP algorithm to reconstruct information.

So the experimental data utilize the size of 176×144 pixel "akiyo" video sequences; continuous 12 frames are divided into three groups, with four in each group. The first frame of each group is encoded I-frame, while the other of the group are encoded P-frame, the reference frame is chosen as previous reconstruction frame. When I-frame encoding, the measurements N respectively set, N=10000, 15000, 20000, 25000. For a fixed value of N, the P-frame encoding measurements N1 respectively set, N1=1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 5500, 6000, 6500. The Experimental results show that, in the same video sequence, the critical I-frame encoded quality is good or bad for the entire video recovery act as an important role. Figure 2, shows how the Encoding video takes place. Figure 3, shows the I-frame reconstruction results in Decoding Process. The encoding quality is equivalent to the sampling number. For a fixed I-frame encoding quality, P-frame of the sampling number is equivalent to video inter frames encoding quality, but P-frame impact is far less than the I-frame for the same sampling situation.

## VI. Conclusions

In this paper, implementation of wireless video transmission system based on automatic recovery with the compressive sensing was developed and discussed. The system consisting of a video encoder, distributed rate controller and an adaptive parity channel encoding scheme that take advantage of the properties of compressed sensed video to provide high-quality video to the receiver using a low-complexity video sensor node. Simulation results showed that the automatic recovery system produces better results in video quality in both a network with a higher load and a small load. Simulation results also showed that fairness is not sacrificed, and is in fact was increased. Finally, the system was implemented on a USRP-2 software defined ratio, and it has been shown that the adaptive parity scheme effectively combats errors in a real channel and it intend to implement the entire system using USRP-2 radios, including the video encoder and will also measure the performance and complexity of this system compared 9 to state-of-the-art video encoders (H.264, JPEG-XR, MJPEG,and MPEG), transport (TCP, TFRC) and channel coding (RCPC,Turbo codes).

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## Author's Biography

**Prof Jammi. Ashok** is presently working as Professor and Head of CSE department at Guru Nanak Institute of Technology, Hyderabad, A.P. He received his B.E. Degree from Electronics and Communication Engineering from Osmania University and M.E. with specialization in Computer Technology from SRTMU, Nanded. His main research interest includes pattern Recognition, Neural Networks, Data mining and Artificial Intelligence. He has been involved in the organization of a number of conferences and workshops. He published more than 55 papers in International journals and conferences. He has submitted his PhD thesis in Anna University in 2012.