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PACKET LOSS CONCEALMENT USING WSOLA & GWSOLA TECHNIQUES

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ABSTRACT:

In this paper, concealment algorithms to reconstruct lost voice packets are discussed. The algorithms are receiver based and its functionality is based on Time Scale Modifications of speech and autocorrelation of a speech signal. The proposed WSOLA algorithm is time domain approach of time scale modification and is used for many applications. Audio signal packet loss concealment is an important application of WSOLA algorithm. WSOLA algorithm extends the packets before the missing packet to conceal the lost packet. Gain controlled Waveform Similarity Overlap and Add (GWSOLA) algorithm is the modified technique of WSOLA. The gain control mechanism is used in the GWSOLA technique which adjusts the level of audio segments to be overlap added to maintain audio signal level consistent. All simulations were performed in MATLAB. Then the output reconstructed signals are compared on the basis of performance parameters MOS value and PESQ value.

KEYWORDS: PLC; WSOLA; VoIP; gain; TSM; GWSOLA

I. INTRODUCTION

Voice is a real time application and the biggest problem it faces is the loss of packets due to network congestion. The Internet implements protocols to detect and retransmit the lost packets. However, for a real time application it is too late before a lost intermediate packet is retransmitted. This causes a need for reconstruction of the lost packet. Therefore, good reconstruction techniques are being researched. In this thesis a new concealment algorithm to reconstruct lost voice packets is reported. The algorithm is receiver based and its functionality is based on Time Scale Modifications of speech and autocorrelation of a speech signal. In this research, a new reconstruction method which improves the speech quality in voice transmission over IP networks has been developed to conceal the lost packets. The implemented algorithm uses Time Scale Modification (TSM) principle for packet loss concealment. TSM is traditionally used to alter the rate of a signal in order to either expand or compress the signal. All time scale algorithm have two steps analysis step and synthesis step. In analysis step the signal is divided into overlapping frames of equal length. The overlapping period or samples of successive frames is known as analysis time shift.

According to time scale factor the overlapping period is increased or decreased in synthesis step. After that the overlap and add operation is performed. The relation between the analysis and synthesis time shift is given by equation (1.1)

$$Ts = \alpha * Ta \qquad [1.1]$$

where Ts – synthesis time shift
Ta – analysis time shift
α- scale factor

If α is greater than 1 then the output signal will be extended and if α is smaller than 1 then output signal will be shorten.

Time scale modification (TSM) approach can be used to overcome the quality degradation caused by the packet loss regions. To conceal the lost packet, packets before the missing packet are extended such that time scale modification must preserve the pitch frequency of speech signal. Overlap and add (OLA) method is the precursor of nearly all TSM algorithms. The OLA algorithm does not analyze the content of the input signal just overlap and add the signal. Synchronous overlap and add (SOLA) algorithm is a modification of the OLA method. But SOLA does not maintain maximum local similarity. WSOLA is the technique that ensures sufficient signal continuity at segment joins that existed in original signal [3]. The proposed work therefore emphasizes on using waveform similarity overlap and adds (WSOLA) technique to conceal the lost packet. Since WSOLA gives good quality output sound than other time scale modification algorithms [3][4]. Gain controlled Waveform Similarity Overlap and Add (GWSOLA) algorithm is the modified technique of WSOLA. The gain control mechanism is used in the GWSOLA technique which adjusts the level of audio segments to be overlap added to maintain audio signal level consistent [5].

II. LITERATURE SURVEY:

W. Verhelst and M. Roelands proposed the waveform similarity overlap and add (WSOLA) algorithm. The concept of waveform similarity is proposed for tackling the problem of time-scale modification of speech, and is worked out in the context of short-time Fourier transform representations. The evaluation of algorithm was done using informal listening test. The evaluation shows that resulting WSOLA algorithm produces high quality speech output, is algorithmically and computationally efficient and robust, and allows for on-line processing with arbitrary time scaling factors that may be specified in a time-varying fashion and that can be chosen over a wide continuous range of values. The conclusion drawn that WSOLA is preferred when only time-scale modification needs to be performed [3].

Alexander Stinger et al proposed to use WSOLA scheme for packet loss concealment. In this work time scale modification of preceding signal segment was modified such that missing packets were covered by the extended version of preceding segments. They considered the problem of discontinuities at the boundary and also the additional delay caused by error concealment while concealing the lost packet. The proposed algorithm was compared with other methods like silence substitution (s), pattern recognition (PR) and pitch waveform replication (PWR) by subjective hearing tests. The mean opinion score (MOS) was taken and it shows that the quality of recovered signal by using proposed algorithm is enhanced as compared to other methods [4].

L. Wang et al proposed waveform similarity overlap and add technique with gain control (GWSOLA), which is modified technique of WSOLA. The algorithm was proposed for packet loss concealment. In the proposed GWSOLA algorithm, they introduce the gain control into the standard WSOLA technique which could adjust the level of the audio segments for overlap and add in order to maintain the audio signal level consistent. They said that GWSOLA algorithm can be applied in the packet loss concealment of real time voice communications, especially for jitter buffer management of mobile VoIP in order to confront packet loss and packet delay as GWSOLA is transmitter independent and suitable for multicast. To get the quality of time recovered signal they had taken Mean Opinion Score (MOS).The results of work show that GWSOLA algorithm is more suitable for packet loss concealment than standard WSOLA algorithm [5].

J.F. Yeh and P.C. Lin said that WSOLA and GWSOLA techniques consider the packets before the missing packet for concealment of lost packet that leads to the misalignment between the original waveform and the recovered waveform. Packets before and after the missing packets are considered for concealment in BWSOLA technique. So BWSOLA technique maintains consistency in amplitude, frequency and phase between recovered signal and adjacent signal. Thus gives noticeable quality improvement in the recovered signal [6].

III. SYSTEM ARCHITECTURE AND IMPLEMENTATION:

A) PERFORMANCE PARAMETERS: MEASURING THE QUALITY OF RECOVERED SIGNAL:

In the proposed work, after recovering the speech signal using Waveform Similarity Overlap and Add techniques (WSOLA, GWSOLA), the quality of the recovered speech signals is compared using two performance parameters.

- Mean Opinion Score (MOS):

MOS is mean opinion score and gives a numerical indication of the perceived quality of the media received. It is commonly used in voice and video communication. MOS is expressed in number, from 1 to 5, 1 being the worst and 5 the best. MOS is quite subjective. [9] It is defined in ITU-T Rec. P.10.

Table No. 1: MOS rating of speech signal

Rating	Speech Quality
1	Unsatisfactory
2	Poor
3	Fair
4	Good
5	Excellent

- Perceptual Evaluation of Sound Quality (PESQ):

PESQ stands for Perceptual Evaluation of Sound Quality and is an enhanced perceptual quality measurement for voice quality in communication networks. It was specifically developed to be applicable to end-to-end voice quality testing under real network conditions. It is specified by the International Telecommunications Union recommendation ITU-T P.861 [9]. This test rates the quality of speech on a scale of 1 to 5. The worst score is 1 and the best score is 5.

Table No. 2: MOS rating of speech signal

Rating	Speech Quality
1	Unsatisfactory
2	Poor
3	Fair
4	Good
5	Excellent

B) METHODOLOGY OF IMPLEMENTATION:

As the prime need of work is data with lost packet we first arranged the signal in the form of packets with sampling frequency 8 kHz. Each packet contains 160 samples i.e. each packet is of 20 ms, then created the input signal with packets loss. In WSOLA and GWSOLA approaches, basic strategy involved is extraction of previous and afterward packets of the lost packet. Then extract overlapping frames from the previous and afterward packets. Perform Overlap add operation on the hanning windowed overlapping frames with greater overlap to get the output of WSOLA approach. In the GWSOLA approach while overlapping frames gain of each frame is added along with frames. TSM is performed on both sided packets using WSOLA and GWSOLA independently.

C) BLOCK DIAGRAM OF IMPLEMENTATION OF WORK:

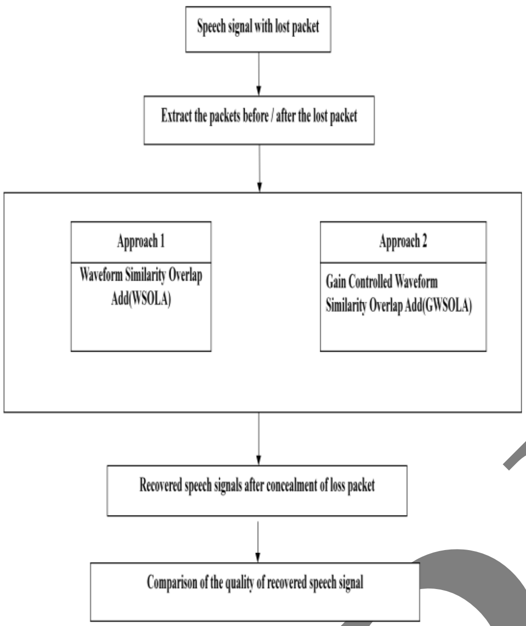

Figure 1 Block diagram of work

IV. SIMULATION AND DISCUSSION:

A) RESULTS OF WSOLA ALGORITHM:

After executing WSOLA algorithm GUI window will be displayed. The speech directory is path for sound folder from where speech signal is to be extracted. One can input speech signal by using recording function. The recording length of the signal is up to 5sec. The figure 2 is GUI window of WSOLA algorithm.

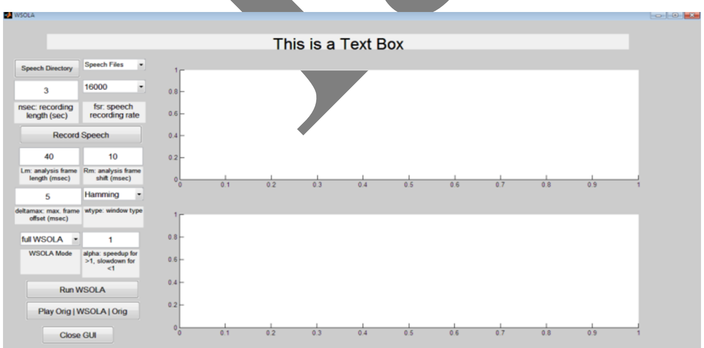

Figure 2 GUI output of WSOLA algorithm

Figure 3 is GUI window of Test signal 1. The red waveform is original signal and the blue waveform is WSOLA based signal. We can execute the signal in frame by frame form also. We can also change the window type. Figure 4 Output command window of Test signal 1.

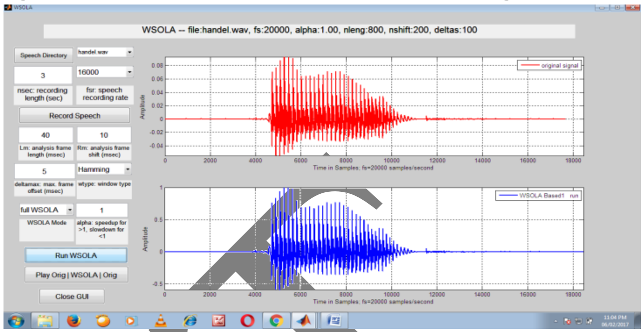

Figure 3 GUI output of WSOLA after applying Test signal1

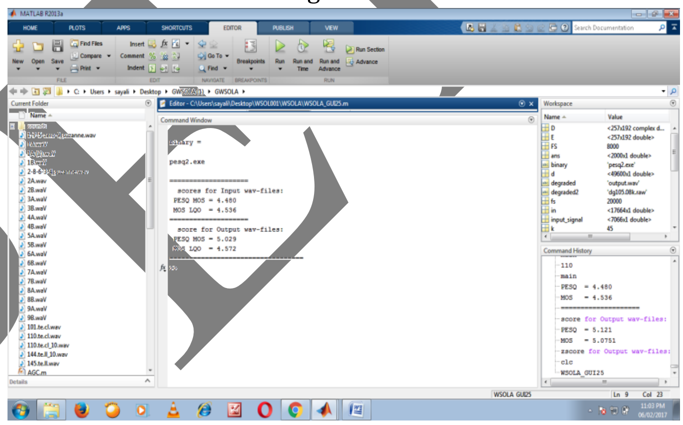

Figure 4 Output command window of Test Signal1

Figure 4 shows command window which is output of WSOLA algorithm. The MOS & PESQ values of both input wav file and output wav file i.e. reconstructed signal is displayed.

B) RESULTS OF GWSOLA ALGORITHM:

The figure 5 shows original signal which is fed to GWSOLA algorithm.

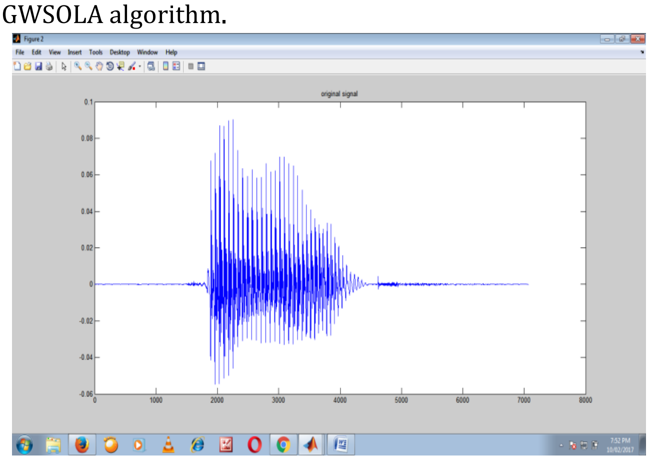

Figure 5 Original Signal of Test signal 1for GWSOLA algorithm

After getting sequence number of lost packet, the algorithm then displays result that consist of original lost packet with the concealed lost packet using GWSOLA algorithm. Figure 6 shows us result of GWSOLA for known lost packet e.g. packet number 25.

The recovered signals by both WSOLA and GWSOLA algorithm are the compared on the basis of performance parameters like mean opinion score (MOS) and perceptual evaluation of sound quality (PESQ).

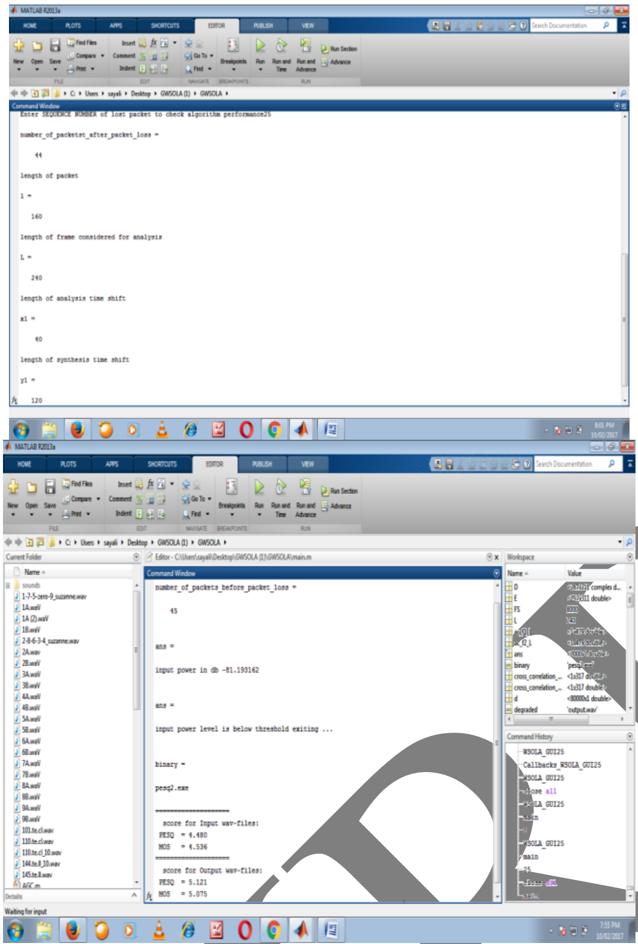

Figure 6 Output command window of Test signal 1

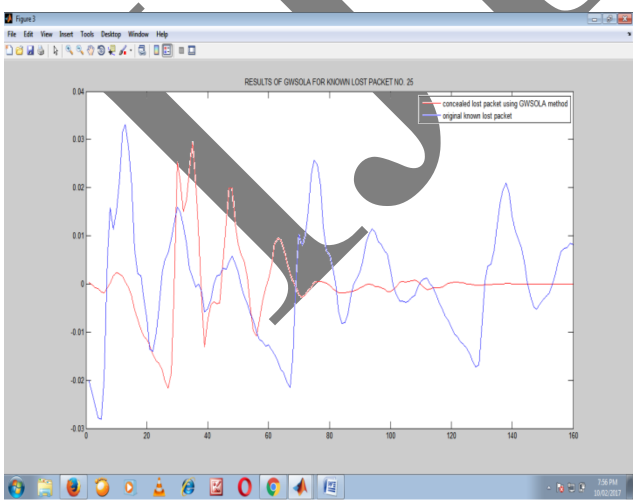

Figure 7 Result of GWSOLA for known lost packet of Test signal 1

Table 3 Comparison of WSOLA and GWSOLA

Sr. No.	Signal name	MOS value of Input signal	PESQ value of Input signal	Algorithm	MOS value	PESQ value	Remark
1	Test Signal 1	4.536	4.480	WSOLA	4.572	5.029	GWSOLA is better
				GWSOLA	5.075	5.121	GWSOLA is better
2	Test Signal 2	1.808	2.200	WSOLA	1.931	2.124	GWSOLA is better
				GWSOLA	2.143	2.163	GWSOLA is better
3	Test Signal 3	1.135	0.879	WSOLA	3.404	3.744	GWSOLA is better
				GWSOLA	3.778	3.812	GWSOLA is better
4	Test Signal 4	1.061	0.345	WSOLA	1.063	1.169	GWSOLA is better
				GWSOLA	1.180	1.191	GWSOLA is better

As per above result we can say the both MOS values and PESQ values of signals after application of GWSOLA algorithm are better than that of WSOLA algorithm.

V.CONCLUSION

From the discussion above, we can see that the standard GWSOLA algorithm is suitable for packet loss concealment in real time voice communications. It extends the successfully received voice frames across the gaps of the lost frames, so that substitutes the lost voice frames by the newly restored ones, while the pitch frequency and timbre of the voice transmitted are maintained unchanged. The shortcoming of the standard WSOLA algorithm is its lack of efficient amplitude controls, which might lead to significant mismatch between the original voice waveform and the restored waveform, and decrease the effect of packet loss concealment. By introducing a gain into the standard WSOLA algorithm, the problem of lacking effective amplitude controls is properly solved, and the restored waveform of the enhanced WSOLA algorithm is obviously more similar to the original one than that of the standard WSOLA algorithm. We can conclude that the GWSOLA algorithm is more suitable for packet loss concealment than standard WSOLA algorithm. It reconstruct the gap caused by lost frame by extends the successfully received voice frames. Both the performance parameters PESQ and MOS value in table shows that GWSOLA algorithm is better than standard WSOLA.

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