Bonus Task: Uniform vs Non-Uniform Quantization

Introduction

This bonus task explores the effects of quantization strategies—uniform and non-uniform—on a recorded voice signal. The goal is to evaluate how these two approaches impact the reconstruction quality after quantization and sampling.

Methodology

1. A real-world voice signal was recorded and truncated to a 2-second segment.
2. Uniform quantization was applied with a fixed step size.
3. Non-uniform quantization used finer resolution in dense regions (e.g., around zero) and coarser resolution elsewhere.
4. The quantized signals were then sampled and reconstructed using sinc interpolation.
5. Finally, we compared the original signal with both reconstructed versions visually and by measuring the error.

Results

Figure 1 shows the original signal overlaid with the uniformly and non-uniformly quantized signals.

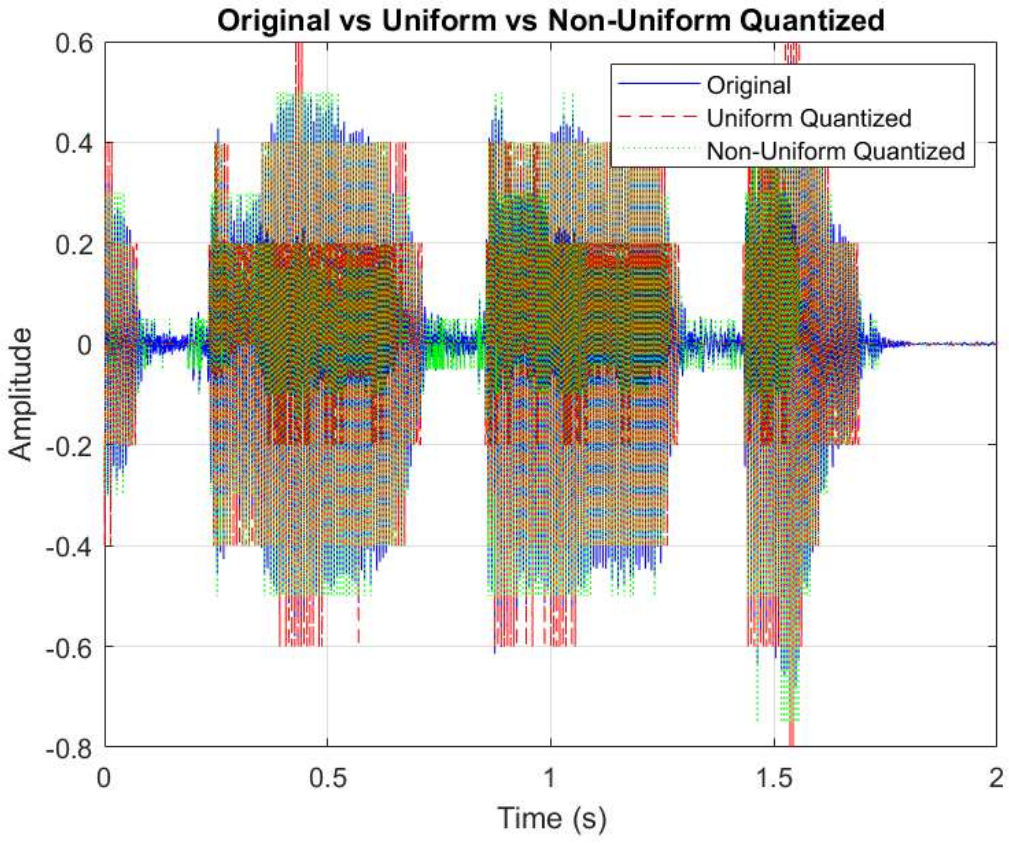


Figure 2 displays the reconstructed signals from both quantization approaches against the original.

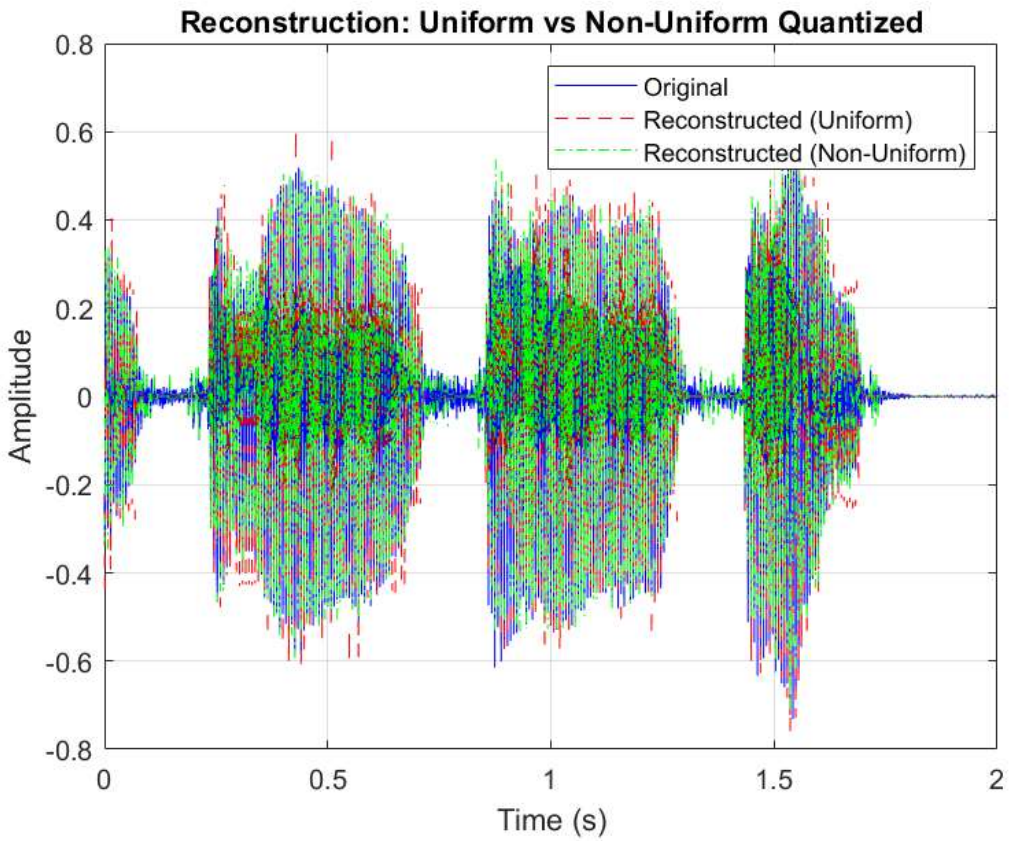
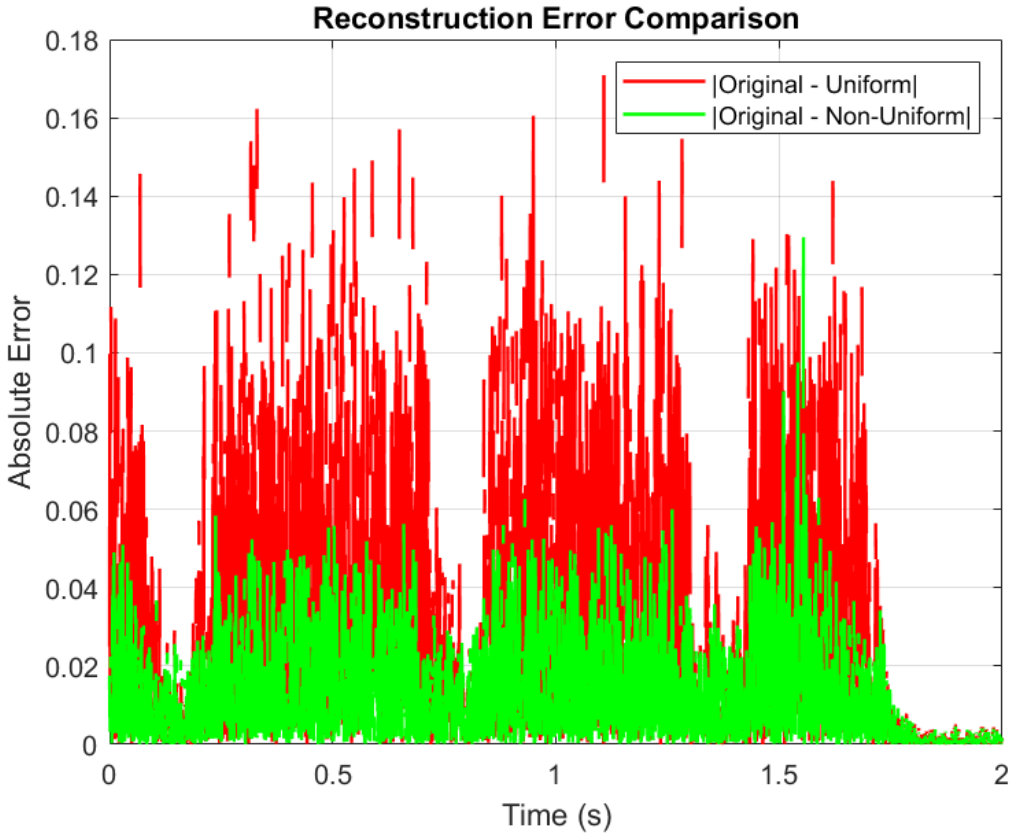


Figure 3 highlights the absolute reconstruction error over time for both quantization methods.



Conclusion

The experiment demonstrates that non-uniform quantization significantly outperforms uniform quantization in terms of preserving the fidelity of the reconstructed signal. The error plot confirms this with visibly lower absolute errors throughout the entire signal duration. This finding supports the idea that adaptive quantization strategies are more suitable for natural signals like speech, which exhibit non-uniform amplitude distributions.