Dual Microphone Noise Reduction Algorithms

MediaTek White Paper

October 2014

This white paper provides a general introduction to the MEDIATEK's robust speech enhancement algorithms.

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1 Introduction

We all have experienced trying to make a phone call from a noisy environment, with the listener at the far-end usually enduring unwanted background noise. It is great if the phone can just mute the background noise for us. Hence, most mobile phones have integrated the noise reduction algorithm to improve the audio quality [1].

In general, noise reduction approaches fall into two main categories, single microphone-based and multi microphone-based methods. Today the single microphone-based noise reduction technology is commonly used in mobile products. The advantage of multi microphone-based noise reduction is its ability to exploit spatial information to reduce non-stationary noise such as music, babbling, and burst noises that cannot be suppressed with a single microphone [2,3]. Multi microphone-based technology typically solves a linear constraint optimization criterion, minimizing the multi-microphone output power subject to a linear constraint, known as look direction constraint, ensures desired response from a specific direction

Although increasing the number of microphones could improve the noise reduction performance, larger number of microphones implies higher costs and increasing requirements in computation load. Moreover, the the location of the microphone on the mobile device is also an issue. As a result, MediaTek is focusing on the development of dual-microphone noise reduction (DMNR).

To achieve the better performance, a pre-trained procedure for the DMNR algorithm is usually needed [4]. The pre-trained procedure is usually performed in a quiet environment with a fixed handset position. If the user does not hold the handset according to a pre-trained orientation, the DMNR algorithm can actually have a worse performance than a single microphone noise suppression algorithm, due to mistakes made distinguishing speech from noise.

In actual usage, however, various holding positions occur all the time. Figure 1 below illustrates ways one may hold the phones.

Figure 1. Different Handset Holding Positions

2 General Dual Microphone Noise Reduction Technology

The figure below represents technology frequently in use today. Speech and “noise” are first extracted with information of pre-defined handset position.

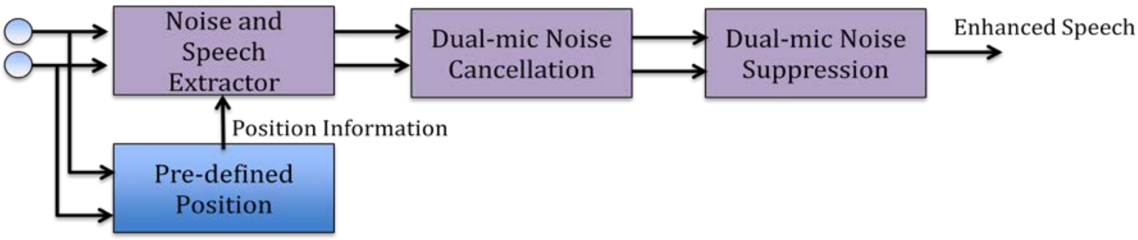


Figure 2. DMNR Algorithm Block Diagram

The desired speech signal can be extracted while blocking the noise signal. However, the extracted signal contains not only speech but also peripheral noise. The Noise Extractor can extract noise while the desired speech signal [6]. The extracted noise, regarded as the noise reference, provides the noise information for Noise Canceller. Since the noise reference is derived, the Noise Canceller could adapt the suitable gain to cancel the noise from the Speech Extractor’s output. Finally, to achieve better noise reduction capability, the Noise

Suppressor is usually utilized and the residual noise can be suppressed according to the estimated signal-to-noise ratio (SNR).

Speech and noise are extracted according to the pre-defined handset holding position. However, if the user does not hold the handset according to a pre-defined position, the reference noise contains not only noise but also speech signal. In this situation, the impure reference noise will cause speech distortion.

3 MediaTek's DMNR Technology

MEDIATEK's Dual Microphone Noise Reduction algorithm, shown in Figure. 3 below, contains the Auto Position Adapter block which can track the desired speech position information automatically. The Auto Position Adapter can track the desired speech position using only microphone signal; there is no need to receive any information from the accelerometer [7]]. Since the desired speech position can be updated adaptively, the Noise Extractor can create a purer reference noise than the general DMNR algorithm can, thereby minimizing desired speech distortion. In addition, the adaption rate is less than 0.5 sec.

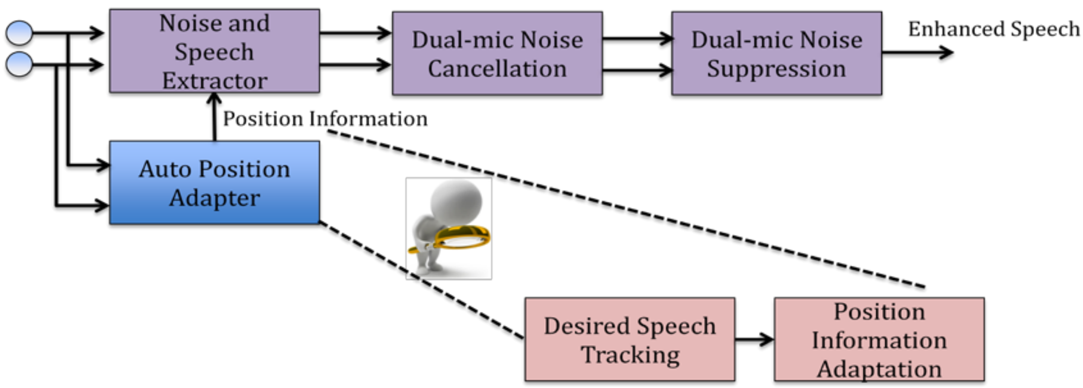


Figure 3. MediaTek DMNR Block Diagram

4 Validation Results

To validate the performance of the Auto Position Adapter experiments were carried out in the MEDIATEK main acoustics laboratory. The handheld positioner was adjusted from the coordinates (0, 0, 10) to (-20, 0, 10). The enhanced speech results with and without the Auto Position Adapter are shown in Figure. 4. It is clear that the MediaTek DMNR algorithm with the Auto Position Adapter has less speech distortion than the general DMNR algorithm.

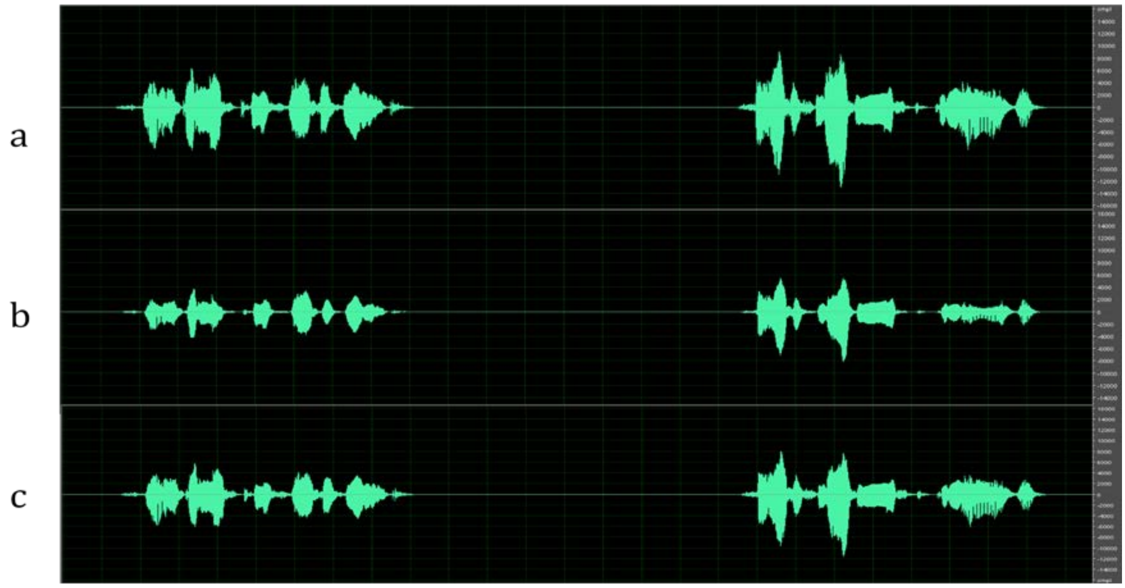
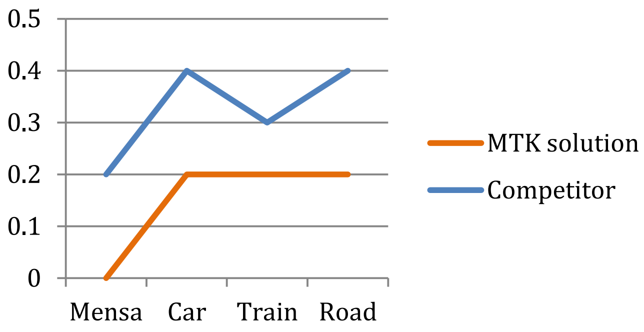
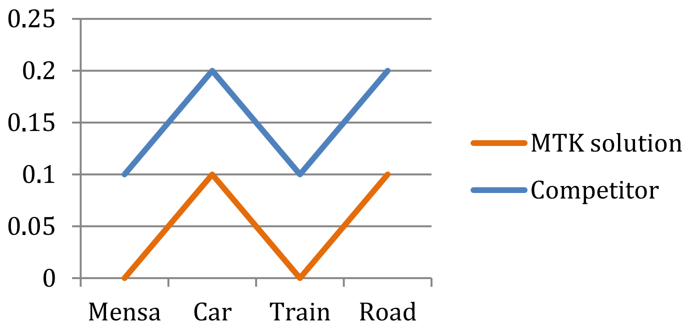


Figure 4. (a): Main microphone received signal, (b): Enhanced signal from general DMNR algorithm, (c): Enhanced signal from MEDIATEK's robust DMNR algorithm

For an objective test, we measured the S-MOS and N-MOS scores in four noise conditions (Mensa, Car, Train and Road) using MEDIATEK's internal K82 phone and our competitor's phone. The handheld positioner was adjusted from the coordinates (0, 0, 10) to (-20, 0, 10) and the S-MOS and N-MOS degradation comparisons are shown in Figure. 5. As can be seen, in N-MOS, our competitor shows 0.1 more degradation than the MEDIATEK solution and in S-MOS, our competitor has 0.1~0.2 more degradation than the MEDIATEK solution. This means that MEDIATEK can be more robust to the variations in handset holding position.



(a) S-MOS degradation



(b) N-MOS degradation

Figure 5. Comparison of S_MOS and N_MOS Degradation

5 Conclusion

This white paper describes the MEDIATEK Dual Microphone Noise Reduction algorithm with robustness to variations in handset holding position. The MEDIATEK's robust DMNR algorithm has a fast adaptation rate to the desired speech position (less than 0.5 s) and can minimize the speech distortion and the degradation of noise reduction when the user changes the handset holding position. Also, the advantage of the auto position adapter has been proven and the S-MOS and N-MOS degradation comparison between MEDIATEK's solution and our competitor is also provided.

6 References

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