

Acoustic Echo Cancelling Technology for Consumer Electronics

1. Why Acoustic Echo Canceling and How ?

Acoustic Echo disturbs smooth communication

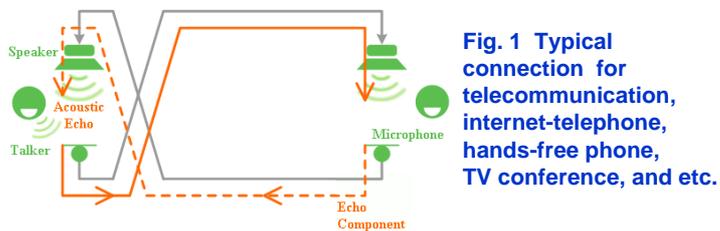


Fig.1 Typical connection for telecommunication, internet-telephone, hands-free phone, TV conference, and etc.

When the talker speaks to his microphone, his voice is transferred and played by the speaker at far end. The microphone at far end picks up the talker's voice. Consequently, the talker hears his own voice echoed back to his speaker with a little delay. This echo disturbs smooth communication.

Echo Canceller keeps communication clear

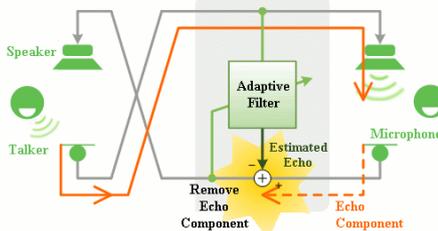


Fig.2 Echo canceling

Adaptive Filter identifies the transfer function between the speaker and the microphone. The echo component is estimated using the transfer function and removed from the coming back voice, captured by the microphone at far end, by echo canceller (gray box)

2. What is the advantage of ARI's Echo Canceling Technology ?

Accurate estimation of echo component

ARI's echo cancelling can accurately estimate echo component. Poor algorithms destroy the voice of talkers and reduce quality of telephone call. (Fig.3, Fig.4, Fig 5)

Rapid convergence in echo component estimation

ARI's echo canceling can identify echo components quickly. Poor algorithms take long to estimate echo component, hence, can NOT remove echo components. (Fig.6.)

Quickly following capability for change on acoustic path

ARI's echo canceling can quickly follow the change of acoustic path, such as movement of microphones. Poor algorithms can not recognize the change and result in the increase of residual echo.

High tolerance to disturbance

Environmental noise, such as air conditioner, refrigerator, the noise incoming from outside and etc., disturbs the estimation of echo. ARI's echo canceling is stable against such disturbances. (Fig.7)

3. Fast H-infinity Filter (FHF)

ARI's excellent echo canceling adapts J-FHF algorithm, which is an improved version of the FHF algorithm. FHF and J-FHF are invented by **Prof. Kiyoshi NISHIYAMA at Iwate University, Japan.** (Note1) The super cool algorithm FHF has all the necessary feature;

- The transfer function between the speaker and the microphone at far end must be accurately identified to estimate and remove echo component perfectly;
- The identification algorithm must be also quick and flexible.

(Note1) Patent No. and Patent name

- WO2002-35727, "System Identifying Method"
- WO2005-15737, "System estimation method, Program, Recording Medium, System estimation device"

4. FHF is applicable for various fields

FHF is applicable not only echo cancelling but also noise reduction, howling suppression, 3D audio, virtual sound, system control, and etc.

ARI has been developing

- Echo cancelling system for Skype,
- Noise cancelling system,
- Howling suppression system,
- Direct identification algorithm of inverse transfer function for 3D audio and virtual sound system,
- Pre-processor for speech recognition system,
- Sound field correction system, and etc.

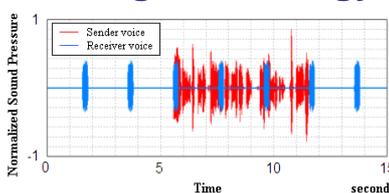


Fig.3 Example of the waveform captured by the mic. at far-end
The blue waveform indicates the voice spoken by the person at far end. The red waveform indicates the voice from the speaker at far end, which is the echo component.

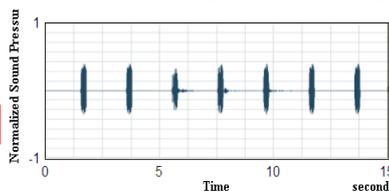


Fig.4 Result of ARI's echo cancelling

ARI's echo cancelling can remove the echo component almost perfectly without destroying voice at far end.

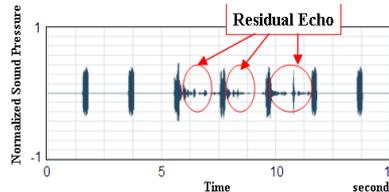


Fig.5 Result of the echo cancelling using conventional algorithm.

Conventional algorithm can not remove the echo component because of the slow convergence. It even affects the quality of the voice at far end.

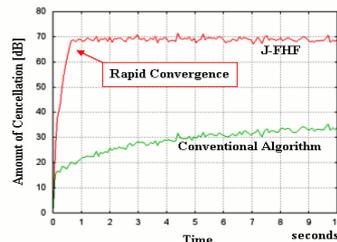
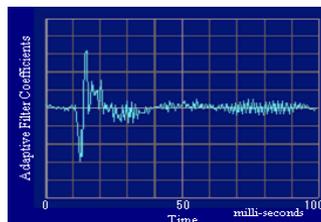
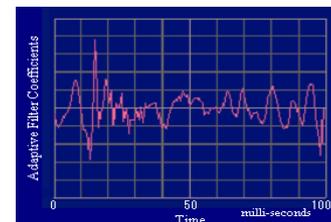


Fig.6 Comparison of convergence speed of J-FHF and a conventional algorithm when used AR signal

J-FHF converges quickly and accurately within a second while the conventional algorithm takes long.



(a) estimation by J-FHF algorithm



(b) estimation by conventional algorithm

Fig.7 Comparison of the example waveforms of filter coefficients (transfer functions) identified in echo cancellers

The coefficients by J-FHF algorithm shows impulse-like response.

The coefficients by conventional algorithm is disturbed by environmental noise.

5. Contact Information

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