Overview of the Cochlear Implant and Brief Comparison among Hearing Aid Devices

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Block Diagrams of the Cochlear Implant

External speech processor

Implantable unit

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<th>External audio signal input</th>
<th>Transmission Coil</th>
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<td>Feedforward and Backward Telemetry</td>
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Speech → Microphone → Analog Pre-processor → DSP Hardware → Power amplifier

Intra-cochlear electrode array → Receiver-stimulator Integrated Circuit → Receiver coil
Functions of the DSP Hardware

Speech signal from the analog pre-processor

A/D conversion → FFT → Average power calculation → Nonlinear mapping

Stimulation level for each channel

Other method is by digital IIR or FIR filter. But, FFT is more efficient, even though the total number of computations is substantially lower than the other two.
Concept of signal processing in Cochlear with digital filter method

Frequencies are decomposed into different band, which corresponded to different electrode position of cochlea respectively.

- Pre-Amplifier
- Bandpass Filter
  - BP1 (Low Freq.)
  - BP2
  - BP3
  - BP22 (High Freq.)

- Envelope Detection
  - Rectifier and Lowpass Filter
  - Compression

- Electrode #1
- Electrode #2
- Electrode #3
- Electrode #22
Comparison among different Hearing Devices

- **Hearing aids**: Sound out
- **Middle ear implants**: Vibration out
- **Cochlear implants**: Electric out
- **Brainstem implants**: Electric out