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Artificial cochlea machine applied design

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Abstract:

Many people complain a problem in their ability to hearing that's result from damaging in the hair cells in cochlea in the inner ear, like a sensorineural hearing loss, in our study we will explain the technology of a cochlear machine design that is overcome the damage inside the inner ear cells and helps the human ears to convert the sounds into an electrical signals detects and stimulate the hearing nerve then to the brain to help these people to restore its ability to hearing at least 50%.

The cochlear machine is an electronic device used inside the inner ear of the human to give the ability to hearing in some cases of deaf it is contains of two parts that's working together to convert the mechanical sound waves into electrical impulses stimulates the auditory nerve. external parts: Microphone, Amplifier, speech processor, transmitting coil, and Internal / implant parts : receiver/stimulator , electrodes transducer array . The second implanted part is a transmitter /receiver stimulator and an electrode array that is converts the signals into electrical impulses trigger the hearing nerve.

We will discuss the cochlea machine design block diagram, and an experimental application.

Introduction:

The normal hearing is accomplished by detecting the sounds waves by the auricle which concentrate the sound waves and direct it into the external auditory canal , vibrate the ear drum (Tympanic Membrane) this vibration transmitted through the middle ear by moving of the auditory ossicles and the oval window which sets up fluid pressure waves in The basilar membrane inside the cochlea portions in the inner ear which moves the hair cells which produces receptor potentials to generate of nerve impulse .

High intensity sound waves cause a large vibrations in the basilar membrane which leads to higher frequency of nerve impulse reaching the brain, louder sounds also stimulates larger number of hair cells as shown in the figure

Figure(1): frequencies distribution through cochlea

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Low frequency sounds causes the membrane to vibrate near the apex , while high frequency vibrations lead to vibrate the basilar membrane at its base

Low frequencies cause the membrane to be displaced near its apex, while high frequencies stimulate the membrane at its base

The hair cells in the inner ear cochlea is responsible to convert mechanical vibration into electrical signals which is mainly work as a displacement transducer that's used in the cochlea machine.

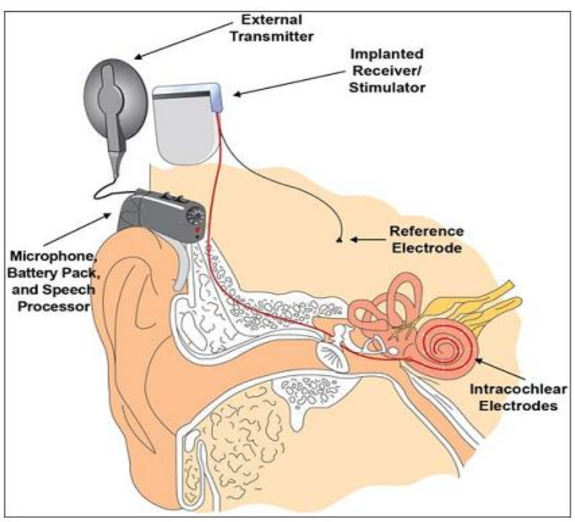
Components of a Cochlea implant machine

The cochlear machine is composed of two major two major parts (1) the outer part that is subjected behind the ear auricle, and contains of microphone that's detects the sounds waves from the environment and a speech processor that arrange the sounds waves detected by the microphone, then to (2) the inner part which contains the transmitting coil that sends the coded signals into the implanted portion inside the skin. as shown in figure (1)

Cochlea machine contains of the following basic parts :

1. Microphone
2. speech processor
3. receiver transmitter
4. interchochlear electrodes

Figure (1): components of cochlear machine system



It is important to use a compatible bio-material of the implantable organs with the body tissues its should have the ability of The durability of biomaterial and a The long-term stability.

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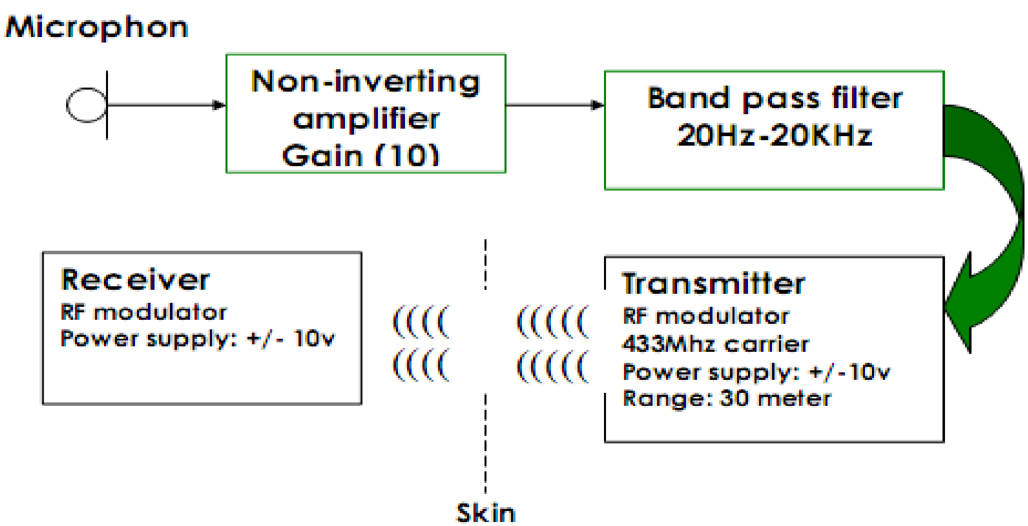
Methods and application:

Cochlea machine applied design:

Figure (2) : simple experimental hardware application of chochlea implant



1) A microphone:

Microphone is a displacement transducer that's converts mechanical waves into electrical output by an electromagnetic transduction.

2) Non-inverting amplifier:

Which amplify the signal of microphone that is mostly small and weak.

3) speech processor:

It selects the sounds most useful for understanding speech and codes them electronically.

bandpass filter with a bandwidth 50Hz-20KHz is responsible of this job.

4) transmitting coil:

it's a coil located behind the patient ear , its transfer the modulating signals from the speech processor into the receiving coil inside the ear.

An electrical transmitter used for this job

5) The receiver:

It converts the electrical signals from transmitter; converted into suitable coded signals that it sends along the electrode array implanted in the chochlea of the patient.
We use an electrical AM receiver for this job.

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Results:

When we applied our experiment and constructed the components as shown in figure (2), and take the output results using digital oscilloscope as shown:

Figure (3): the output signal from the electrical transmitter

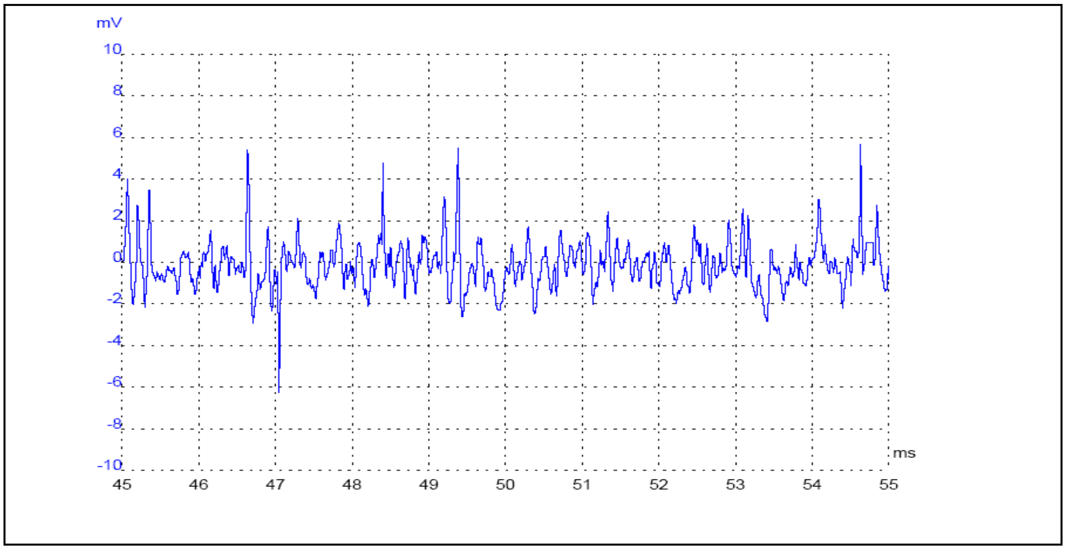
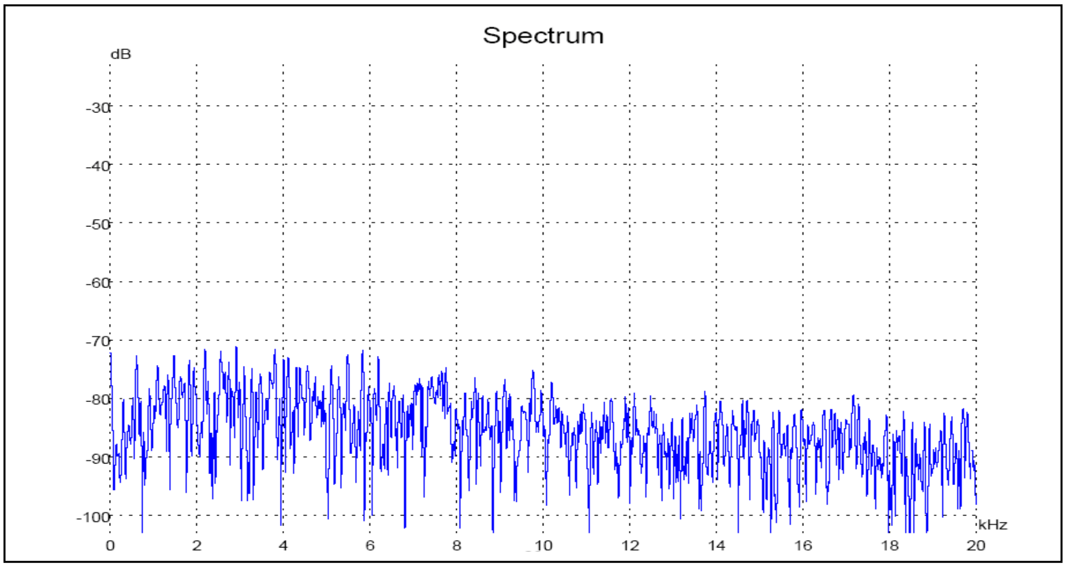


Figure (4): the output signal from the electrical receiver



Conclusion:

We present an overview of one technique that has been used for cochlea prosthesis, and suggest artificial cochlea model, We chose a single channel cochlear implant model that's shown in **figure (1).** The purposed prototype was experimentally tested in the lab, and its results shown in figures (2,3) above. First we connect the microphone to the non-inverting amplifier to amplify its week signal, and then we use a band pass filter to represent the job of a speech processor that's found in the commercial devices (make one channel of 20Hz-20KHz range). Then we feed the signal to an RF transmitter then we get the output signal from the receiver. The output signal from receiver is a function of the sound frequency. As the value or the loudness of the sound is changes the output signal detected is change. We display the signal using digital oscilloscope to give more clear output.

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