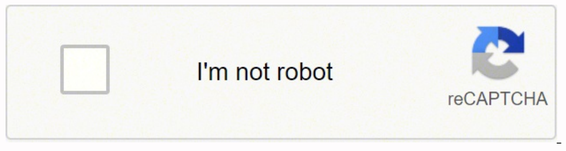

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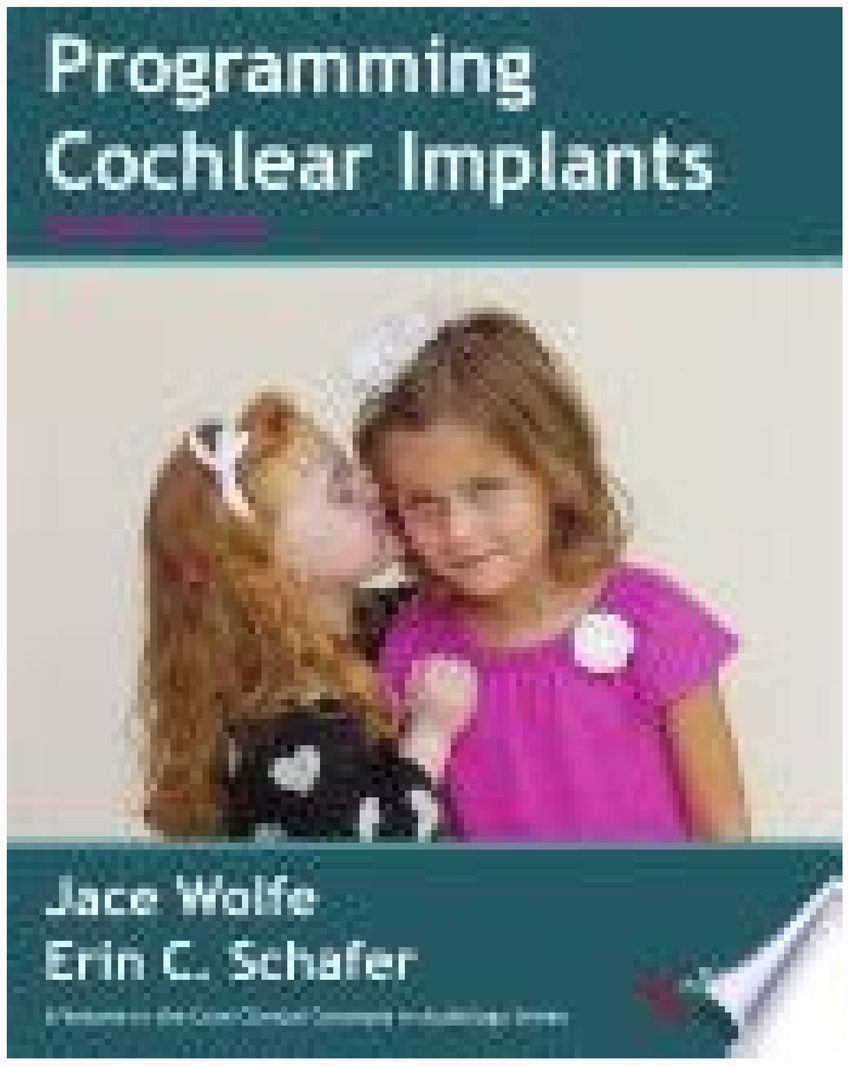
Image guided cochlear implant programming



Automatic electrode configuration selection for image-guided cochlear implant programming

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ABSTRACT

Cochlear implants (CIs) are neural prosthetics that stimulate the auditory nerve pathways within the cochlea using an implanted electrode array to restore hearing. After implantation, the CI is programmed by an audiologist who determines which electrodes are active, i.e., the electrode configuration, and selects other stimulation settings. Recent clinical studies by our group have shown that hearing outcomes can be significantly improved by using an image-guided electrode configuration selection technique we have designed. Our goal in this work is to automate the electrode configuration selection step with the long term goal of developing a fully automatic system that can be translated to the clinic. Until now, the electrode configuration selection step has been performed by an expert with the assistance of image analysis-based estimates of the electrode-neural interface. To automatically determine the electrode configuration, we have designed an optimization approach and propose the use of a cost function with feature terms designed to interpret the image analysis data in a similar fashion as the expert. Further, we have designed an approach to select parameters in the cost function using our database of existing electrode configuration plans as training data. The results we present show that our automatic approach results in electrode configurations that are better or equally as good as manually selected configurations in over 80% of the cases tested. This method represents a crucial step towards clinical translation of our image-guided cochlear implant programming system.

KEYWORDS: Cochlear implant, stimulation strategy, image-guided cochlear implant programming

1. INTRODUCTION

Over the last 20 years, cochlear implants (CIs) have become the most successful neural prosthesis and are used to treat severe-to-profound hearing loss [1]. In CI surgery, an array of electrodes is blindly threaded into the cochlea. After the surgery, the processor worn behind the ear sends signals to the implanted electrodes, which stimulate the auditory nerve pathways within the cochlea. After implantation, the CI is programmed by an audiologist. The CI programming begins with selection of a general signal processing strategy, e.g., continuous interleaved sampling [2]. Then the audiologist defines the "MAP," i.e., the CI processor instructions that determine what signals are sent to the implanted electrodes in response to incoming sounds. The MAP is determined by specifying the electrode configuration, i.e., which electrodes are active, by specifying stimulation levels for each active electrode based on measures of the user's perceived loudness, and by selecting a frequency allocation table that specifies which electrodes will be activated when specific sound frequencies are detected. Electrode activation stimulates the spiral ganglion (SG) nerves, the nerve pathways that branch to the cochlea from the auditory nerve. In natural hearing, an SG nerve is activated when the characteristic frequency associated with that pathway is present in the incoming sound. The SG nerves are tonotopically ordered by decreasing characteristic frequency along the length of the cochlea, and this precisely tuned spatial organization is well known [3-4] (see Figure 1a).

Recent research has suggested that hearing outcomes with CIs are correlated with the location where the electrodes are placed in the cochlea [5-10]. In surgery, the array is blindly threaded into the cochlea with its insertion path guided only by the walls of the spiral-shaped intra-cochlear cavities. The final positions of the electrodes are not generally known in the traditional clinical workflow. However, we have developed techniques that enable accurately locating the electrodes using CT images [11-12]. Recent research by our group [12,16] has shown that the spatial relationship between the neural pathways and the electrodes can be used to estimate electrode interactions at the neural level, i.e., cross-electrode neural simulation overlap (see Figure 1b), which is a phenomenon known to negatively affect hearing outcomes [13,14]. We have shown in a large clinical study that when stimulation overlap is detected and the configuration of active

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After finishing these simple steps for the ABF, you can continue with the normal assembly process. Map-specific settingsSets map-specific front-end processing levels, such as strong wind noise reduction for one map and mild for another. It is equipped with two sockets for audio processor, which allow simultaneous bilateral connections. 1 Identify the electrode contact point with OTOPLAN is a powerful and intuitive surgical planning software that allows you to visualize detailed 3D anatomy from standard imaging. Faster, easier and more powerful than ever before Guided WorkflowThe suggested activities are highlighted to help you perform the recommended activities quickly and easily for both intraoperative measurements and assembly sessions. The MSAC evaluates new medical services proposed for public funding and advises the government on whether or not to fund a new medical service (and, if so, its circumstances) based on a comparative assessment of safety, clinical effectiveness, cost-benefit and total cost, using the best available evidence. The upgrade is faster and easier than ever, just download the software. Triphasic PulseThis unique shape of the pulse helps to control current diffusion, particularly useful for patients with non-auditory stimulation. Troubleshooting Easily check how the RONDO 3 and SONNET 2 microphones respond to sound to make sure the processor is receiving input correctly.* Advanced Program Options The Telecoil booster and adjustable microphone gain for direct audio input enable you to optimize the way the processor operates ceases audio levels when using external audio sources.* Firmware Updates On site for Rondo 3, Sonnet 2 and DL-COIL allow you to quickly update the processor without having to send the device to assistance. * Our new session view is a complete dashboard of everything you want to know about a one processors during an editing session. OTOPLAN instantly calculates the natural tonotopic frequency for each electrode contact.** 2 Apply anatomical fitting With a few clicks¨ you can import detailed data on the position of electrode MAESTRO 9.0 from OTOPLAN. We are here to work with you and we are committed to providing outstanding service and support to our professional partners.With our state-of-the-art Cochlear implant systems¹, we offer the best hearing experience for your patients and the best clinical experience for you.Ã Ã Ã With adaptive directional microphones and connectivity wireless, SONNET 2 delivers superior hearing performance in any listening environment. Learn how wireless charging, directional microphones and connectivity wireless make RONDO 3 incredibly simple and just amazing. With MAESTRO 9.0 you have an intuitive workflow for everyday editing, but we also have advanced editing tools for greater control and understanding. You can see the telemetry for each electrode. MSAC also considers changes and revisions to existing services funded under Medical Performance Program (MBS) other programs (e.g. blood products or screening programs). Cortical ResponsesMeasures the late-latency response to confirm whether stimulation is generating a response in the auditory center of the brain. Why© MED-EL: A trusted partner For over 30 years MED-EL Ã is a trusted partner and leader noise innovation. You can go live on one side or bilaterally and quickly adjust charge levels directly in the session view for volume balancing without opening a map.Ã Our long arrays and exclusive FineHearing technology provide the closest pitch match¹ to the Of any IC, so you can provide a much narrow correspondence with the acoustic acoustic frequencies. Other companies can use a bimodal fitting formula with partial integration, which can compromise the la of ear of hearing aid.[ft][ft][ft][ft][ft][ft][ft][ft][ft][ft][ft] Our full integration approach can² offer a more natural frequency range and sound perception to both ears. About MSAC Apply for Public Funding State Application The Medical Services Advisory Committee (MSAC)¨ an independent non-statutory committee established by the Australian Government Minister of Health in 1998. Fine Structure Processing strategies (FS4, FS4-p, FSP) provide tonotopic and temporal information, reflecting natural hearingPulse shape options : two-phase and three-phase pulses, interphase gaps (IPG) Four program positionsProgressive maps: automatic generation of maps with increased volumeEAS integrated acoustic accessories (6 channels EAS acoustic collection) Longitudinal patient record: Patient history provides a quick overview of previous measurements and mappingsImport and export data with integrated option for anonymization patient dataVisual Enhancement Tool (VRT): Integrated media player to support visual reward editingCompatible with all current multi-channel MED-EL cochlear implants currently available EL MAESTRO 9.0 audio processors New functionalityÃ New bimodal display in post-operative sessions that allows bimodal synchronization for hearing aid patients*Support for OTOPLAN data import and calculate a frequency band distribution based on OTOPLAN data*New system control dialog allowing functional control of some hardware components of an audio processor*Support software update *Telecoil booster and direct audio input booster*Professional online portal* *Integrated link to myMED-EL, an online platform for professionalsBackup of the configuration of Store configurations online and access them from anywhere The following intraoperative and postoperative measures are available: Impedance Telemetry and Field Telemetry (IFT): Easy and fast implantation checkElectrically evoked compound action potential (ECAP) measurements: AutoART Ã¨ the fastest ECAP¹ automatic measuring instrument (inoperative: 90 seconds for all 12 channels, post-operative: 3-4 minutes for all 12 channels), ART offers extended configuration options and additional measurement typesElectrically evoked Stapedius Threshold (ESRT): Check the function of intraoperationally implantation or find an objective baseline for postoperationally mountingEvocated Electrically Hearing Brain Torso Response (EABR): Check if stimulation is generating a response in the brain's hearing centerAdvanced ART Setup tool: Record electrically and acoustically coordinated intracochlear potentials evoked with the first clinically available cochlear microphone (ECoG) tool FittingAutomatic ECAP based maps: ARTFit automatically generates a blend map based on an ECAP measurement for energy consumption independent of strategy: The power consumption of the Ã¨ processor is independent of the encoding strategy selectedVolume Balance: Simultaneous balancing of bilateral CIs, SSD cases or CIs in hearing aidsFunctionality remote installation requirementsPC or laptop/notebook hardware requirements in connection with one of the supported MicrosoftÂ® WindowsÁ® operating systemsÂÂ® Dual-core processor with a Clock of 1.6 GHz or higher2 GB of RAM or more¹2 GB of free disk space or more¹Color display with a resolution of 1024 ÂÂÂ 768 or higherOne high-power USB 2.0 (or higher) port free of chargeOne free printer port 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