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# Recent Advances in Hearing Aid Technology-A Review

Animita Das, Dr.Tabitha Janumala
*Dept of Electrical and Instrumentation Engineering , RVCE, Bangalore-560059, India*

***Abstract: Hearing aids are electroacoustic gadgets commonly worn in or behind the ear and are intended to enhance the speech Nowadays hearing aids support various application unlike the traditional ones such that it can act like headphones streaming audio signals from internet-enabled devices connected wirelessly via Bluetooth. This paper aims to review the various advancements in the hearing aid technology. System on chip technology of the microcontroller have been used in various studies to develop and design an effective hearing assistant device and help the people with hearing impairment to lead a normal life. Ten articles have been reviewed for the study and it can be concluded that IoT is the future for an efficient, cost effective hearing assistive system [1]***
***Keyword: Hearing aids, Internet of Things (IoT), System on- Chip (SoC), Microcontroller, Bluetooth***

## I. INTRODUCTION

Smart hearing assistants are electronic gadgets which are intended to improve hearing in individuals with hearing inability. According to WHO (2018) information, the predominance of hearing impedance (HI) in India is around 6.3% (63 million individuals). Hearing disability often lowers the confidence of the people and find it difficult to lead a normal life. The main challenge faced by the conventional hearing aid was its inability to distinguish between desired and undesired sound.[1]

## II. TYPES OF HEARING AIDS

### *A. In the Ear Hearing Aids*

ITE aids are worn in the ear canal and are usually custom-fit, based on an impression that is taken during hearing aid consultation. These styles are typically available in different skin tones to blend with the outer ear. Some types of ITE hearing aids fit very deeply within the ear canal, while others are closer to the outer ear.

### *B. Behind the Ear Hearing Aids*

BTE aids sit behind or on top of the outer ear with tubing that routes the sound down into the ear canal via a custom-fit earmold or a dome style that doesn't block the entire ear canal opening. BTE styles are available in different colors to match hair or skin tone, as well as flashier designs for personalized flair.For either ITE or BTE, most devices come with standard button batteries that must be replaced anywhere from 3-20 days. However, rechargeable batteries are becoming more common.

## III. STATE OF ART DEVELOPMENTS

There are various studies about the developing hearing aid technology making it more user friendly economically and aesthetically better. From the conducted literature survey, it can be concluded that the research is more focused on developing hearing assistant device that can be connected wirelessly to internet enabled devices.

In the paper titled, "**Smartphone-Based Self Hearing Diagnosis using Hearing Aids"** by Fei Chen and Shuai proposed a new solution for self-hearing diagnosis based on smartphone, which uses hearing aids as audio sources. From the obtained results it was concluded that the proposed solution can be used for self-hearing diagnosis and minimizes the test time compared to the conventional method.[2]

In the paper titled, "**Enhanced smart hearing aid using deep neural networks**" by Soha A. Nossier proposed three noise aware speech enhancement solutions. They trained the deep neural network-based speech enhancement approaches to distinguish different noise types and classify it as important or not. They aimed to add the alerting feature to the speech enhancement process, so that the speech enhancement and an alerting system can be embedded in one device.[3]

In the paper titled, "**Automated machine learning based speech classification for hearing aid applications and its real-time implementation on smartphone**", by Gautam Shreedhar Bhat developed a machine learning based voice activity detector that was implemented on a smartphone for real-time application. The developed VAD improved the performance of speech processing applications used in hearing aid devices. [4]

## IV. PREVIOUS RESEARCH

Many studies have been done on smart hearing aids. This section discusses about some of the articles which have been

In the paper titled "**IoT based Smart and Efficient Hearing Aid using ARM Cortex Microcontroller**" by Bina Rajan et al designed a cost-effective, reliable and a secure IoT based hearing assistive device which encompass the system on- chip property of microcontrollers which enabled the user to connect the internet of things-based device directly to the hearing aid reducing the mixing of sound from multiple devices.[5]

In the paper titled "**Internet of Things for Hearing Impaired People**" by Jeyaranjani J and Nesarani A proposed a reliable assistive mobile application which when connected to the low-cost wearable device mobile application enable the user to communicate with hearing people. The authors believe that the proposed architecture will unveil new research facet for the IoT application.[6]

In the paper titled **"Smart Hear: A Smartphone-Based Remote Microphone Hearing Assistive System Using Wireless Technologies**" by Yu-Cheng Lin et al proposed a new smartphone-based hearing assistive device which helps the wearer to remotely communicate and be able to conquer the stigma associated with hearing assistive device and provide easy customization to audio preferences. It can also be made extendable with advanced speech processing in smartphones.[7]

In the paper titled "**SmartAid: A Low-Power Smart Hearing Aid for Stutterers**" by Moritz Scherer et al designed a novel smart hearing aid for stutterers with an event driven architecture to minimize the consumption of power. Experimental results show that the device can last for up to 8 days on a single charge due to its low average power consumption.[8]

In the paper titled, **"Intelligent Hearing System using Assistive Technology for Hearing-Impaired Patients**" by Wessam Shehieb developed an Assistive Intelligent Hearing Aid System (AIHAS) is proposed that supports hearing impaired patients and enable them to live a normal life. Auditory Assistive mode is also added to AIHAS to train and assist children with speech disorders caused by hearing impairment at a younger age. The AIHAS also allows association with a smartwatch for easier system access. The system prototype has been developed and tested with multiple patients. The proposed AIHAS is an intelligent, low cost, reliable and a portable solution.[9]

In the paper titled, "**Smart Control of Hearing Aid Using EEG**", by Anukool Noymai et al demonstrated the application of EEG signal to control a beamforming function of a hearing aid. It was concluded that the potential use of EEG as an enabler for smart control of hearing aid.[10]

In the paper titled, "**System Architecture of a Smart Binaural Hearing Aid Using a Mobile Computing Platform**" by Yingdan Li et al proposed a smart binural hearing aid with the application of advanced binaural DSP algorithms to the acoustic signals received from the microphones attached to both the ears. The acoustic signal received from four microphones was processed using a real-time DSP software and wirelessly transferred back to each ear to recreate the acoustic signal which activated the user's ear drums.[11]

In the paper titled, "**Real-time implementation of hearing aid with combined noise and acoustic feedback reduction based on smartphone**", by Maxim Vashkevich et al demonstrated a smartphone-based hearing aid with combined noise and acoustic feedback reduction. Spectral weighting approach was used as a reduction algorithm which makes it very sensitive to fast changes in feedback path either caused by displacement of the speaker, microphone or room acoustics. The aim of the proposed work was to show the efficiency of the implemented solution especially for devices with moving speaker and microphone setup. [12]

In the paper titled, "**Integrating Signal Processing Modules of Hearing Aids into a Real-Time Smartphone App**", by Tahsin A. Chowdhury et al proposed to combine three important modules of the signal processing pipeline that are used in a typical digital hearing aid as a real-time smartphone app. The real-time characteristics of the developed integrated app are reported as well as an objective evaluation of its noise reduction was performed. [13]

In the paper titled, "**A Smartphone App-Based Digital Hearing Aid with Sliding-Band Dynamic Range Compression**" by Nitya Tiwari et al implemented the sliding-band compression as a smartphone app for use as a hearing aid. In the proposed work the frequency dependent gain function was measured based on the specific hearing limits and critical bandwidth based short time power spectrum. In the proposed work it was concluded that analysis and synthesis based on FFT can be combined with other techniques for computational efficiency. [14]

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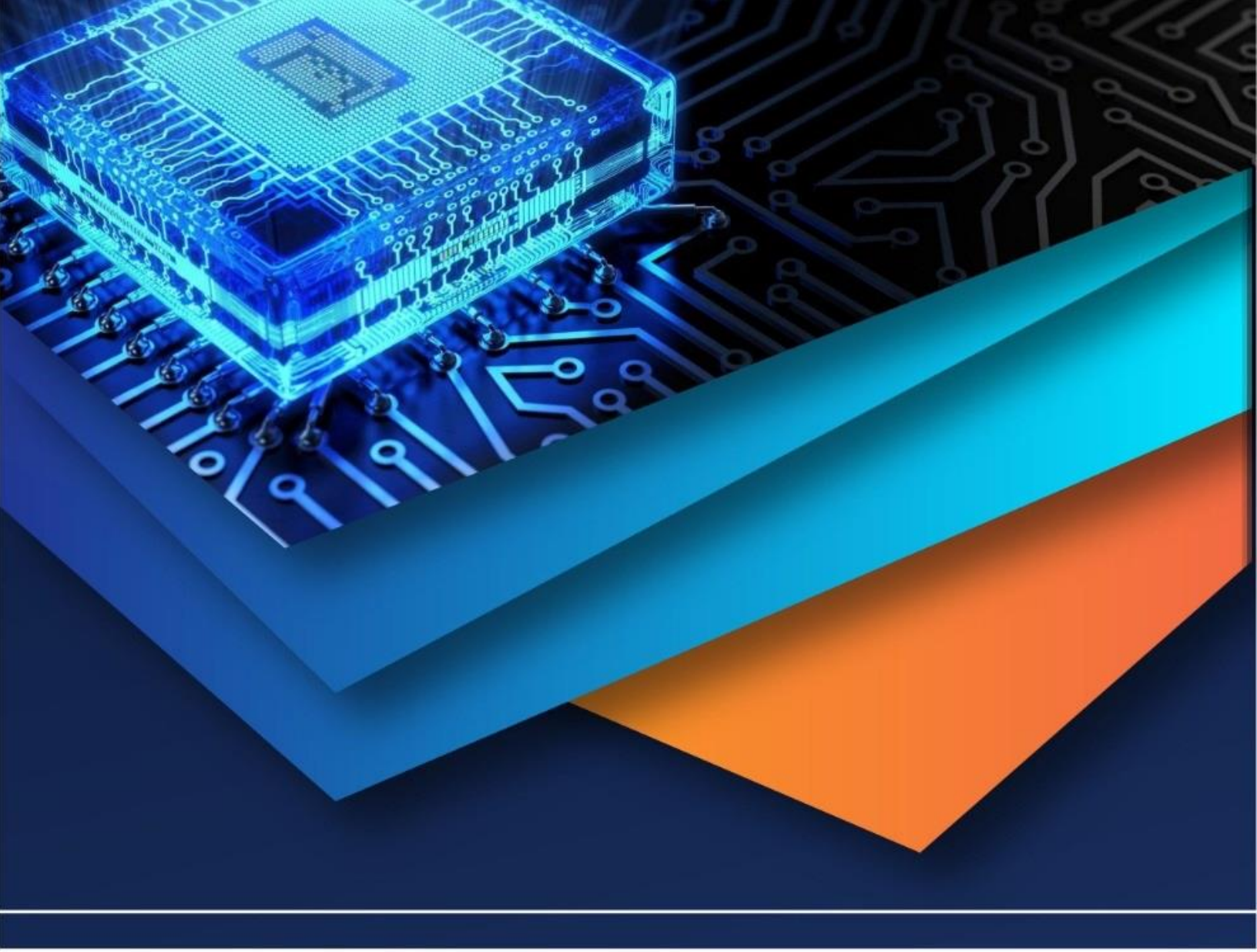

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