DHVANIK - Wearable Tympanometric Diagnostic Tool for Middle Ear Ailments

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Abstract

Tympanometry is a simple test used to monitor the functioning of the middle ear. A tympanogram generated from the test can detect problems such as presence of fluid, middle-ear infection (otitis media), tear in the tympanic and problems associated with the eustachian tube all of which are the leading causes of hearing loss, especially in children. Though simple, millions of people are denied access to tympanometry due to the high cost of tympanometers as well as the knowledge required to operate the equipment. DHVANIK aims to provide a low cost head-phone sized tympanometer that transfers the results directly to a smartphone and requires no specialized knowledge to operate. Also, access to the internet will allow the results to be shared with doctors located far away so that appropriate steps can be taken.

Introduction

DHVANIK as previously mentioned is a preliminary diagnosis tool and not a replacement for specialized equipment available with specialist doctors. It is based on simplicity and includes the very basic components comprising a low cost microcontroller, barometer, speaker and microphone allowing it to be low cost. Also, DHVANIK opts for a smartphone as the means of both analyzing and displaying results. This also allows the device to be able to communicate data to multiple devices through the associated app and as mentioned before brings networking and wireless capability to an otherwise standalone device.

Result (Tympanograms)

DHVANIK makes tympanogram which provides information regarding how fluently the sound passes through ear. Based on the condition of the ear, there are usually 3 types of tympanogram which are shown as result:

Technical Model
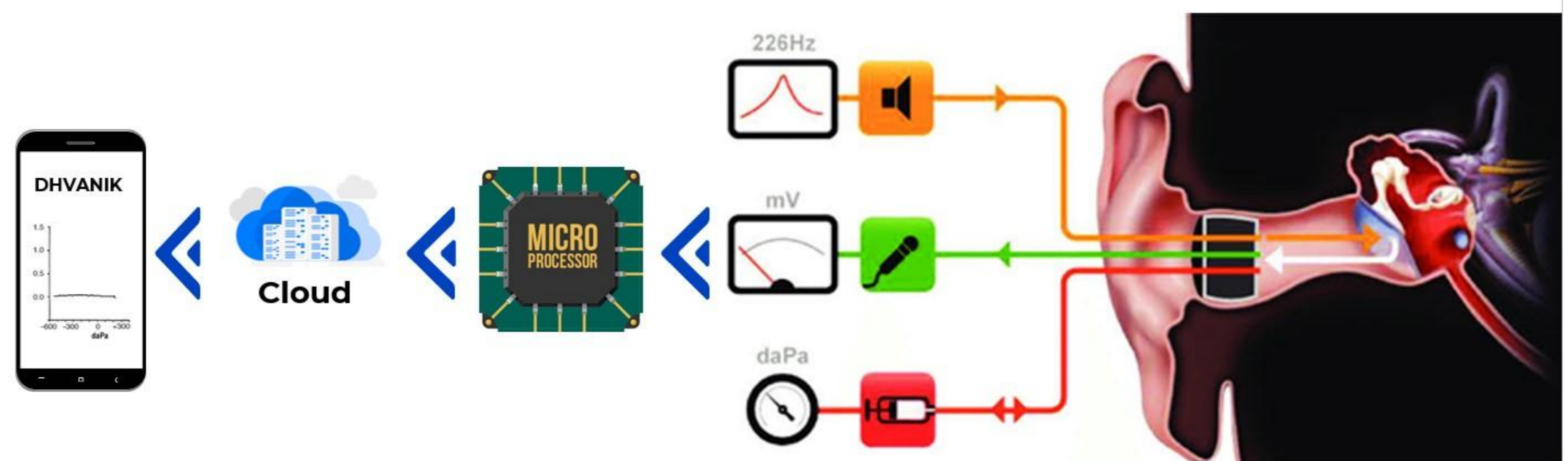
Proposed Design

DHVANIK detects middle ear problem using frequency generator, microphone and pressure sensor in controlled air pressure condition. The microcontroller gives signal to air pump which will generate positive and negative pressure in the range of 1000 dpa. Microphone will generate fixed frequency in the range of few KHz. Normally, the air pressure in the ear canal is the same as ambient pressure. Also, under normal conditions, the air pressure in the middle ear is approximately the same as ambient pressure since the eustachian tube opens periodically to ventilate the middle ear and equalize pressure. This produces a series of data measuring how admittance varies with pressure, which is plotted as a 'Tympanogram'. All the data will be sent to smartphone via Wi-Fi and then to cloud.
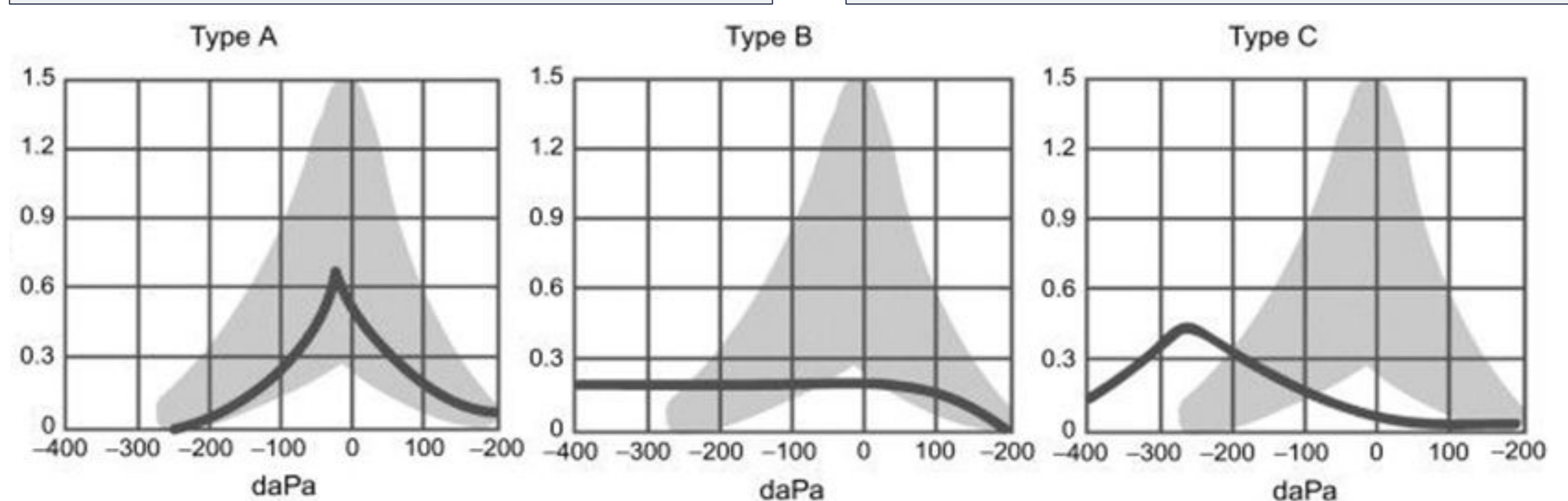
Market Advantage

Total production cost is around ₹1850/- while available devices in the market cost around 1-3 lacs. The reduction in cost is because of DHVANIK being preliminary diagnostic tool but the available products are more accurate

Addressable Market

The addressable market for DHVANIK comprises of general doctors in clinics, small hospitals and primary health centers in rural areas. DHVANIK takes the concept of being user-friendly in the sense that a person with no medical training can use it. This device is also intended to target patients who have a case of recurring middle-ear infections. The purchase of DHVANIK for such customers is analogous to a diabetic patient having a blood glucose monitor.

Future Goals

This venture is presented in Inter IIT Techmeet 2019. We will implement the following goals in DST and Texas Instruments IICDC 2019/20. We will Integrate Machine Learning model to compare dataset of the graph of a particular patient over time, and generate a particular warning if the graph varies more than a specified limit. Relevant companies producing cures of hearing ailments (for eg. Eardrops) can advertise their products through recommendation based on the tympanogram generated.

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