Implementation Of Client Management Database Program For Digital Hearing Aids Fitting System

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Abstract: A hearing aid performs the role of fitting in order to provide those with a hearing problem with a better hearing ability in ordinary circumstances. The existing Fitting system in the hearing aid is consisted somewhat complex, and simply performs the role of Fitting without any supervisions of those with a hearing problem. Such as these methods makes it unable to establish an organized supervision, and shows a problem in making high efficiency. In order to solve this problem mentioned as above, the based thesis have connected the Fitting program and the patient-management database program for the easy use by the user.

1. INTRODUCTION

Nowadays, the DSP (digital signal processor) technique has advanced rapidly and it is spreading in our lives. Due to these technical advancements, the area of hearing aid also had much progress in a few years, and the system is changing from analog to digital [1].

While the ability to hear louder noises of the patients with hearing problem isn't much different from the ordinary people, the ability to hear smaller noises drops greatly, so not all the sounds should be amplified equally.

In other words, the Fitting process is need for the hearing aid in order to speculate the amplifying rate for the patients with hearing problem [2]. Fitting is a process to provide a suitable hearing aid to the right patients and which enables them to hear more comfortably. In other words, it minimizes the amplifications of the useless sounds and gives a better hearing ability when using it. Especially, the Fitting process of the digital hearing aid not only amplifies the sounds, but also divides the audible frequency rates of the human into several channels from low rates to high rates, therefore, amplifying and controlling the exact rate according to its' own patients[3-5] .

The Fitting program used in the digital hearing aid nowadays is activated separately from the existing database, so when performing the Fitting process, it arouses problems such as inputting all the information like lost hearing levels of the clients, and is too complicated for the system user and the client supervisors to use it. The client management program not only should transmit the exact hearing rate to the Fitting program, but should also apply the certain algorism to the hearing aid according to the patient.

Therefore, this thesis expects to, find and solve the problems of the existing Fitting systems, and giving the additional client management functions to give the exact Fitting to the patients and structuring a link between the database of the patient and the Fitting system.

2. FITTING ALGORITHM

The Fitting algorism of the hearing aid divides into two types, such as the linear algorism, which controls the labial and producing a benefit level from it, and nonlinear algorism, which holds the threshold value in an audible level [3]. The past linear algorithms such as NAL, POGO, Berger algorism became the baseline of the hearing aid prescriptions by the experience of hearing aid experts, and since the benefit was decided upon the threshold value by the controlled labial, a theoretical target curve line value is given, no matter what the hearing problem is. In whole, the curve line is used to give the exact magnified rate by checking the actual benefit earned by the ear of hearing problem patients in separate frequencies. The linear algorithm such as these was proper to the earliest analog hearing aids, but possessed a problem that it didn't give much thought to the requiring rate based upon the hearing levels. So the linear algorithm can't provide a precise Fitting to the patients with a complex hearing loss. But, since the nonlinear algorithm was made based upon the comparison between the hearing rate of the normal persons and the patients, the target curve which the algorithm tries to achieve is all different based upon the hearing loss level of the patients [3-5].

Normally, the digital hearing aid chooses a nonlinear algorithm which gives the benefit according to the hearing loss level of the patient. Fig 6 algorithm of nonlinear algorithms was made by paper that Killon and Fikret-Pasa(1993) described three categories of hearing loss and calculated the amount of gain that would satisfy the loudness requirements for those losses[6]. Fig 6 of that article was an illustration of the gain required to achieve those goals, thus, the name Fig 6. In whole, Fig 6 is a prescription diagram WDRC (Wide Dynamic Range Compression), based upon the threshold value and by using the loudness data, enables to control the compressed quality; making low level sounds little, normal level sounds comfortable and loud sounds loud [3].

Pic 1 shows the WDRC algorism.

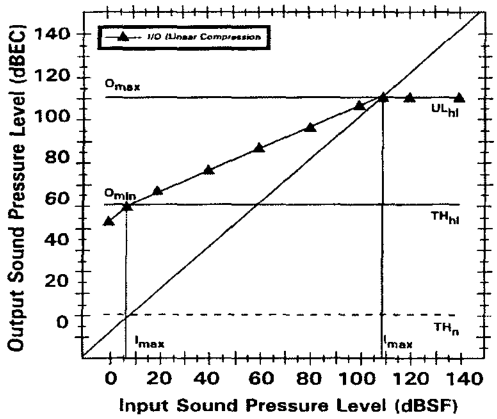

Figure 1. WDRC algorithm

In pic1, the x level shows the input sounds pressure level, y the output level. If, the input sound is 5dB, the output becomes 60dB, and if the input is 110dB, output becomes 110dB. But if the input exceeds 110dB, it amplifies without compression. So, the compression ratio based upon the input level of 5dB and 110dB becomes 2.3: 1, the ratio between x level and y level.

In the Fitting method on Fig6, after inputting the data of hearing loss rate earned from the tests in to the computer programs, by giving 3 input sounds such as soft and low sounds(40dB SPL), ordinary conversation sounds(65dB SPL), loud environment sounds(95dB SPL) calculates the 3 Fitting insertion benefit target curve automatically.

The 3 target benefit curves are ordinarily used as useful data in loudness growing curves which the sensibility neural hearing loss patients have, such as giving a lower benefit on strong sounds and higher benefits on soft sounds [2]. Table 1 shows the calculation method of benefits per frequency level based upon the algorism.

Table1. Fig 6 Formulas

A. Low level sounds	Range
1. G =0	0 to 20 HL
2. G = HL-20	20 to 60 HL
3. G = HL-20 -0.5*(HL-60)	HL >= 60 HL
B. MCL	
1. G =0	0 to 20 HL
2. G =0.6 * (HL-20)	20 to 60 HL
3. G =0.8 * HL- 23	HL >= 60 HL
C. High level sounds	
1. G =0	0 to 40 HL
2. G =0.1 * (HL-40)^1.4	HL >= 40 HL

The gains (G) from step A, B, C are the ideal insertion gain value of the hearing aid. These gains should again be changed into 2cc Coupler value, same as the ideal quality of the ear, and in order to do that, adds the 2cc correction value and extra gain values and then, transmits to the hearing aid through Hi-Pro box.

3. DATABASE FOR FITTING SYSTEM

Based theses have connected the Fitting program and the patient-management database program. In the client management program, it gains personal information and hearing loss data, and by using the hearing loss data from the Fitting system, calculates the gain value through Fig 6 algorism. In the micro control part, if the patient doesn't satisfy with the gain value earned from Fig 6, by controlling the gain by a micro controller, sends the value again to the hearing aid. Pic 2 shows the flow of realized system.

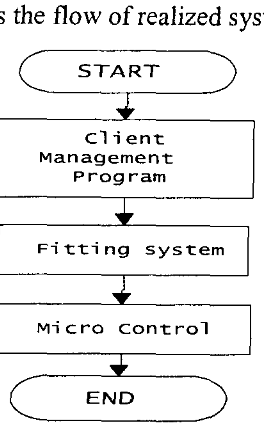

Figure2. Precision fitting

3-1 Client management program

In the client management program, by establishing the basic information and hearing loss rate into a database, eliminates the inconvenience of inputting the data every time the user uses the Fitting process.

Pic 2 shows the client management program.

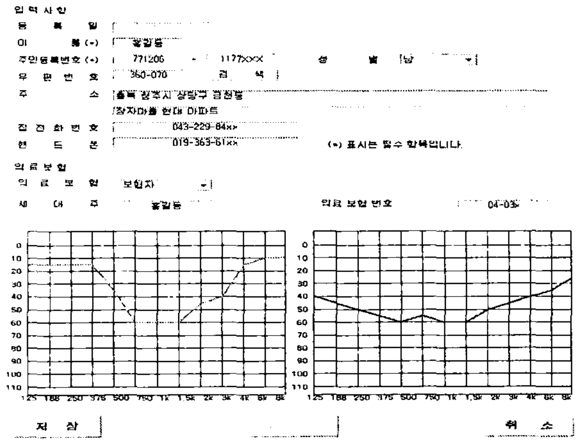

Figure3. Client management program.

The main objective of the client management program is to establish an organized client management and sending an exact hearing loss rate to the Fitting system. By using the graph, it is designed so that the user can easily input the hearing loss rate, and enables the user to easily update the changed hearing loss rate. Also, it's the audiogram part where it shows the input part, and has showed the hearing loss late of the patient from the database program.

Dividing the frequency level into 13 parts, from 125Hz~8 KHz, it is consisted so as to input the hearing loss rate of the patient in to the according frequency rate. The graph left of pic2 shows the hearing loss rate of the right ear, and the graph on the right shows the loss rate of the left ear. The x level shows the frequency, while the y level shows the hearing loss. Also, by gripping exactly the structure of existing Fitting system, have constructed an interface environment which can enable an exact Fitting process by sending the hearing loss rate as an audiogram part of the Fitting system. Especially, if the hearing loss rate of the patient isn't transferred correctly, it can arouse a critical physical problem such as tympanum rupture, so this part is to be acknowledged.

Pic 3 shows the search program of the client.

The search categories of the search window consist of name, age, sex.

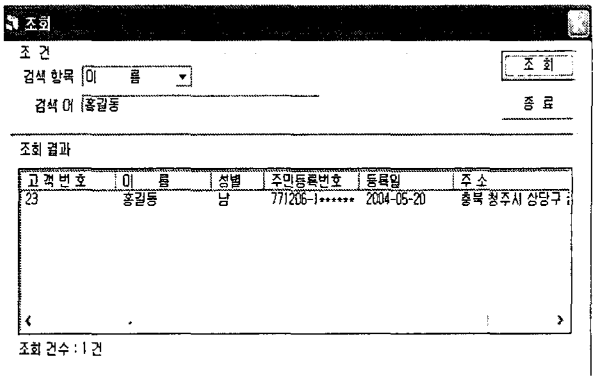

Figure4. Client search program

In this part have structurized the database so that the user could easily access to the clients' information. Using this program, accessing to the hearing loss rate of the client, and finding out the distribution chart from the analysis of the whole clients' age and sex becomes possible.

3-2 Fitting system

The Fitting program receives hearing loss gain from the frequency rate of the patient, and after calculating the exact gain cost, sends the gain cost calculated from the DSP chip. Fig 6, based on WDRC, which maximizes the patients' narrow dynamic range to hear the normal person's dynamic range, has safe insertion possibility and clear pronunciation interpretation. So the Fitting program is realized by Fig 6 algorism.

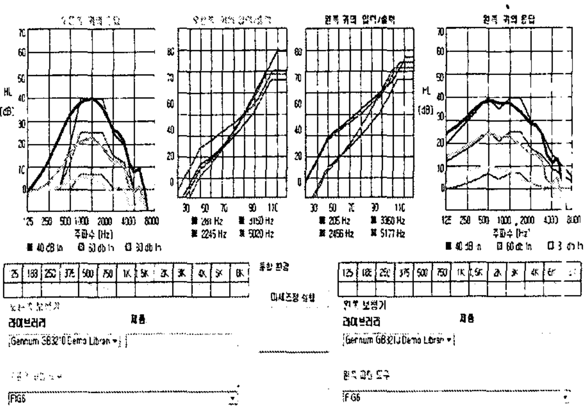

Figure5. Fitting program

Pic 5 shows the result of the Fitting algorism performed upon the hearing loss rate sent from the audiogram of the hearing aid. Of 4 graphs, the 2 graphs placed on the outside are frequency response graph, and the 2 graphs placed on the inside are in/output graph of the hearing aid. From the frequency response graph, 3 string lines stands for the theoretical gains earned from the Fig 6 algorism, while the thick line stands for a value which is gained by adding the correction gain to the theoretical gains.

These 3 thick curves are the target curves which can satisfy the most appropriate hearing conditions to the patient.

In the Fitting part it should be designed so that, it should contain a library furnished to the DSP Chip, and by adding a channel selection function, although the type of the hearing aid may be different, by selecting the library and the channel of the DSP Chip, should be adjusted to the target curve as needed. Though the target curve may be earned based upon the hearing loss rate of the patient from Fig 6, the target curve can't be replied to all for it is not a general rate for all the patients. So, the Fitting algorism alone can't satisfy the optimum MPO. Also, since some patients show psychological hearing loss, a performance of micro controlling is needed for an exact fitting.

This process is showed upon pic 6.

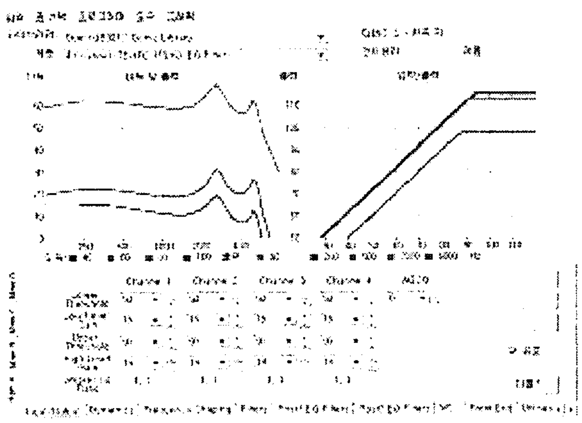

Figure6. Micro Control

On pic 6, the right side of the graph stands for frequency response curve and the left stands for the in/output graph. Each curve on the graph shows the independence AGC (Automatic Gain Control) channel processing. The in/output curve of each channel can be controlled to 5 parameters. The 5 parameters are low level gain, lower threshold, high level gain, upper threshold, and compression ratio. From these 5 parameters, calculation of compression ratio is performed by controlling 4 at the maximum.

The compression ratio is calculated from the in/output ratio from lower threshold to upper threshold. By detail controlling of the 4 individual parameters, the actual insertion gain cost which the patient can finally satisfy is calculated.

5. CONCLUSION

Based theses have connected the database system and the Fitting system of the digital hearing aid in to one. The realized system can save the hearing loss rate of the patient in to the database program, and by using the Fig 6 method, can calculate the needed gain from the saved fitting system. Also, by establishing a vast database of age, sex, pattern of hearing loss, can find out the distribution chart of the clients. Also, by establishing a vast database of age, sex, pattern of hearing loss, can find out the distribution chart of the clients.

Further on, a study upon the Fitting algorism of the hearing pattern using the patterns of the database is to be needed.

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