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(54) SYSTEM AND METHOD FOR ANALYZING AND EVALUATION OF AUDIO SIGNALS

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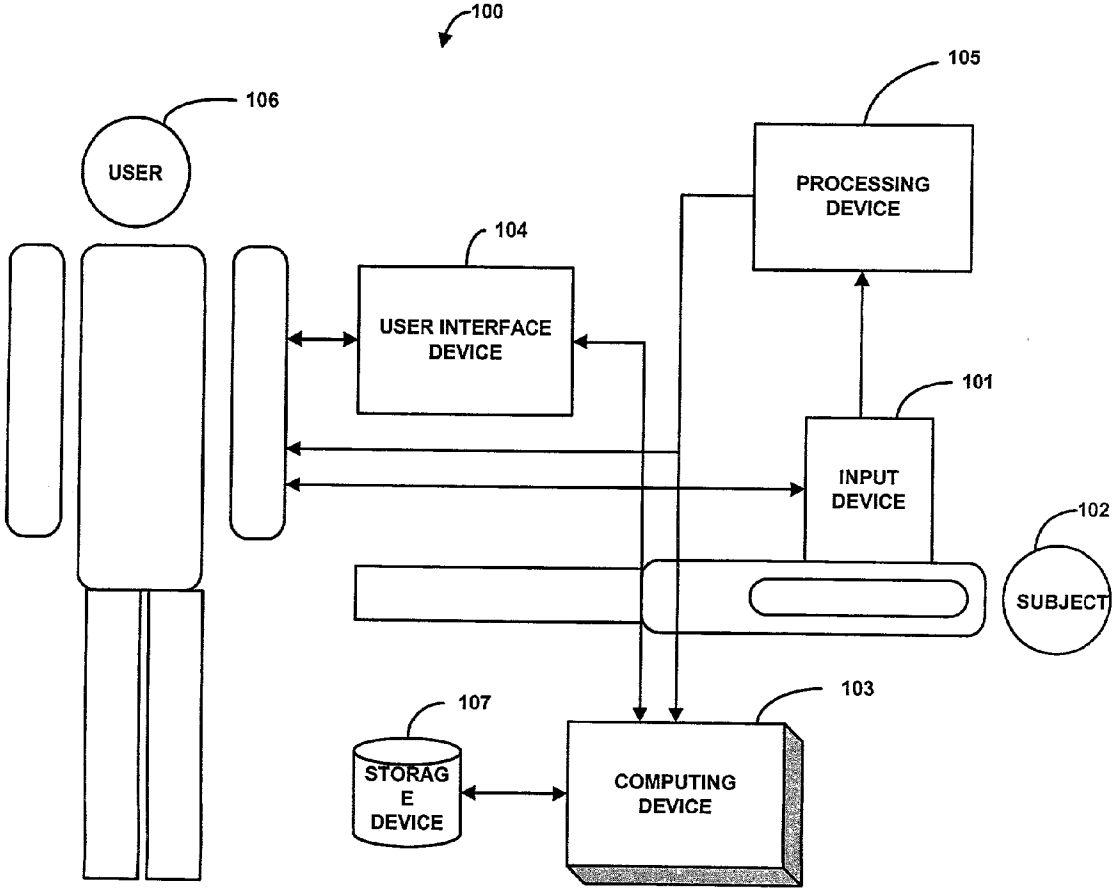
(57) **ABSTRACT**

A system and method for analysis and evaluation of audio signals is disclosed. The method comprises receiving information from an input device; calculating complexity of the received information; calculating indicative parameter of the complexities; and converting the indicative parameter into results for play and display, whereby better usage of audio information is achieved. The system comprises input device for capturing audio signals; processing device for manipulation of captured audio signals; computing device for calculating audio signals parameters; storage device for storing audio signal related information; and user interface device for user interface with input device, processing device, computing device and storage device, whereby a user can receive immediate and accurate analysis and evaluation of captured audio signals.



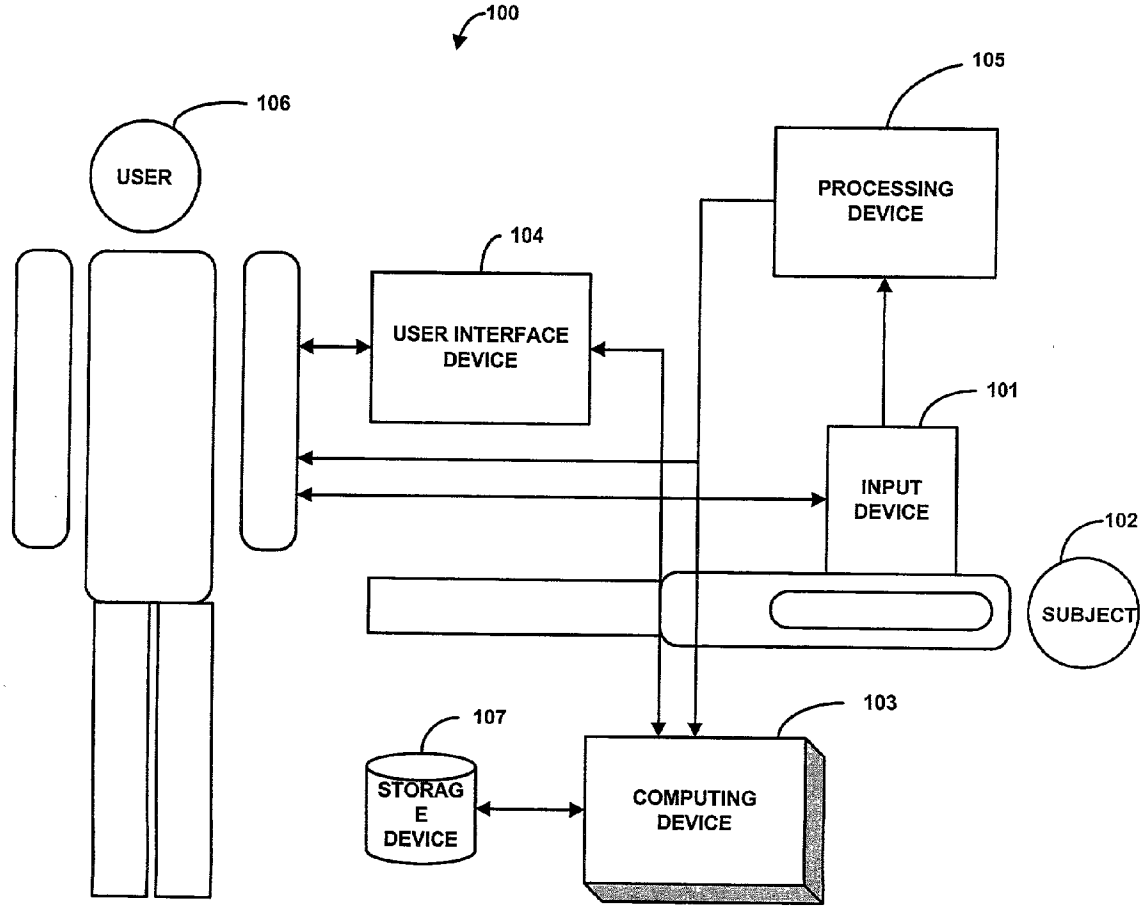

100
105
106
USER
PROCESSING DEVICE
104
USER INTERFACE DEVICE
101
INPUT DEVICE
102
SUBJECT
107
103
STORAG E DEVICE
COMPUTING DEVICE

Fig. 1

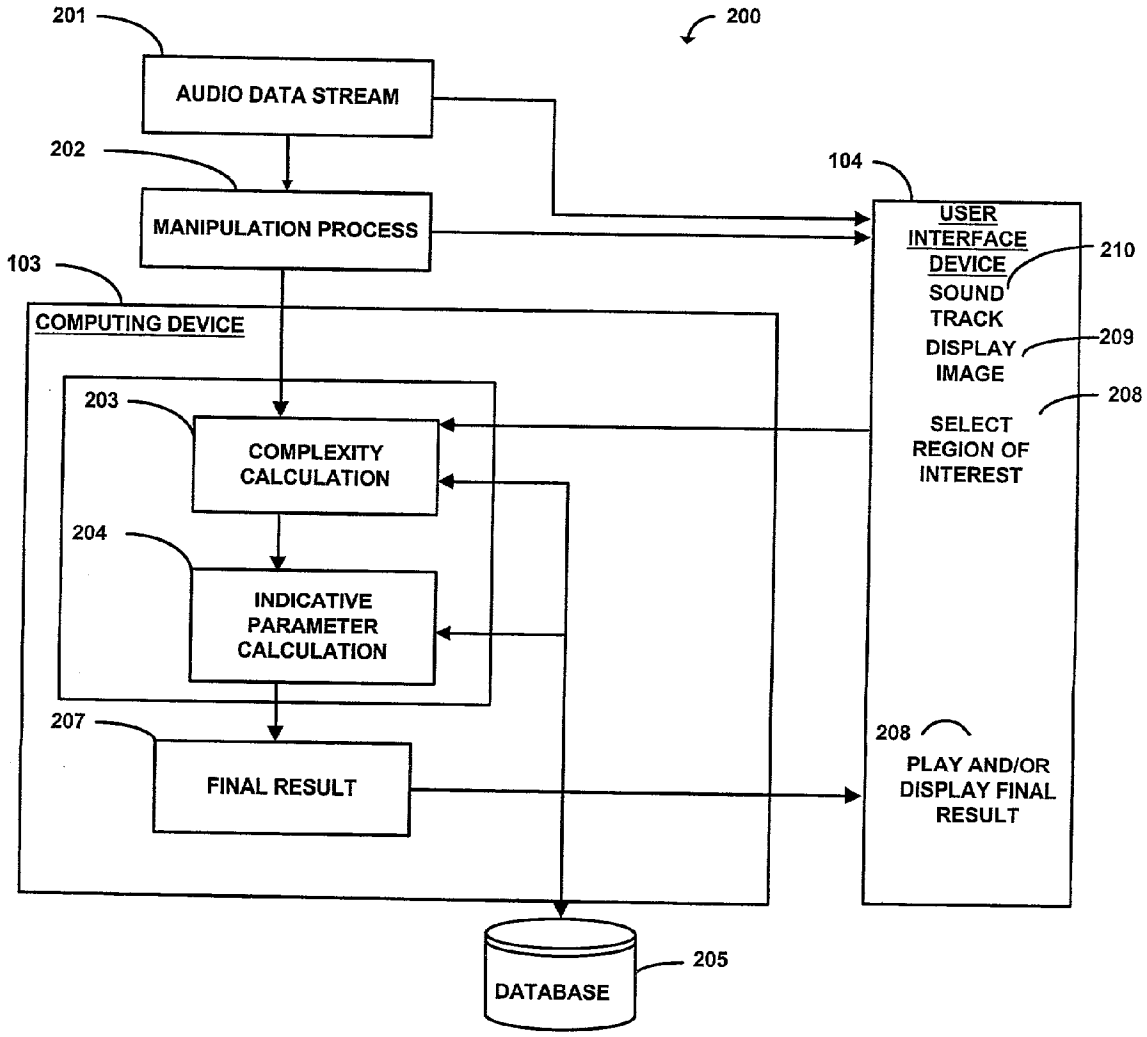

201
200
AUDIO DATA STREAM
202
MANIPULATION PROCESS
104
USER INTERFACE DEVICE
210
SOUND TRACK
209
DISPLAY IMAGE
208
SELECT REGION OF INTEREST
103
COMPUTING DEVICE
203
COMPLEXITY CALCULATION
204
INDICATIVE PARAMETER CALCULATION
207
FINAL RESULT
208
PLAY AND/OR DISPLAY FINAL RESULT
205
DATABASE

Fig. 2

SYSTEM AND METHOD FOR ANALYZING AND EVALUATION OF AUDIO SIGNALS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from PCT Application No. PCT/IL01/01074, filed Jan. 8, 2002, and Israeli Patent Application No. 146597, filed Nov. 20, 2001, each of which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to audio data selection, analysis and summary for the facilitation of relevant data extraction, more specifically the analysis of medically related Audio data for the facilitation of medical purposes.

[0003] The twentieth century has brought about great scientific discoveries and with them an explosion of new diagnostic tools such as the X ray machine, Ultrasound and Doppler machines, the nuclear imaging machines, Magnetic Resonance Imaging machines and the like. The Auscultatory Medical Diagnostic Tools (AMDT) such as the stethoscope is one of the most archaic yet basic tools of diagnosis. The Auscultatory Medical Diagnostic Tools (AMDT) such as the stethoscope have not changed significantly since their invention, their use by physicians is declining due to their subjective nature. Typically a physician auscultates the body surface above or in substantial proximity to the organ under examination, listening to any abnormal sounds such as abnormal lung sounds, abnormal heart sounds, abnormal blood flow sounds, abnormal fetal heart sounds, abnormal bowel sounds and the like. When used by an experienced physician an AMDT can be a valuable, simple to use and simple to operate diagnostic tool. The AMDT's flaws are due to the highly subjective nature of the human sound interpretation capabilities, thus, no standardization, recording, and accepted forms of analysis are practiced to date. The AMDT are basically audio amplifiers of sound emanating from the human body. Said sounds are in fact Audio Data Stream (ADS). The audio data stream contains a wealth of information regarding the observed organ and body elements. The human ear is a relative insensitive audio receiving tool; it perceives sounds in a very limited range, and thus the human brain receives a substantially small part of the audio data emitted from the human body. In addition, the human brain's interpretation is not impartial; it is affected by many factors such as internal-environment such as psychic state, physical well being and the like, as well as many other environmental stimuli, such as visual, smell, vibratory, as well as secondary audio stimuli, and the like. As a consequence the human interpretation of ADS is substantially incomplete.

[0004] An audio data stream can also be acquired by Ultrasound (US) machines using the Doppler mode. Said machines are typically used to assess the flow of bodily fluids, typically within veins, arteries and other bodily fluid conduits and reservoirs. Typically the examiner will place the instrument in substantially close proximity to the area examined and listen to the audio interpretation of the ultrasound waves returning from the tissue. The US-Doppler machine described hereinabove uses high frequency sound to measure flow and convert it into a low frequency sound adapted to the human ear's range. The human hearing and interpretation capability though elaborate and complex is insufficient to analyze fully the enormous wealth of information contained within Audio Data Streams obtained by various medical diagnostic tools. There is therefore a need in the art for an accurate diagnosis of the information contained within electrical graphs.

SUMMARY OF THE INVENTION

[0005] A system and method for analysis and evaluation of audio signals is disclosed.

[0006] The method comprises receiving information from an input device; calculating complexity of the received information; calculating indicative parameter of the complexities; and converting the indicative parameter into results for play and display, whereby better usage of audio information is achieved.

[0007] The system comprises input device for capturing audio signals; processing device for manipulation of captured audio signals; computing device for calculating audio signals parameters; storage device for storing audio signal related information; and user interface device for user interface with input device, processing device, computing device and storage device, whereby a user can receive immediate and accurate analysis and evaluation of captured audio signals.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1** illustrates parts of the system of the present invention; and

[0009] **FIG. 2** illustrates operation of the system of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0010] Preferred embodiments will now be described with reference to the drawings. For clarity of description, any element numeral in one figure will represent the same element if used in any other figure.

[0011] The present invention provides for a system and method for analysis and evaluation of Audio Data Stream (ADS) obtained from various instruments measuring analog audio signals such as a stethoscope, fetoscope etc. The system and method can be used for non-invasive diagnosis. The invention discloses a system and method according to which audio data complexity calculation can be implemented on audio data recording streams of medical examination tools as well as other tools measuring and displaying audio data records. The input data is recorded in real-time via audio sensitive instruments previously described in the art and mentioned hereinabove. A streaming data of different analog audio frequencies referred to as Audio Data Stream (ADS) is recorded and then converted to a digital form by an audio to digital conversion element. The digital recording is received by the application. A complexity calculation of the at least a part of the data is performed. An indicative parameter is calculated using the complexity calculation according to predefined information obtained beforehand. The indicative parameter is manipulated so as to supply the output result. The output result is useful in the analysis, quantification and evaluation of Audio Data Stream (ADS).

[0012] Turning now to **FIG. 1** wherein parts of the system of the present invention and an exemplary operation is disclosed and referenced **100**. Input device **101** is an Audio Medical Diagnostic Tool (AMDT) such as a stethoscope such as an **3**M stethoscope from Littmann, a fetoscope, a vascular Doppler, as well as any other instruments capable of receiving and preferably enhancing audio signals, such as an analog audio signals to produce data. Data could include, for example, a heart beat murmur, blood vessel flow pattern, and the like. In **FIG. 1** Input device **101** is typically manipulated by user **106** and is place in preferably close proximity to the subject **102** area of interest. Input device **101** is preferably manipulated by the user **106** such that an optimal location is chosen for Audio Data Stream (ADS) collection. In **FIG. 1** only one input device is depicted for sake of clarity. It will be evident to the person skilled in the art that any number of input devices as well as different types of input devices can be connected to the other elements of the system such as the user **106**. Analog data obtained by input device **101** is transferred preferably via an acoustic conductor, or any other suitable form known in the art to the processing unit **105**. Processing unit **105** is functional in converting ADS from analog to digital format as well as enhancing and filtering ADS as well as transmitting said data to computing device **103** and user **106** via suitable cable, Infra Red (IR) apparatus, modem device and similar transfer means of digital information. The parameters used by processing device **105** can be located within the processing device **105**, received from user **106** by way of user interface device **104**, stored on storage device **107** as well as on other locations outside the proposed system (not shown). Processing unit **105** can be located in substantial proximity to input device **101** such that sound propagation need not be enhanced. Computing device **103** is a software program or a hardware device such as a PC computer, such as a PC computer, hand held computer such as Pocket PC and the like. Within a computing device **103** input received from processing unit **105** is processed and an output data is transferred to the interface device **104**. Interface device **104** may be a computer screen, a hand held computer such as Palm Pilot, a monitor screen, a printer device, a speaker system, head phones, as well as other interface devices capable of transferring visual, audio and other information to the human user **106**. The output data can be stored on a storage device **107** such as a computer hard disk as well as any storage device. The output data can also be sent for storage, viewing and manipulation to other parties by hard wire (not shown), IR device (not shown) or any other transfer modalities. Interface device **104** can be used by user **106** to alter operation of input device **101**, computing device **103**, processing unit **105** or any of them. Such activity can be done by the user **106** via direct human interaction with interface device such as by touch, speech, manipulation of attached mouse device and the like. Operation alterations can include manipulating sensitivity range, enhancing range, filtering modes and the like. User **106** can directly manipulate input device **101** typically by touch but also by any other means compatible with input device **101**. User **106** can also receive raw analog ADS directly from input device **101** preferably by an acoustic cable device such as a hollow polymer tube used with of a stethoscope, by air conduction through an analog audio amplifier-speaker device (not shown), as well as any other acceptable means of sound transport. Output information of computing device **103** as well as other data information of storage device **107** can be viewed on the user interface device **104** such as graphs, pictures, summary analysis, and the like, as well as manipulated by the user **106** for other purposes such as transferring the data, saving the output data, and the like. Said output information as well as data information can also become available to the user as audio data excerpts via the user interface device **104**, an analog audio amplifier-speaker device (not shown) etc.

[0013] It may be evident to the person skilled in the art that audio-digital converter as well as an amplifier and the processing unit **105** can be located in any number of locations throughout the system such that data can be used and transferred efficiently. For example, it is preferable that the processing unit **105** be located close to input device **101** such that analog data will not be transferred over long distances thus reducing the amount of lost data by natural dissipation of sound as well as to reduce external interferences. Another example, can relate to user **106**, such that the user may receive digital as well as analog data through the user interface device **104**, the input device **101** as well as from processing unit **105**. User **106** can use such aids as a digital to audio converter (not shown) and an audio transferring means such as a stethoscope hollow polymer tube. User **106** can also perceive analog audio signals transferred via air from an amplifier and microphone located on user interface device **104** as well as on other elements of the system.

[0014] Turning now to **FIG. 2** where operation of the system **200** of the present invention is disclosed where an Audio Data Stream (ADS) **201** such as discussion between user **106** and subject **102** both of **FIG. 1** during a psychiatric interview is obtained by input device **110** of **FIG. 1**. A Video Data Stream (VDS) **211** such as the continuous video of the subject **102** of **FIG. 1** during a psychiatric interview is obtained by input device **101** of **FIG. 1**. The ADS **201** and VDS **211** are optionally transferred by suitable means to the processing device **105** of **FIG. 1** where manipulation **202** of the received data is then performed. The manipulations can include amplification, filtering, audio to digital conversion, color correction, and any other manipulations that can be done on audio and video data for the purpose of receiving a pure digitalized audio and video data from the preferred target. Working parameters and databases for the manipulation process **202** is obtained from a predefined data located in the processing device **105** of **FIG. 1**, database **105** as well as directly from user **106** of **FIG. 1** as well as through user interface device **104**. It can be easily understood by the person skilled in the art that any of the above mentioned operations can be performed in other locations within the system such as within computing device **103** also of **FIG. 1** as well as in other locations as well as outside the said system. Manipulated ADS is then transferred to Computing device **103** as described also in **FIG. 1**. and then undergoes a complexity calculation **203** and Indicative parameter calculation **204**. The complexity calculation **203** performed on the ADS stream **201** is preferably done on at least one substantially small part of the data. Complexity calculation **203** can be performed automatically as predefined in parameters within computing device **103** also of **FIG. 1**. The calculation can be accomplished on at least one substantially small selected part of said data as predefined in database **205**. Said calculation can also be performed on at least one substantially small selected region of interest **206** of said

data by user (not shown) using the user interface device **104** also of **FIG. 1**. Indicative calculation **204**, previously described in related application hereinabove is a quantitative data element calculated with respect to predefined parameters such as previously inputted ADS streams (i.e. normal breathing sounds of an **18** year old White female, etc.), predefined formulas describing known and predicted ADS stream behavior and patterns (i.e. Pneumonia in a 60 years old African American obese male, Intussusceptions obstruction in a 5 years old male, vascular narrowing of the dorsalis pedis artery of a patient with vascular insufficiency etc.) as well as other parameters such as age, social circumstances, body stature, racial origin, occupation, previous illnesses, current illnesses and the like. Said data can be stored before hand as well as stored continuously with operation. Said data can be stored on the predefined database **205** as well as on any database device (not shown) connected to computing device **103** of **FIG. 1** as well as any remote databases devices (also not shown). Calculated indicative parameter **204** can be displayed to the user in raw state (not shown) on the user interface device **104** also of **FIG. 1**. Said parameter can also be saved on the computing device **102** of **FIG. 1** as well sent to other computer devices (not shown) by methods known in the art. Calculated indicative parameter **204** can be converted to an easy to understand, final result **207** such as a certainty of an auscultatory audio stream with enhancement of abnormal findings, diagnosis, an audio and image representations of the ADS, such as an audiogram, such as audiogram manipulated to graphic representation on paper, a summary of the streaming ADS input selected, a region of interest of the streaming ADS by predefined parameters located within the predefined database **205**, a suggested immediate therapy indication and the like. Final result **207** is then transferred to the user interface **104** also of **FIG. 1** and is played and displayed **208** to the user (not shown). The audio data stream **201** as well as manipulated ADS **202** can be directly transferred to the user (not shown) and to the user interface device **104** also of **FIG. 1** for observation, supervision as well as for the manipulation of the location of the input device **101** of **FIG. 1** and of the manipulation processes **202**. User **106** of **FIG. 1** can preferably control all steps of information acquisition, manipulation, viewing, listening, storing, sending and the like. ADS stream **202** can be played to the user as a sound track **210** as well as displayed as an image display **209** during the system's operation. Thus allowing the user to observe and if needed to manipulate the system operation in real time using the user interface device **104** also of **FIG. 1** as well as his hands as previously discussed.

[0015] The person skilled in the art will appreciate that what has been shown is not limited to the description above. Many modifications and other embodiments of the invention will be appreciated by those skilled in the art to which this invention pertains. It will be apparent that the present invention is not limited to the specific embodiments disclosed and those modifications and other embodiments are intended to be included within the scope of the invention. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A method for analysis and evaluation of audio signals, the method comprising:

receiving information from an input device;

calculating complexity of the received information;

calculating indicative parameter of the complexities;

converting the indicative parameter into results for play and display, whereby better usage of audio information is achieved.

2. A system for analysis and evaluation of audio signals, the system comprising:

input device for capturing audio signals;

processing device for manipulation of captured audio signals;

computing device for calculating audio signals parameters;

storage device for storing audio signal related information;

user interface device for user interface with input device, processing device, computing device and storage device, whereby a user can receive immediate and accurate analysis and evaluation of captured audio signals.

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