(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 February 2009 (12.02.2009)

PCT

(10) International Publication Number
WO 2009/019683 A2

(51) International Patent Classification:
A61B 5/00 (2006.01)

(21) International Application Number:
PCT/IL2008/001045

(22) International Filing Date: 29 July 2008 (29.07.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/836,184 9 August 2007 (09.08.2007) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: INTERACTIVE SYSTEM AND METHOD FOR NEUROMOTOR FUNCTIONING ASSESSMENT AND TRAINING

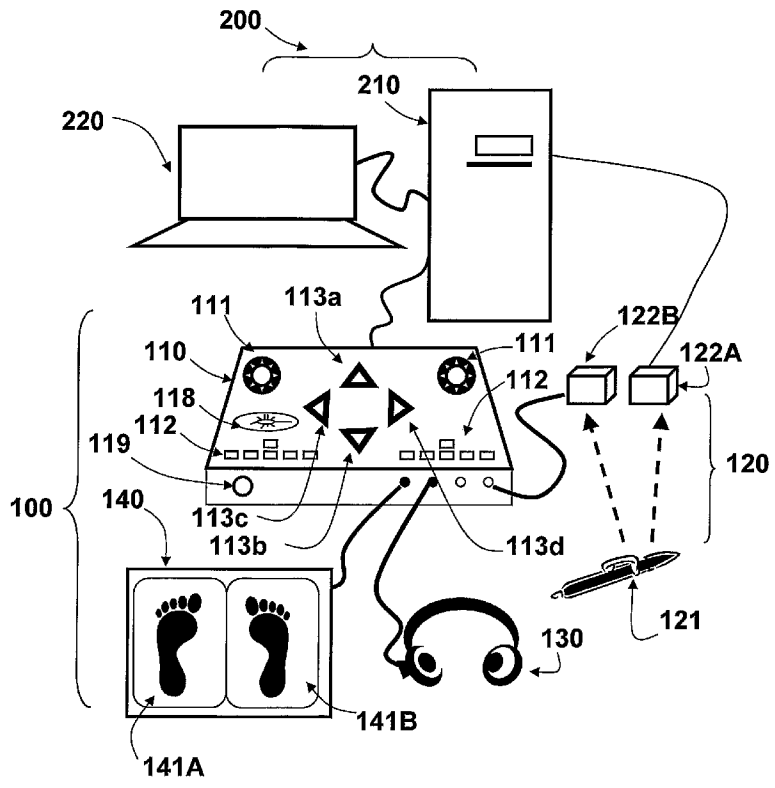


Fig. 1

(57) Abstract: The present invention discloses an interactive system for neuromotor functioning assessment and training of a subject, using rhythmic-based techniques. The system may comprise an acquisition unit and an analysis unit connected by communication means. The acquisition unit may comprise measuring devices and may unit enable producing rhythmic aural and/or visual indications and measuring the subject's performing of actions under the produced rhythmus. The actions may be carried out according to predefined exercises using the measuring devices. The analysis unit may include a software application that allows receiving, storing, displaying and analyzing of acquisition data arriving from the acquisition unit. At least one of the measuring devices may be a graphic-tool such as, for example, a digital pen connected to a receiver, enabling to measure the subject's lifting of the hand while performing graphical actions such as writing.

WO 2009/019683 A2

Published:

— *without international search report and to be republished upon receipt of that report*

Interactive System and Method for Neuromotor Functioning Assessment and Training

FIELD OF THE INVENTION

[0001] The present invention generally relates to the field of behavioral-functioning diagnosing techniques. More particularly, the present invention relates to interactive rhythmus-based systems for assessing neuromotor functioning and learning skills.

BACKGROUND OF THE INVENTION

[0002] Today, there is a growing awareness of parents, teachers and therapists regarding the connections between neuromotor functioning of subjects and the subjects' learning skills and other behavioral, psychological and mental problems, disorders and the like.

[0003] A subject may be any human tested or trained for identifying learning skills related problems such as toddlers, children and the like.

[0004] Many learning-related disorders such as dyslexia, dysgraphia, Attention Deficit Hyperactivity Disorder (ADHD) and many more, are found to be neurological disorders that may affect the subject's learning abilities such as concentration, speed of thought, reading and writing and the like. Therefore, diagnosing problems in certain motor activities may relate to or indicate the subject's learning skills or behavioral difficulties.

[0005] Studies show a clear connection between the brain's ability to automate physical activities and the level of timing functioning (mainly controlled by the cerebellum – an area in the brain that is responsible for the regulation and coordination of complex voluntary muscular movements as well as the maintenance of posture and balance) and the subject's learning skills, learning and behavioral disorders. For example, subjects with cerebellum damage may show difficulties in performing timed tasks {see Rebecca M. C. Spencer, Richard B. Ivry, Howard N. Zelaznik, "Roll of the cerebellum in movements: Control of timing or movements translations?", 2004}.

[0006] Studies have shown that exercises involving requiring subjects to maintain monotonic and/or rhythmic physical activity while performing different actions such

as reading, writing, speaking and the like may be a powerful tool both for diagnosing the subject's level of neuromotor functioning, as well as for training subjects with low neuromotor functioning to improve the subjects' learning skills and behavior.

[0007] Recent studies reveal that the neuromotor functioning of a subject may be estimated and graded when a subject performs refined exercises in which he/she performs fine graphical actions such as writing the alphabet letters or copying shapes while following a metronome monotonic rhythmus – writing a letter per a metronome-nock, for example.

[0008] A patent number US6,719,690 by Cassily James F. discloses a timing assessment tool that is manipulatable by a user in response to the user's expected occurrence of a rhythmic reference signal. The timing assessment tool derives a rhythmic assessment from a pattern of user responses to the user's expected occurrence of the rhythmic reference signal. An analyzer, which may include a database, is provided to respond to the rhythmic assessment to indicate a diagnosis and/or corrective intervention. Cassily's tool include sensing devices such as hand and feet sensors measuring the responses of a user to the rhythmic signal.

[0009] Cassily's patent enables measuring the time-shifts between the subject's responses under a heard or visually displayed rhythmus and the actual rhythm played by the system. Those shifts indicate the neurological pattern and functioning of the subject.

SUMMARY OF THE INVENTION

[0010] The present invention is an interactive system and a method for measuring, analyzing and presenting of neuromotor functioning-assessments of at least one subject to facilitate in assessing the subject's learning and behavioral skills by measuring the subject's neuromotor performances, using various measuring devices used according to various exercising techniques. The system may comprise an acquisition unit and an analysis unit, where the two units may be connected by any communication means known in the art to allow the acquisition unit to transmit acquisition data to the analysis unit where the data can be analyzed.

[0011] According to some embodiments of the present invention, the acquisition unit may include measuring devices that may allow measuring the subject's performances of predefined exercises that include rhythmic operation of actions that involve using those devices.

[0012] Additionally, at least part of the actions of each exercise may be performed by the subject according to a predefined rhythmus applied to the subjects through aural and/or visual indications. For example, the system may produce a metronomic sound transmitted to the subject by aural means such as speakers and/or earphones, where the system may require the subject to perform the actions according to the rhythm that is produced.

[0013] The exercises and data acquisition may be supervised by a user that may be any person responsible for testing the subject. For example, the user may be a teacher, a parent, a psychologist and the like.

[0014] Additionally, the analysis unit may comprise a software application that may enable inputting, receiving, storing, displaying and analyzing of acquisition data arriving from the acquisition unit as well as remote tuning of at least some of the devices.

[0015] According to some embodiments of the present invention, the measuring devices may include a graphic-tool that may be, for example, a digital pen connected to a pen receiver or a digital touch screen enabling to sense movements of a pen like instrument. The pen, for example, may allow sensing the subject's hand movements when performing graphic actions of a graphic exercise and assessing the subject's graphic and didactic neuromotor functioning, according to the subject's performing of said actions.

[0016] For example, the exercises may involve writing the alphabet letters according to a metronomic constant rhythmus, where the system may measure the timing parameters of the subject's hand lifts comparing these parameters with the timing parameters of the rhythmus, where the distance between the measured and the produced timing may be defined as a time shift. The time shifts may indicate the subject's neuromotor functioning, where the shifts (as part of the acquisition data) may be compared to reference shifts defined in the analysis unit as part of a reference data.

[0017] The acquisition unit may additionally include a stepper. The stepper may include a plurality of pads that may allow sensing the subject's stepping impact upon each pad.

[0018] According to some embodiments of the invention, the acquisition unit may comprise an acquisition box connected to the measuring device, at least some of the aural transmitting devices such as the earphones and to the analysis unit, enabling to

transmit the acquisition data to the analysis unit by any communication means known in the art.

[0019] According to some embodiments of the present invention, the acquisition box may comprise at least one sound producer; at least one speaker; visual indicators; at least one keypad; and input and output portals. The box may enable producing aural rhythmic indication using the speakers, the earphones and visual rhythmic indication using the visual indicators and acquiring measuring data from the connected and/or integrated measuring devices such as the keypad, the stepper and the graphic-tool.

BRIEF DESCRIPTIONS OF THE DRAWINGS

[0020] The subject matter regarded as the invention will become more clearly understood in light of the ensuing description of embodiments herein, given by way of example and for purposes of illustrative discussion of the present invention only, with reference to the accompanying drawings, wherein

Fig. 1 is a schematic illustration of a system for assessing neuromotor and behavioral functioning assessing and training, according to some embodiments of the present invention.

Fig. 2 schematically illustrates an acquisition box, according to some embodiments of the present invention.

Fig. 3 schematically illustrates an acquisition box's connections, according to some embodiments of the present invention.

Fig. 4 schematically illustrates a software application connected to the acquisition box and to a web server, according to some embodiments of the present invention.

Fig. 5 schematically illustrates a diagnostic module, according to some embodiments of the present invention.

Fig. 6 schematically illustrates a motor diagnosis, according to some embodiments of the present invention.

Fig. 7 schematically illustrates a didactic diagnosis, according to some embodiments of the present invention.

Fig. 8 schematically illustrates a graphic diagnosis, according to some embodiments of the present invention.

Fig. 9 is a flowchart that schematically illustrates the process of using the analysis and the acquisition units through a graphical user interface's options, according to some embodiments of the present invention.

Fig. 10 schematically illustrates a display chart of sessions, exercises and exercises' results, according to some embodiments of the present invention.

Fig. 11 schematically illustrates a stepper, designed as an eight-shaped walking platform, according to some embodiments of the present invention.

[0021] The drawings together with the description make apparent to those skilled in the art how the invention may be embodied in practice.

[0022] An embodiment is an example or implementation of the inventions. The various appearances of "one embodiment," "an embodiment" or "some embodiments" do not necessarily all refer to the same embodiments. Although various features of the invention may be described in the context of a single embodiment, the features may also be provided separately or in any suitable combination. Conversely, although the invention may be described herein in the context of separate embodiments for clarity, the invention may also be implemented in a single embodiment.

DETAILED DESCRIPTIONS OF SOME EMBODIMENTS OF THE INVENTION

[0023] The present invention is a system and a method for measuring, analyzing and presenting of neuromotor functioning-assessments of at least one subject to facilitate in assessing the subject's learning and behavioral skills by measuring the subject's neuromotor performances, using various measuring devices used according to various exercising techniques. The system may comprise of an acquisition unit **100** and an analysis unit **200**, where the two units may be connected by any communication means known in the art to allow transmission of data.

[0024] According to some embodiments of the present invention, the acquisition unit **100** may include measuring devices that may allow measuring the subject's performances of predefined exercises that include rhythmic operation of actions that involve using those devices.

[0025] Additionally, at least part of the actions of each exercise may be performed according to a predefined rhythmus applied to the subjects through aural and/or visual indications. For example, the system may produce a metronomic tapping sound

transmitted to the subject by aural means such as speakers **111** and/or earphones **130**, where the system may require the subject to perform the actions according to the rhythm that is produced.

[0026] The acquisition unit **100** may measure the timing parameters (in predefined precisions), in which the subject has performed the actions required by the exercise as well as the shifts between the original rhythmus produced by the system and the subject's timing parameters acquired by the acquisition unit **100**.

[0027] A user may operate the system and control the rhythm of the rhythmus-producer by using tuning means **118** installed in the system. The user may be any person that tests the subject's neuromotor performances. For example, the user may be a teacher, a psychologist, a parent, etc. The subject may be any person that is tested by the system such as, for example, a child, a toddler, an adolescent child, an adult, a person with learning or motor disabilities and the like.

[0028] While the description below contains many specifications, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of the preferred embodiments. Those skilled in the art will envision other possible variations that are within its scope. Accordingly, the scope of the invention should be determined not by the embodiment illustrated, but by the appended claims and their legal equivalents.

[0029] Reference in the specification to "one embodiment", "an embodiment", "some embodiments" or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least one embodiments, but not necessarily all embodiments, of the inventions. It is understood that the phraseology and terminology employed herein is not to be construed as limiting and are for descriptive purpose only.

[0030] The principles and uses of the teachings of the present invention may be better understood with reference to the accompanying description, figures and examples. It is to be understood that the details set forth herein do not construe a limitation to an application of the invention. Furthermore, it is to be understood that the invention can be carried out or practiced in various ways and that the invention can be implemented in embodiments other than the ones outlined in the description below.

[0031] It is to be understood that the terms “including”, “comprising”, “consisting” and grammatical variants thereof do not preclude the addition of one or

more components, features, steps, or integers or groups thereof and that the terms are to be construed as specifying components, features, steps or integers. The phrase "consisting essentially of", and grammatical variants thereof, when used herein is not to be construed as excluding additional components, steps, features, integers or groups thereof but rather that the additional features, integers, steps, components or groups thereof do not materially alter the basic and novel characteristics of the claimed composition, device or method.

[0032] If the specification or claims refer to "an additional" element, that does not preclude there being more than one of the additional element. It is to be understood that where the claims or specification refer to "a" or "an" element, such reference is not be construed that there is only one of that element. It is to be understood that where the specification states that a component, feature, structure, or characteristic "may", "might", "can" or "could" be included, that particular component, feature, structure, or characteristic is not required to be included.

[0033] Where applicable, although state diagrams, flow diagrams or both may be used to describe embodiments, the invention is not limited to those diagrams or to the corresponding descriptions. For example, flow need not move through each illustrated box or state, or in exactly the same order as illustrated and described.

[0034] Methods of the present invention may be implemented by performing or completing manually, automatically, or a combination thereof, selected steps or tasks. The term "method" refers to manners, means, techniques and procedures for accomplishing a given task including, but not limited to, those manners, means, techniques and procedures either known to, or readily developed from known manners, means, techniques and procedures by practitioners of the art to which the invention belongs. The descriptions, examples, methods and materials presented in the claims and the specification are not to be construed as limiting but rather as illustrative only.

[0035] Meanings of technical and scientific terms used herein are to be commonly understood as by one of ordinary skill in the art to which the invention belongs, unless otherwise defined. The present invention can be implemented in the testing or practice with methods and materials equivalent or similar to those described herein.

[0036] Any publications, including patents, patent applications and articles, referenced or mentioned in this specification are herein incorporated in their entirety into the specification, to the same extent as if each individual publication was

specifically and individually indicated to be incorporated herein. In addition, citation or identification of any reference in the description of some embodiments of the invention shall not be construed as an admission that such reference is available as prior art to the present invention.

[0037] Fig. 1 schematically illustrates a system for neuromotor functioning assessment and training facilitating in diagnosing of the subject's behavioral functioning and learning skills, according to some embodiments of the present invention. According to these embodiments, the system may comprise:

- an acquisition unit **100** that may enable producing rhythmic aural and visual stimulation and measuring the subject's performances and responses under these stimulations, where the performances and responses may be carried out according to predefined exercises using predefined measuring devices;
- at least one analysis unit **200** that may include a software application **250** that allows receiving, storing and analyzing of acquisition data arriving from the acquisition unit **100**.

[0038] According to some embodiments of the present invention, as illustrated in Fig. 1, the acquisition unit **100** may comprise: a graphic-tool **120** such as a digital pen **121** connected to at least one pen receiver **122**, at least one stepper **140**, at least one set of earphones **130** and at least one acquisition box **110**. The graphic tool **120** may allow sensing the subject's hand movements while performing graphical exercises such as writing, drawing, etc. using the pen **120**, and transmitting the sensed data to the acquisition box **110**. The stepper **140** may sense the subject's steps separating one foot from the other and enabling sensing and identifying each foot's stepping impact upon each stepper's **140** pad (**141A** and **141B**) and optionally measuring the impact's intensity as well. The stepper **140** may further transmit the measuring data to the acquisition box **110**. The earphones **130** may allow the subject to hear rhythmic sounds transmitted by the acquisition box **110** while performing the actions of the exercises.

[0039] According to some embodiments of the present invention, the analysis unit **200** may comprise a processing unit **210** and a display unit **220** that allow receiving of the acquisition data from the acquisition unit **100**, processing the acquisition data by comparing the acquisition data with reference associated data stored in the processing

unit **210** and displaying the acquisition data, the reference data and the final analysis results.

[0040] The reference data may compose of normative values, parameters, etc. of the exercises' results adapted to a predefined grading mechanism.

[0041] According to some embodiments of the present invention, the processing unit **210** may be a computer, for example, and the display unit **220** a computer screen with a software application **250** installed.

[0042] Additionally, the system may further enable displaying of instructional information to the user to assist the user in operating the software application **250**, in instructing the subject regarding the exercises, in exhibiting the exercises instructions, in explaining the analysis results and their meaning etc.

[0043] According to embodiments of the present invention, as illustrated in Fig. 2, the acquisition box **110** may comprise:

- at least one speaker **111**;
- visual indicators **113**;
- at least one keypad **112**;
- input **114** and output **115** portals;
- at least one sound tuner **118** ;
- a volume button **119**; and
- at least one microprocessor **10**.

The microprocessor **10** may comprise a sound-producer **11** and a timing unit **12**. The sound producer may produce rhythmus sounds controlled by the user using the sound tuner **118** and the volume button **119** and/or the application's **250** interface through virtual control buttons and tuners. The timing unit may enable measuring and storing time related data associated with the measuring data received from the measuring devices (e.g. the stepper **140**, the pen receiver **121** and the keypad **112**). For example, a subject may be requested by a user to step upon the stepper **140** according to a predefined rhythmus played by the acquisition box **110** that the user can hear by using the earphones **130** and/or the speakers **111**; the user may step on the stepper **140** where the timing unit **12** acquires the timing parameters of each step (meaning the time spot over the timescale) and allows measuring of the shifts between the subject's timing and the "actual" timing produced by the sound producer **11**.

[0044] Depending upon embodiments of the invention, the measuring of time shifts may be carried out in the processor **10** and/or in the analysis unit **200**, where the

analysis unit **200** may receive the measured timing parameters and the timing parameters of the produced rhythmus and calculate the shifts between them.

[0045] Fig. 3 schematically illustrates the acquisition box's **110** connections, according to some embodiments of the present invention. The microprocessor **10** may be connected to the analysis unit **200** through a Universal Serial Bus (USB) controller **17**. The distinguished parts of the measuring devices (e.g. the pads of the stepper **140**, each keypad's **112** key and the like) may be regarded as switches. Connected to the microprocessor **10** by any communication and transmission means known in the art.

[0046] According to some embodiments of the present invention, the visual indicators **113** may be light bulbs such as light emitting diodes (LED), for example. Some of the exercises may include following the rhythmus of the top LED **113a**, bottom LED **113b**, left LED **113d** and right LED **113d** as illustrated in Fig. 2. The subject may be requested, for example, to press certain keys on the left and/or right keypads **112** using certain specified fingers, according to a predefined rhythmus indicated by the flickering of the LED indicators **113** and/or a rhythmic sound.

[0047] Fig. 4 schematically illustrates the software application **250** connected to the acquisition box **110**, according to some embodiments of the present invention. The application **250** may include a graphical user interface (GUI) **251** to allow graphically displaying of information, data and analysis results. The GUI **251** may comprise a diagnostic module **253** to enable displaying and distinguishing the exercises and the exercises' diagnostic purposes and a training module **254** that to enable setting up a training program according to the subject's diagnostic performances and the subject's personal details (e.g. the subjects' age, physical condition and the like).

[0048] Fig. 5 schematically illustrates a diagnostic module **253**, according to some embodiments of the present invention. The diagnostic module may comprise:

- a motor diagnosis **20** enabling to display exercises and exercises' results relating to the subject's neuromotor functioning using the stepper **140** and the keypad **112** as the substantially main measuring devices;
- a didactic diagnosis **30** that involves exercises that may assess and train the subject's didactic skills such as writing using the digital pen **120** and pen receiver **121** as the main measuring devices; and
- a graphic diagnosis **40** that involves exercises that may assess and train the subject's graphic skills and their consequent neuromotor skills such

as drawing, copying of shapes and the like using the digital pen **120** and the pen receiver **121** as the main measuring devices.

[0049] Fig. 6 schematically illustrates the motor diagnosis **20**, according to some embodiments of the present invention. The motor diagnosis **20** may comprise of two main exercises types:

(1) A gross motor diagnosis **21** that may involve exercises in which the subject may be required to step on the stepper **140** while hearing various rhythmus beats (using the earphones **130** and/or the speakers **111**) with the purpose to try and follow the rhythmus with his/her stepping over the stepper's **140** pad. The acquisition box **110** may measure the timing parameters of the subject's steps and record the real timing parameters of the produced rhythmus where the processing unit **210** may analyze the acquisition data and calculate the time-shifts between the real and the acquired parameters; and

(2) A refined motor diagnosis **22** that may involve exercises in which the subject may be required to follow both an aural and a visual rhythmic indications (that may follow the same rhythmus) in order to press keys on the keyboards **112**. Theses exercises may require pressing specific fingers over specific keys according to the position of the visual indication manifested through the visual indicators **113**.

[0050] Fig. 7 schematically illustrates the didactic diagnosis **30**, according to some embodiments of the present invention. The didactic diagnosis **30** may comprise of two main exercises types:

(1) Gross didactic diagnosis **31** in which the subject may be required to write down the ABC letters according to their natural sequence, where the system may measure the amount of correct and incorrect letters written and the time interval that took the subject to write them. This may be calculated into an average number of letters per minute that may be used for a gross didactic diagnosis of the subject's learning skills, for example.

(2) Refined didactic diagnosis **32** in which the subject may be required to write down the ABC letter according to their natural sequence, using the graphic toll **120**, and according to a played rhythmus where the system may measure the number of "lifts" the user has made where "lifts" are defined hereinafter when the subject lifts the graphic tool **120** when writing. For example, when writing the letter A the subject may lift the tool **120** once between the triangle and the

middle line and the second time to move on to the next letter. In the refined diagnosis **32**, the system may further measure and calculate the timing shifts between the original played rhythmus and the subject's lifts timing.

[0051] Fig. 8 schematically illustrates the graphic diagnosis **40**, according to some embodiments of the present invention. The didactic graphic **40** may comprise of two main exercises types:

(1) a gross graphic diagnosis **41** in which the subject may be required to copy written text and/or to copy predefined number of predefined shapes, where the system may measure the number of correct and incorrect words and/or shapes the subject has managed to accomplish per a predefined timeframe (e.g. the number of correct words per minute).

(2) a refined graphic diagnosis **41** in which the subject may be required to copy written text and/or to copy predefined number of predefined shapes, using the graphic tool **120**, according to a predefined rhythmus, where the system may measure the same parameters as in the gross diagnosis **41** as well as the timing shifts between the original played rhythmus and the subject's lifts timing.

[0052] Additionally, the diagnostic module **253** may further comprise an attentiveness-area (AA) diagnosis, according to some embodiments of the present invention. The AA diagnosis may allow testing the optimal sitting position of the subject in a classroom, for example, by testing the subject's natural listening/hearing optimum, sight optimum etc. For example by testing which ear is instinctively turned towards a sound source, which eye instinctively turns towards a light source etc. The user who examines the subject may input the results of all these "focus tests" into the application **250** using the GUI **251** selections where the application **250** may output the resulting position out of predefined classroom where the user selects the number of seats, rows and columns.

[0053] Additionally, the diagnostic module **253** may further comprise a "naming" diagnosis, according to some embodiments of the present invention. In the naming diagnosis, the subject may be required to read out from a predefined text where the system may measure the number of correct and the number of incorrect words read by the user, the time interval the reading required to enable calculating the number of correct words read per a predefined time interval etc.

[0054] According to embodiments of the present invention, to allow a more refined naming diagnosis, the acquisition unit **100** may additionally comprise recording devices and word analyzing hardware and/or software tools to enable measuring timing shift of words from a predefined rhythmus aurally and/or visually indicated to the subject by the acquisition box **110**.

[0055] According to some embodiments of the present invention, the acquisition unit **100** may be connected to the user's computerized system **200** where the computerized system may be connected to a web server **300** that may maintain a website through which a web application **250** containing a web GUI **251** may allow the user to enter a personal account in which he/she may store subjects' acquisition data. Additionally, the server **300** may provide the user with an access to at least one database **350** enabling a multiplicity of users to share the same reference data, exercises instructions, reference results and the like.

[0056] Fig. 9 is a flowchart that schematically illustrates the process of using the analysis **200** and the acquisition **100** units through the GUI **251** options, according to some embodiments of the present invention. The process may comprise the steps of:

- entering the GUI **251** and starting a new session **81** – where to enter the application's **250** GUI **251** the user may be required to enter a website and/or to open a client program installed in his/her personal computer (depending on embodiments of the invention);
- the GUI **251** may require the user to select a diagnostic **82** or a training **91** process;
- upon selecting of the diagnostic process, the user may be required to select the diagnosis type **83**, for example, according to the diagnosis types distinctions mention above (e.g. didactic, graphic etc.);
- upon selecting the diagnostic type, the user may be required to select the exercises' type **84** (e.g. gross or refined) where a list of exercises may automatically be displayed allowing the user to –
- select an exercise **85**;
- acquiring the acquisition data **86**, where the user may instruct the subject regarding the exercise and the usage of the exercise related measuring devices and indications, operate the relevant features of the acquisition box **110** and/or the relevant devices and allow the subject to perform the actions of the exercise. While the subject performs the exercise, the acquisition box

110 may online record all timing parameters and other device and exercise related data (e.g. pen **121** lifts / stepper's **140** impacts, original indication rhythmus etc.).

- Transmitting the acquisition data to the analysis unit **87** for further processing;
- analyzing the acquisition data **88** by, for example, comparing the acquisition data or a processed acquisition data to a reference data stored and/or retrieved by the analysis unit **200**;
- once the analysis of the exercise is completed, the user may select another exercise of the same type **89**, another exercise of the same diagnostic type but of a different exercise type **90**;
- once the subject has performed all the exercises set up by the user (e.g. a tutoring psychologist) the user may select a new session **91** repeating steps **83-90**.
- One the user has selected all desired sessions and the subject has performed at least some of the exercises of the selected sessions – the GUI **251** may display the results of the sessions and exercises in a results screen **92** as illustrated in Fig. 10.

[0057] Additionally, once the user has selected the training rout **93** – the user may select the training type **94** and be presented of substantially the same types of exercises as of the diagnostic module **253** of the GUI **251**.

[0058] Fig. 10 schematically illustrates a display chart of sessions, exercises and exercises' results, according to some embodiments of the present invention. The GUI **251** may allow the user to execute operations **61** such as adding a new session to the table **61A**, deleting an existing session **61B**, opening a new exercise **61C** and the like, where the sessions and exercises are selected out of predefined lists.

[0059] Additionally, the GUI **251** may facilitate the user in saving and displaying the sessions' tables of each of the user's subjects separately specifying the subject's details **67** by displaying them whenever the subject's account is opened.

[0060] Additionally, the sessions' table may exhibit a grade of each exercise – calculated according to predefined criterions based on comparison with statistics-based models, for example.

[0061] Additionally, the application **250** may enable outputting a quantified total grade or several grades relating to several fields tested, where each grade may be

compared to a grades table enabling to estimate the subject's functioning level in each field. For example, a grade from one to ten indicating the dyslexia level where below five is considered dyslexia.

[0062] According to embodiments of the invention, the system may accumulate statistical data relating to the exercises results of a multiplicity of subjects tested by a multiplicity of users. The system may process this data to update and improve the reference data to which the acquisition data is compared.

[0063] Fig. 11 schematically illustrates a stepper **140**, designed as an eight-shaped walking platform, according to some embodiments of the present invention. The stepper **140** may comprise a multiplicity of sensors enabling to sense the subject's footsteps and footsteps' impact intensity upon each pad **141** of the stepper **140**. This stepper **140** type may be used, for example, for testing the subject's ability to walk according to an eight-shaped line where the crossing shape of the sign 8 may require operating different hemispheres and may test different neuromotor functioning levels. Additionally, the stepper's **140** exercises may require the subject to walk and/or jump along the eight-shaped markings according to a rhythmus produced by the acquisition unit **100** while performing other actions according or not according to the same rhythmus.

[0064] According to some embodiments of the invention, the stepper **140** may enable sensing of the subject's stepping and position of steps without the use of pads **141**. The stepper **140** may be a seismic or an optic detector enabling to scan a predefined area and sense the subject's feet and/or legs movements.

[0065] Additionally, the graphic tool **120** may be a digitizer screen that allows detection of the subject's graphic operations by, for example, sensing a pen's pressure upon said screen.

[0066] Alternatively, the graphic tool **120** may be an optical sensor enabling to sense the subject's hand movements.

[0067] According to some embodiments of the invention, the user may control the measuring devices through the analysis unit **200** where the GUI **251** may include control options to allow the user to control various measuring devices and features. For example, the user may be enabled by the GUI **251** to control the rhythmus and volume of the sound and visual indications, turn at least some of the devices on and off through the GUI **251** etc.

[0068] Additionally, the GUI **251** may include at least one questionnaire format to allow the user to input the subject's details such as, for example, the subject's medical and psychological history, personal details such as name, sex and age, socioeconomic background, grades at school and the like. Upon filling the questionnaire, the GUI **251** may automatically open a "personal file" of the subject enabling to store all the questionnaire as well as the exercises results in this file.

[0069] Additionally, the GUI **251** may further allow the user to enter either the each subject's specific file and/or the user's workspace by requiring the user to input security codes such as a password and/or a user name.

[0070] According to some embodiments of the invention, the sound and rhythmus may be any type of musical and/or sound pieces played according to a certain rhythmus. For example, the sound may be a sound of a falling coin replayed according to a predefined rhythmus, or a musical piece where the subject is requested to perform the exercise according to his/her interpretation as to what the rhythmus of the musical piece is and/or according to the piece's changing rhythms.

[0071] While the invention has been described with respect to a limited number of embodiments, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of some of the preferred embodiments. Those skilled in the art will envision other possible variations, modifications, and applications that are also within the scope of the invention. Accordingly, the scope of the invention should not be limited by what has thus far been described, but by the appended claims and their legal equivalents.

What is claimed is:

1. An interactive system for neuromotor functioning assessment and training of a subject, using rhythmic-based techniques, said system comprising:
   - an acquisition unit that comprises measuring devices, wherein said acquisition unit enables producing rhythmic aural indications and measuring the subject's performing of actions under said rhythmus, wherein said actions are carried out according to predefined exercises using said measuring devices;
   - at least one analysis unit that includes a software application that allows receiving, storing, displaying and analyzing of acquisition data arriving from said acquisition unit;

   wherein said measuring devices include at least one graphic-tool, wherein said tool enables sensing the subject's hand movements when performing graphic actions with at least part of said tool, allowing said system to assess the subject's graphic and didactic neuromotor functioning, according to the subject's performing of said actions.
2. The system of claim 1 further including of visual indicators enabling to produce visual indications according to predefined rhythms.
3. The system of claim 1 wherein said acquisition unit comprises said graphic-tool, at least one stepper, at least one set of earphones and at least one acquisition box, wherein said box comprises:
   - at least one sound producer;
   - at least one speaker;
   - visual indicators;
   - at least one keypad; and
   - input and output portals;

   wherein said box enables producing aural rhythmic indication using the speakers, the earphones and visual rhythmic indication using said visual indicators and acquiring measuring data from said stepper and graphic-tool.
4. The system of claim 3 wherein the input portals enable connecting to said stepper and graphic-tool to allow receiving measured acquisition data from said stepper and graphic-tool, wherein the output portals enable connecting to said speaker and to said analysis unit to allow transmitting of data to said analysis unit where

further analysis of the acquisition data acquired from said stepper, said graphic-tool and the at least one keypad is carried out.

5. The system of claim 3 further comprising of a tuner enabling a user to define the rhythmus of the aural and visual indications.

6. The system of claim 4 wherein said analysis unit comprises:
   - a processor enabling to analyze the data received from said acquisition box and producing of analysis results; and
   - a display unit enabling to display instructional information acquisition data related information;

   wherein said analysis is carried out by processing of the acquisition data acquired by the acquisition box and comparing at least part of said acquisition data with reference data to produce the final analysis results, wherein said reference data is stored in said analysis unit.

7. The system of claim 1 wherein said software application comprises a graphical user interface (GUI) that includes a diagnostic module and training module, where the diagnostic module allows displaying of diagnostic exercises according to the subject's details and the user to select said exercises according to a predefined menu.

8. The system of claim 7 wherein said diagnostic module comprises:
   - a motor diagnosis enabling to display exercises and exercises' results relating to the subject's neuromotor functioning using the stepper and the keypad as the substantially main measuring devices;
   - a didactic diagnosis that involves exercises that enable to assess and train the subject's didactic skills using the graphic-tool as the main measuring devices;
   - a graphic diagnosis that involves exercises that may assess and train the subject's graphic skills and their consequent neuromotor skills using the digital graphic-tool as the main measuring devices.

9. The system of claim 8 further comprising of an attentiveness-area (AA) diagnosis that involves exercises that facilitates in assessing the subject's optimal area in a classroom from which the subject will acquire a substantially optimal attentiveness.

10. The system of claim 7 wherein said application is a web application enabling a multiplicity of users to share the same database and to enter a designated website

maintained by at least one web server, wherein each user has a personal account enabling each user to view said user's data and results measured by the user's own acquisition unit connected to the web server by computerized electronic and digital means.

11. The system of claim 3 wherein said keypad is installed within said box enabling to measure the subject's pressing of each key and identifying each key that has been pressed as well as measuring the timing parameters in which each distinguished key is pressed by the subject.

12. The system of claim 1 wherein said graphic-tool includes at least one digital pen and at least one pen-receiver wherein said pen enables sensing the subject's hand movements while using said pen and transmitting sensing signals to the receiver and wherein said receiver enables receiving said signals and transmitting the measured signals to the acquisition unit.

13. The system of claim 3 wherein said stepper includes at least one pad, wherein said pad enables sensing a subject's stepping upon said pad as well as sensing the intensity of the subject's step.

14. The system of claim 13 wherein said stepper includes an eight-shaped marking, allowing measuring the subject's performances when the subject walks upon said stepper according to said marking and according to an aurally produced rhythmus.

15. The system of claim 1 wherein said graphic tool is a digitizer screen.

16. The system of claim 1 wherein said graphic tool is an optical sensor enabling to sense the subject's hand movements.

17. The system of claim one wherein said stepper is an optical sensor enabling to senses the subject's legs and feet movements.

18. The system of claim 1 wherein said stepper is a seismic sensor enabling to sense the subject's feet movements.

19. A method for neuromotor functioning assessment and training of a subject, using an acquisition unit that comprises measuring devices wherein said unit enables producing rhythmic aural indications, and an analysis unit comprising of a software application with a graphical user interface (GUI),

said method comprising the steps of:

- performing at least one exercise, wherein said subject performs actions associated with said exercise according to a predefined rhythmus and

wherein said performance involves using at least one of the measuring devices;

- acquiring acquisition data, wherein said data includes timing parameters, which indicate the subject's performing of each action along the timescale;
- comparing the acquisition data with a reference data, wherein said comparison is carried out by the analysis unit enables assessing the subject's neuromotor functioning;

wherein the actions of at least some of the exercises require the subject to perform graphical actions according to said predefined rhythmus.

20. The method of claim 19 wherein said comparison of the acquisition data with the reference data including comparing the timing parameters of the subject's performance of actions with the timing parameters of the predefined rhythmus.

21. The method of claim 20 wherein said comparison results are defined as shifts, wherein said shifts are measured according to predefined precisions.

22. The method of claim 19 wherein said subject carries out said graphical actions of graphical exercises by using a graphical tool as at least one of the measuring devices.

23. The method of claim 22 wherein said graphical exercises include writing letters, copying of text and copying of predefined shapes, wherein said graphical tool enables sensing the subject's lifting of said tool.

24. The method of claim 19 wherein one of the exercises includes stepping over a stepper according to a predefined rhythmus, wherein said stepper is one of the measuring devices that allows sensing of the subject's stepping impact upon said stepper.

25. The method of claim 19 wherein said acquiring of acquisition data is carried out by an acquisition box included in said acquisition unit, wherein said box enables producing of aural indications of said predefined rhythmus, receiving of the measured data from the measuring devices, storing of said data as well as the timing parameters of the produced rhythmus and transmitting the timing parameters of the produced rhythmus, the measured data and other related data to the analysis unit.

26. The method of claim 19 further comprising the step of filling a questionnaire, wherein said GUI includes at least one questionnaire format enabling the user to fill the subject's details and automatically opening of a personal file under the

subject's name enabling to store all the subject's details as well as the subject's exercises results under said file.

27. The method of claim 19 further comprising the step of inputting at least one security code, wherein the GUI enables the user to enter said user's account by inputting of said codes.

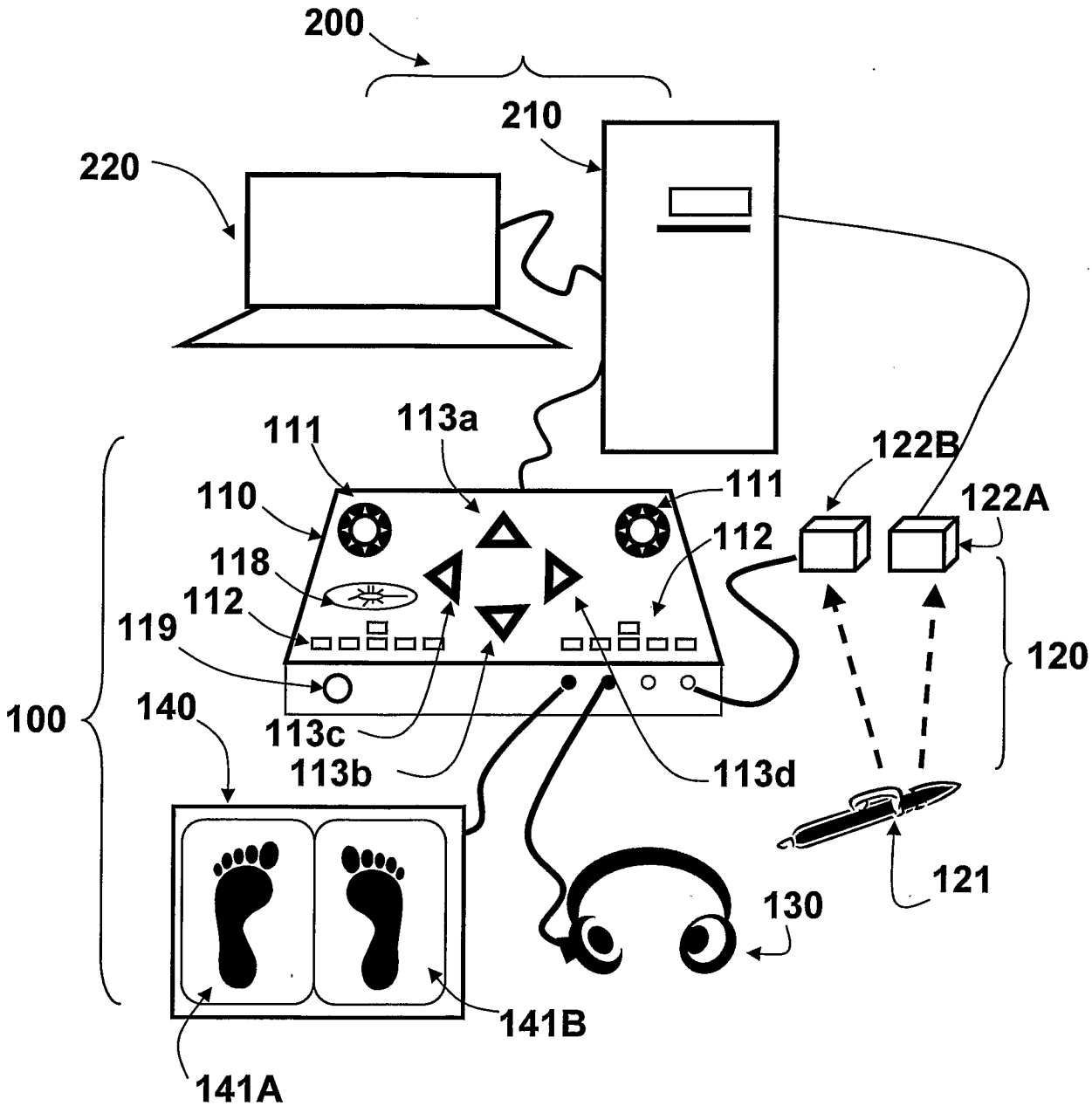

200
210
220
111
113a
122B
110
111
122A
112
118
112
119
120
100
140
113c
113b
113d
121
130
141B
141A

Fig. 1

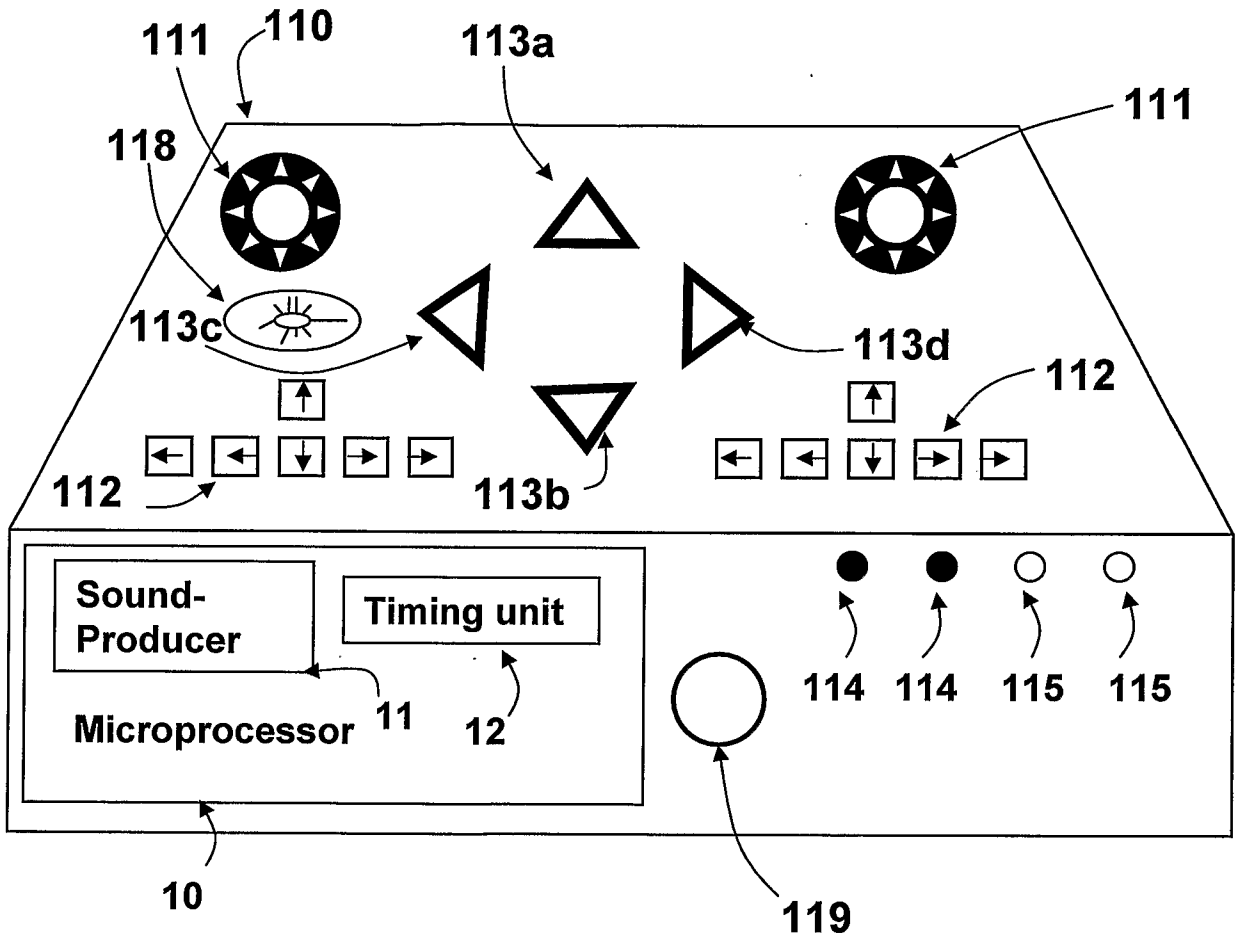

111
110
113a
111
118
113c
113d
112
112
113b
Sound-
Producer
Timing unit
Microprocessor
11
12
114
114
115
115
10
119

Fig. 2

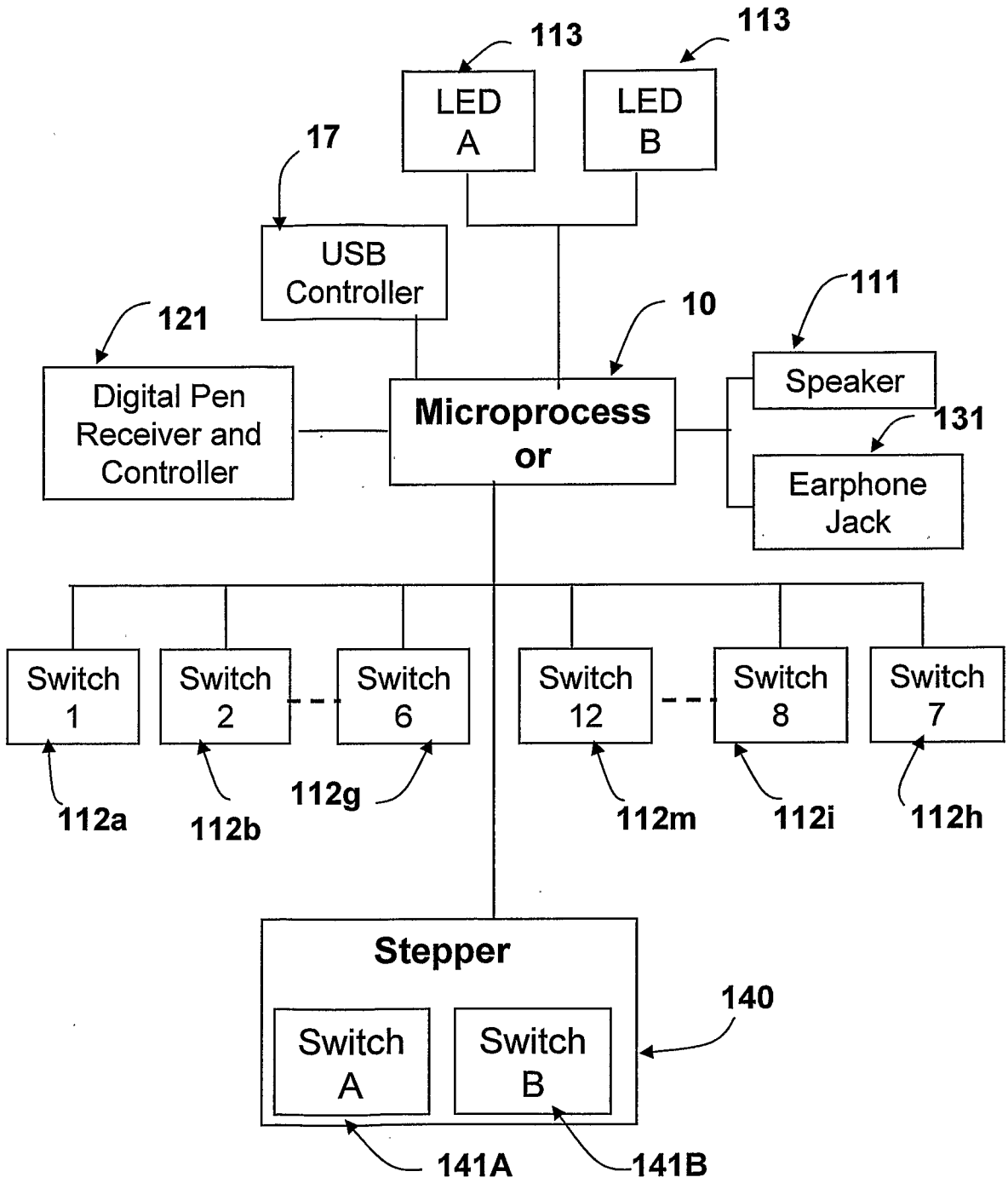

113
113
LED A
LED B
17
USB Controller
121
10
111
Digital Pen Receiver and Controller
Microprocessor
Speaker
131
Earphone Jack
Switch 1
Switch 2
Switch 6
Switch 12
Switch 8
Switch 7
112a
112b
112g
112m
112i
112h
Stepper
140
Switch A
Switch B
141A
141B

Fig. 3

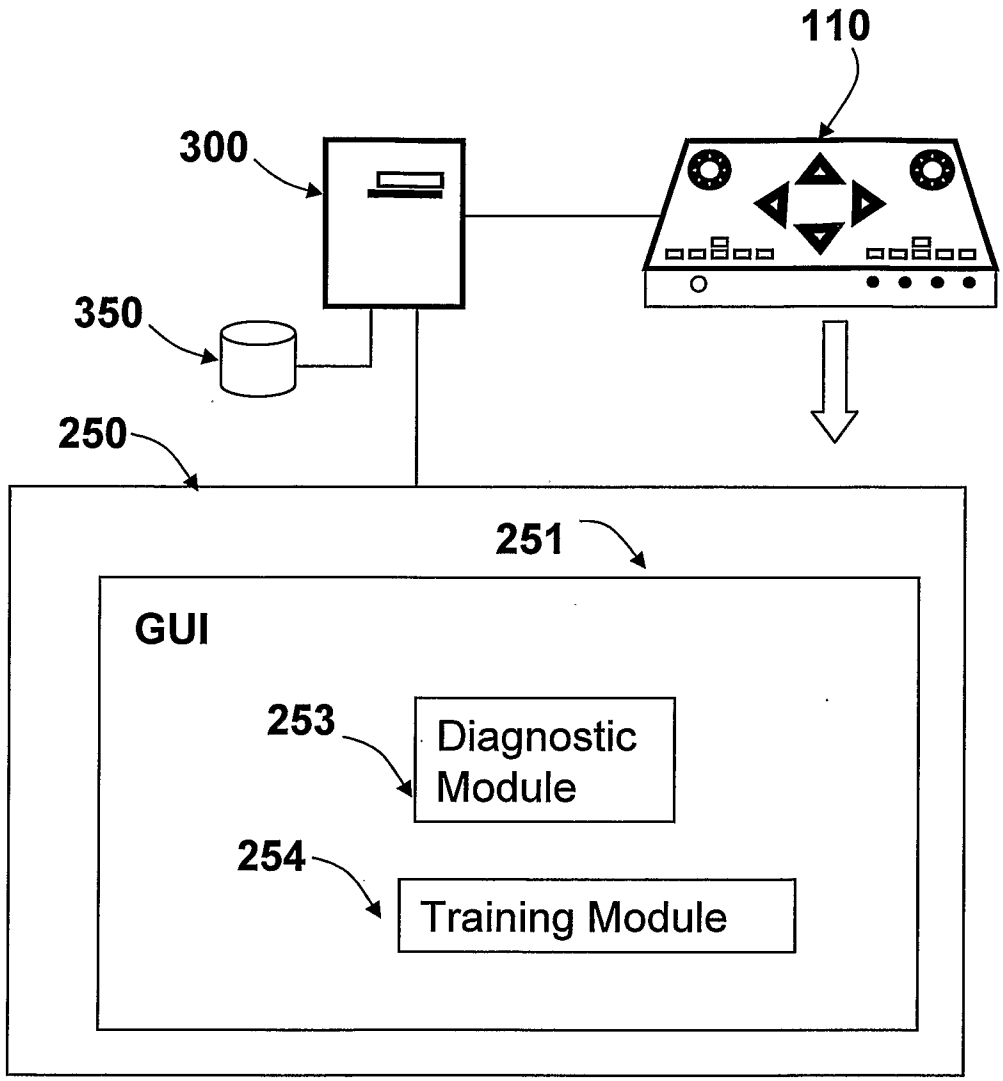

110
300
350
250
251
GUI
253
Diagnostic Module
254
Training Module

Fig. 4

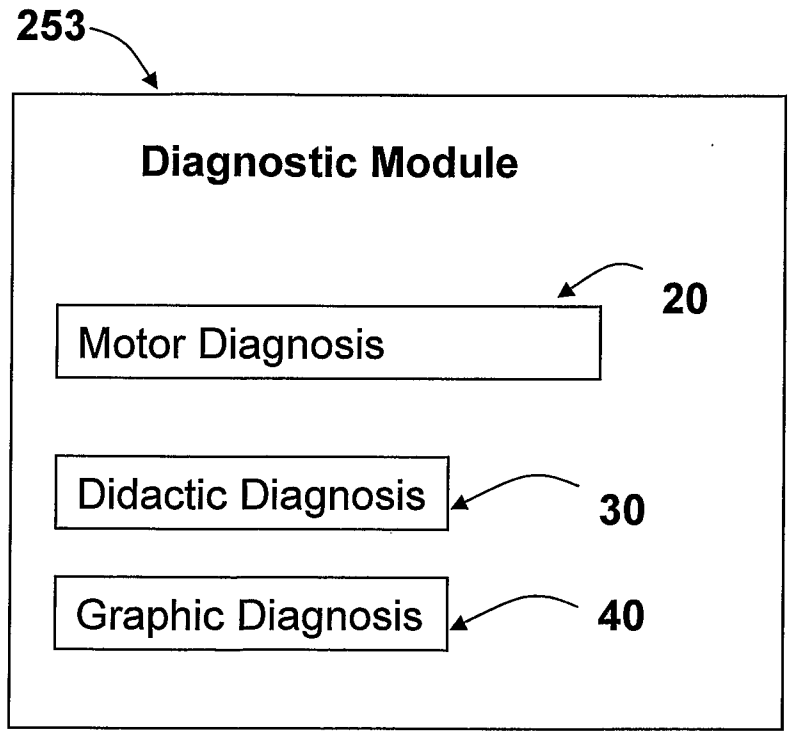

253
Diagnostic Module
20
Motor Diagnosis
Didactic Diagnosis
30
Graphic Diagnosis
40

Fig. 5

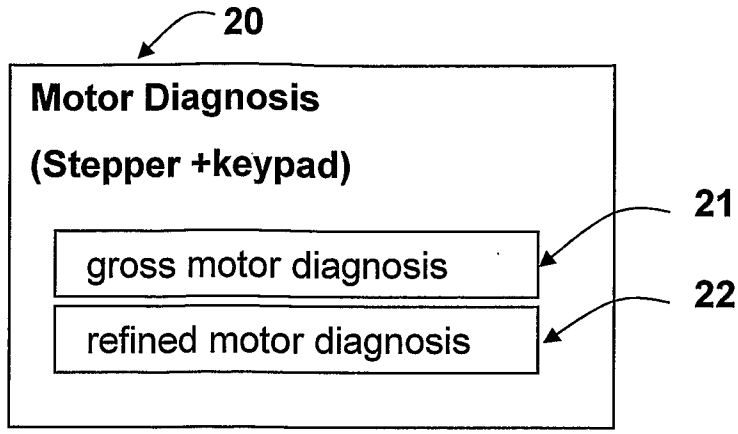


Fig. 6

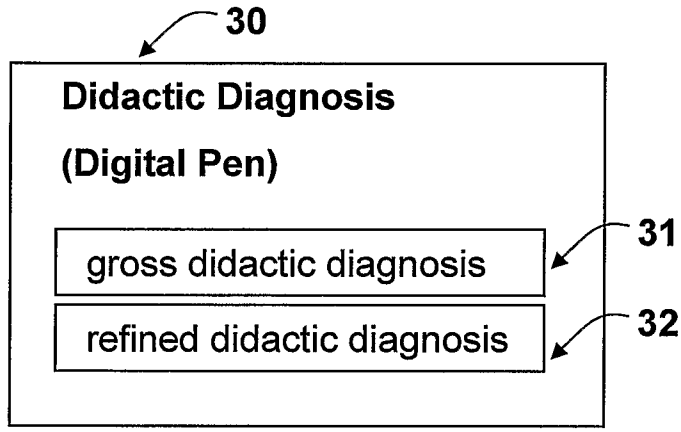


Fig. 7

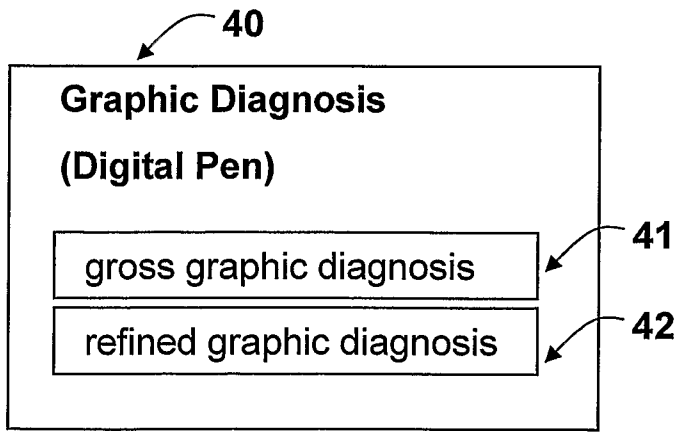


Fig. 8

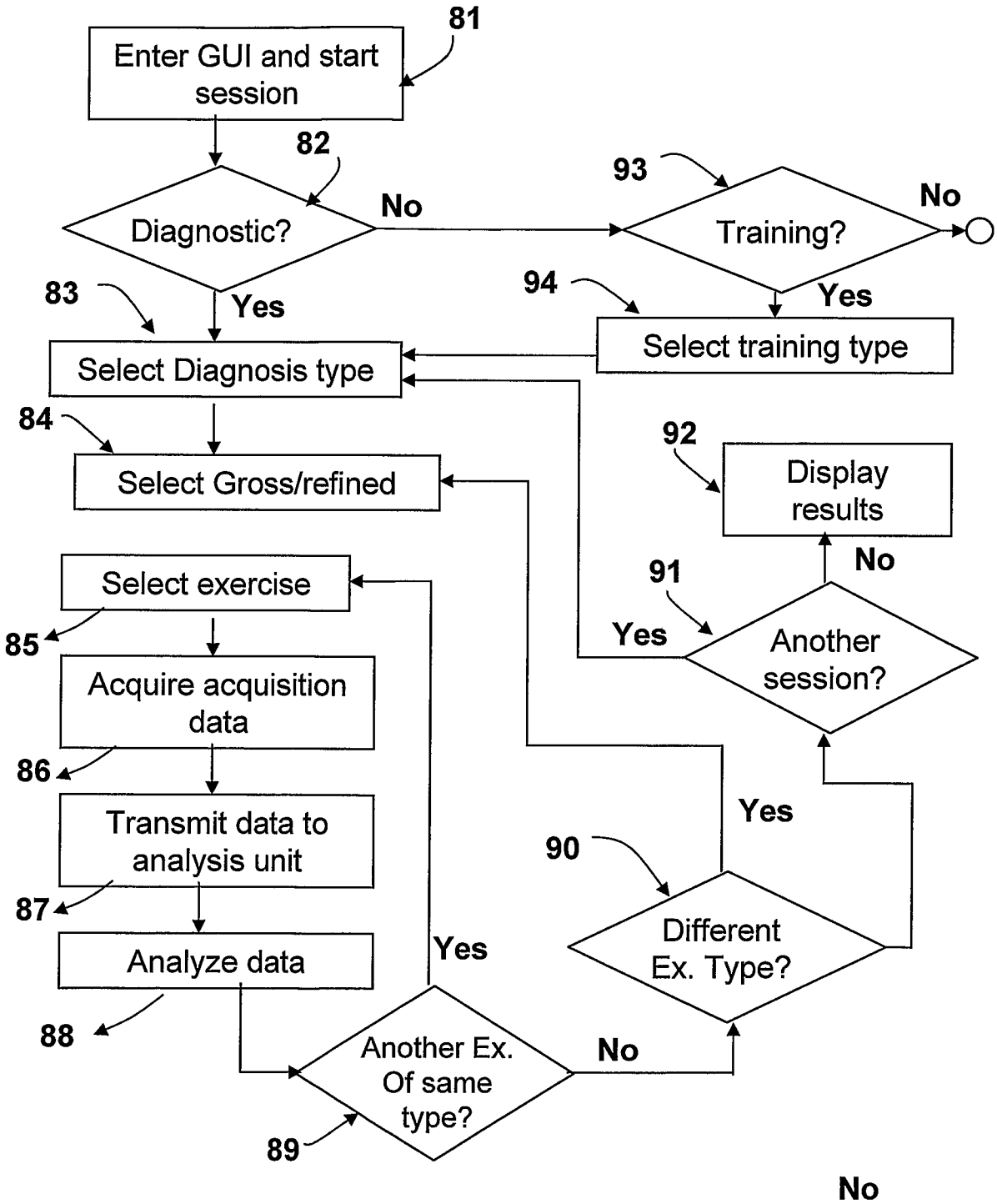
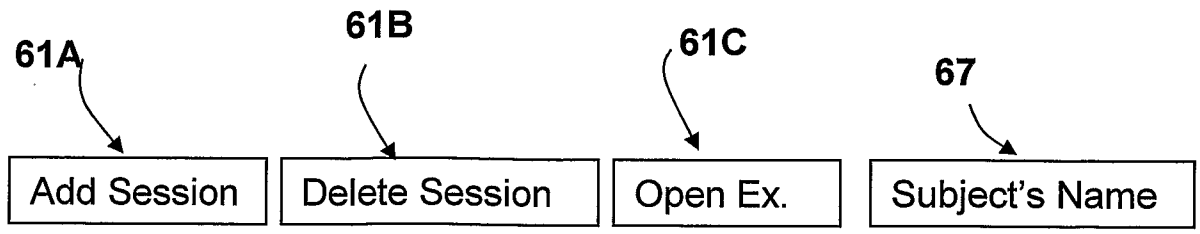

81
Enter GUI and start session
82
Diagnostic?
No
93
Training?
No
Yes
94
Select training type
83
Yes
Select Diagnosis type
84
Select Gross/refined
92
Display results
No
Select exercise
91
85
Yes
Another session?
Acquire acquisition data
86
Transmit data to analysis unit
Yes
90
87
Different Ex. Type?
Analyze data
Yes
88
Another Ex. Of same type?
No
89
No

Fig. 9



Session 1	Session 2	Session 3	Session 4
1-1. Motor (Gross) Stepper: Grade: ____	2-1. Didactic (Gross) Letters Per Min: Grade: ____	3-1. Graphic (Gross) Words Per Min: Grade: ____	4-1. Aural (Gross) Words Per Min: Grade: ____
1-2. Motor (Refined) Keypads: Grade: ____	2-2. Didactic (Refined) Rhythmic writing (letters) Precision : Grade: ____	3-2. Didactic (Refined) Rhythmic writing (words) Precision : Grade: ____	4-2. Aural (Refined) Rhythmic reading (words) Precision : Grade: ____
1-3. Motor (Refined) Eye-hand: Grade: ____		3-3. Graphic (Gross) Shapes Per Min: Grade: ____	
		3-4. Didactic (Refined) Rhythmic copying (shapes) Precision : Grade: ____	

60

Fig. 10

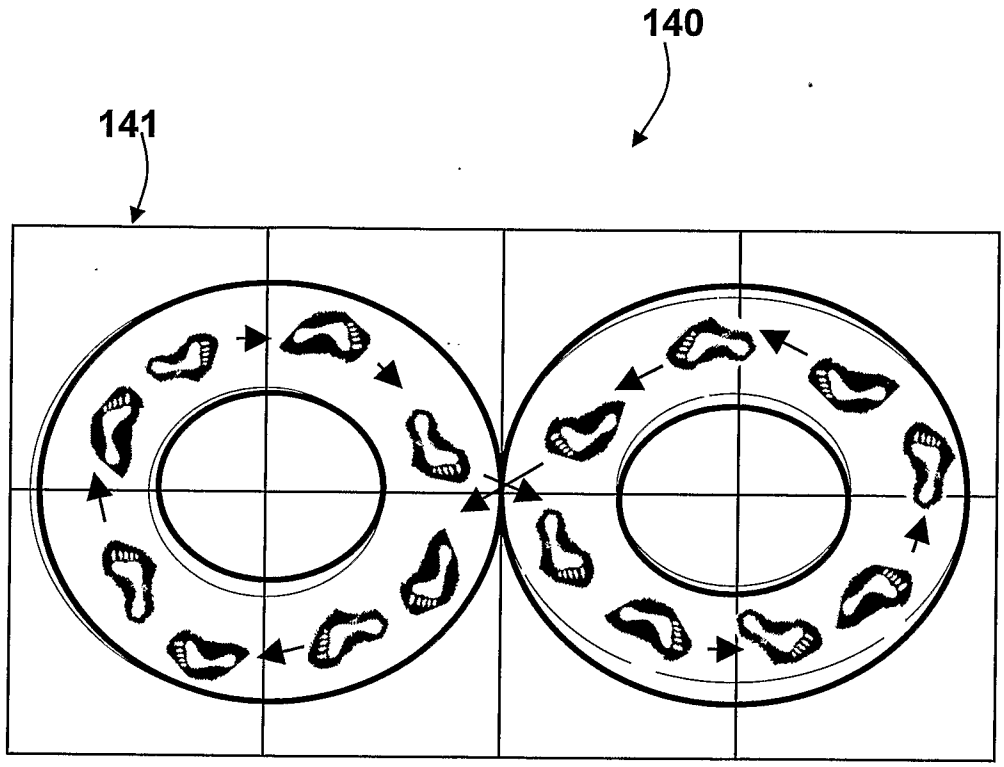


Fig. 11