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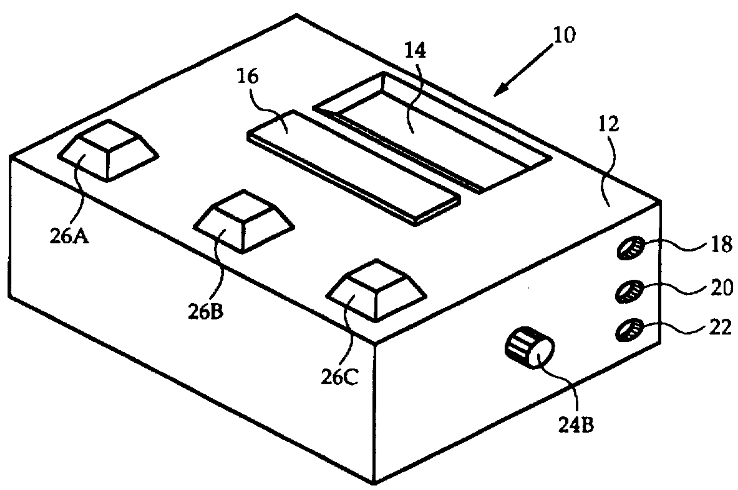

(57) Abstract

This invention is a portable device (10) for assessing motor symptoms of a patient, including a bradykinesia testing system for measuring reaction and movement times of the patient, a tremor testing system for measuring tremors in extremities of the patient, and a rigidity testing system for measuring rigidity in the hand of a patient. The rigidity testing system includes a digital shaft encoder (44) with a rotatable shaft (24) that is actuated by the patient's fingers. A microprocessor (46) is connected to the bradykinesia, tremor, and rigidity testing systems for computing test results which are stored along with test instructions in an electronic memory (48), which is connected to the microprocessor (46). A user interface (16) is connected to the microprocessor (46) for programming in test parameters. The device is compactly housed to enable hand carried portability, and an input/output port (20) and printer port (22) are provided for transmitting test results to a host computer or printer.

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PORTABLE MOTOR SYMPTOMS ASSESSMENT DEVICE

RELATED APPLICATION INFORMATION

This application claims priority from copending U.S. application Ser. No. 08/641,143 filed April 25, 1996, which is hereby incorporated by reference.

TECHNICAL FIELD OF THE INVENTION

The present invention relates to the field of motor symptoms assessment, and in particular to a portable electronic device for assessing three key motor symptoms of a patient.

BACKGROUND OF THE INVENTION

Many neurological diseases, such as Parkinson's Disease, have three key motor symptoms: bradykinesia (slowed voluntary movement), rigidity, and tremor. Assessment of these three motor symptoms is necessary to determine the progression of the disease and to document the patient's response to drug administrations and other therapies. These three motor symptoms are also associated with alcohol and drug withdrawal and must be assessed to document the progress of a recovering addict. Further, in studies of new drugs, researchers must determine what affects the new drugs have on a patient's motor symptoms.

Thus, the assessment of these three motor symptoms must be performed for a variety of medical applications. The assessment should be performed as often as necessary, in some cases several times per week, for precise and accurate tracking of a patient's progress. Further, the assessment should objectively quantify the patient's motor symptoms in a uniform and easily reproducible manner.

Unfortunately, most of the conventional methods for assessing these motor symptoms are not performed objectively. Instead, the assessments are performed subjectively by a trained clinician. A subjective assessment makes quantifying small changes in the clinical state of a patient extremely difficult. A subjective assessment also prevents an effective comparison of test results when the results are produced by two different clinicians.

Some progress has been made in developing systems which provide an objective assessment of a patient's tremor. U.S. Patent 4,306,291 issued to Zilm et al. on December 15, 1981, U.S. Patent 4,817,628 issued to Zealear et al. on April 4, 1989, U.S. Patent 5,265,619 issued to Colmby et al. on November 30, 1993, and U.S. Patent 5,293,879 issued to Vonk et al. on March 15, 1994 all disclose systems for measuring tremor in a patient. Each system includes an accelerometer which is strapped to an extremity of the patient. The accelerometer produces signals representative of the patient's tremor and these signals are then analyzed by a computer to produce an objective assessment of the tremor.

Although these systems are effective for objectively measuring one key motor symptom, tremor, none of these systems has a mechanism for measuring the other two motor symptoms, bradykinesia and rigidity. They are therefore inadequate for assessing all three key motor symptoms of a patient. Each of these systems suffers from the added disadvantage of requiring a trained clinician to administer the tremor test. Consequently, the patient must visit the trained clinician each time a tremor measurement is required. As a result, these conventional systems for measuring tremor place a large travel burden on the patient and consume both the patient's and clinician's time for each tremor assessment.

A system for quantitatively assessing all three key motor symptoms of a patient is described by Ghika et al. "Portable System for Quantifying Motor Abnormalities in Parkinson's Disease", IEEE Transactions in Biomedical Engineering, Vol. 40, No. 3, March 1993. In Ghika's system, three separate test apparatuses are required for measuring the three key motor symptoms. Each of the three test apparatuses is connected to a desktop computer equipped with an analog interface board. The first test apparatus measures tremor and includes two solid state accelerometers attached to two lucite boards. The patient's hand is then sandwiched between the two lucite boards so that tremor measurements may be taken.

The second test apparatus is for measuring bradykinesia. The second test apparatus includes three light bulbs with three corresponding buttons placed below the bulbs. The bulbs are sequentially lit under the control of a computer program and the patient moves as quickly as possible to press the corresponding button under a newly lit bulb. Reaction times and movement times of the patient are measured and stored in the computer.

The third test apparatus measures rigidity at the patient's elbow. The third test apparatus includes a lucite cradle for holding the patient's forearm. The lucite cradle is mounted on a metal plate with low friction ball bearings so that the clinician may move the patient's forearm back and forth. While moving the arm back and forth, the clinician uses a metronome to try to maintain a constant frequency of 0.67 Hz. As the clinician moves the cradle, a goniometer measures the angular displacement of the patient's forearm and a load cell records the amount of torque applied by the clinician to move the cradle. The angular displacements and applied torques are recorded in the computer for further analysis.

The system described by Ghika has several disadvantages that prevent its widespread use. First, the system requires a trained clinician to administer the three tests to the patient, so that the patient must still visit the clinician's office each time a motor symptoms assessment is required. Second, the system requires three separate test apparatuses and a desktop computer for measuring the three key motor symptoms, so that the system is not easily portable.

Thus, all of the prior art systems for measuring the motor symptoms of a patient require a trained clinician to administer

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