

Motor Task Manager an Innovative System for Diagnosis and Rehabilitation of the Upper Limbs

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THE CHALLENGE

Motor Task Manager is an innovative system designed to analyse the shoulder-elbow motion while performing reaching task. It is specifically designed to provide a cheap and easy to use instrument to perform clinical diagnosis and rehabilitation, and to supervise pharmacological therapy and to study learning processes.

THE SOLUTION

The Motor Task Manager represents an innovative way to perform upper limb analysis since no similar system are commercially available (shoulder – elbow motion analysis is generally achieved by means of stereoscopic instrumentation, that is very expensive, or goniometric devices, that are very less accurate). Scientists have not longer to waste their time to analyse movement profiles by means of several and expensive software tools.

Short Summary

The Motor Task Manager represents a cheap and easy to use system to perform the shoulder-elbow movement analysis for diagnosis and rehabilitation in degenerative disorders (e.g. Parkinson's Disease, Alzheimer's Disease, Multiple Sclerosis, etc.) and/or after strokes. The National Instruments NI LabWindows/CVI let to decrease the designing and developing costs and to provide the full management of the experimental session, from the protocol parameters definition to the report sheet printing by means of very user-friendly GUIs.

The Motor Task Manager (MTM) is an innovative system designed to analyse the shoulder-elbow motion while performing reaching task. Reaching to visual targets involve transformations in the neural representation of the configuration of the arm in space and the speed of movement as the hand moves from its initial position to the target (i.e. its final position). This implies that at first brain plans movements (feed-forward model) by integrating visual information about target location and proprioceptive information about arm position, then brain adjust muscle strength and smooth movement (feed-back control) by integrating visual and information about instantaneous position of the arm to precisely reach the target. When a neural disease or a stroke modifies the brain's capability to integrate information and generate correct movement, the analysis of reaching task would evidence the degree of the pathology. Some degenerative pathologies, such as Parkinson's Disease, Multiple Sclerosis, Huntington Disease, etc. strongly affect day-life movements and require pharmacological treatments and the availability of easy to use and portable device to monitor the disease evolution and to immediately check the effect of a particular dose in the drug treatment would represent a very valuable tool.

The MTM represents a very cheap system to realize the shoulder-elbow movement analysis. The system let to objectively characterize the evolution of the motion capability in response to simple motion tasks. In particular, in subject affected by degenerative pathologies it is possible to supervise the pharmacological

therapy and to understand if it is improving the subject conditions of if it has to be changed or if the drugs have to be increased etc.

In subject that are under medical rehabilitation because of an injury or an ictus it is possible to better supervise the rehabilitation treatment. Therefore the Motor Task Manager represents a very valuable instrument to support the daily work of therapists, neurologists, physiatrists, researchers etc who have to deal with persons affected by motion limitations.

The motor task requires the subject to move a cursor with an hand on the digitizing surface while their hand position and target locations are dis-

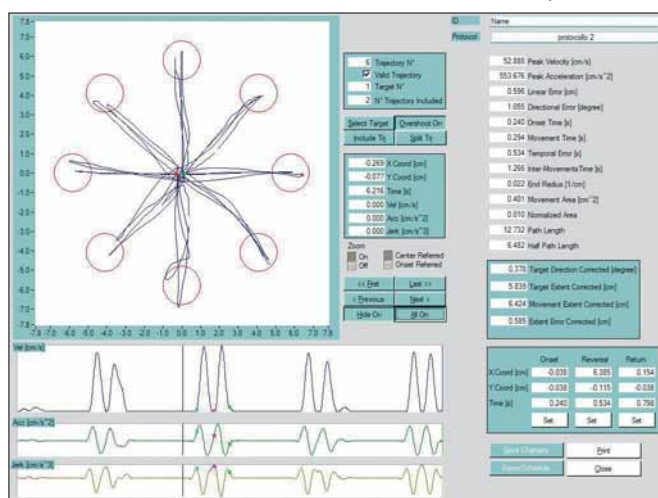


Figure 1: The figure shows the analysis panel. It reports the main extracted parameters such as performed trajectories; speed, acceleration and jerk profiles, directional error, linear error, time error etc. It also permits to manually redefine the onset, reversal and return (i.e. the three fundamental points that characterize the arm movement).



Figure 2: The figure shows the system: the laptop on the left let the doctor creates and selects the protocols, and supervises and analyses the subject performances; on the right, the subject seats in front of the LCD display, his wrist is blocked to avoid any interference with shoulder-elbow movements, and he interacts by means of the digitizing board.

played on a computer screen with a cursor indicating hand position on the digitizing surface. The MTM software has been developed by National Instruments LabWindows/CVI and it controls the experiment, generates screen displays and acquires kinematic data at 200Hz. The subjects sit in front of a lcd computer screen (17") and a system of seat-belts prevent any undesired shoulder movement. All motor tasks require out and back movements of the arm from a central start area to one of the radial targets. Generally the background color is white, targets color is black and cursor color is red. At the start of a trial block, the subject moves the screen cursor within the central start area and a series of three tones are usually sounded to provide the required tempo of the movement to follow. With the fourth and successive tones, subsequent targets turn black and subjects are instructed to move their hand smoothly out and back to each target without corrections and with sharp reversal movements. Targets can be randomly presented or they can follow an a-priori defined sequence (e.g. evaluation of learning capabilities). Generally it is asked the subject to learn how to perform the tasks in a training session.

Then MTM processes the x- and y-coordinates of each hand path and extracts movement parameters such as reaction time, time error, directional error, speed profile, acceleration and jerk profiles, etc, and all of these parameters are widely adopted by the scientific community to identify in movement capabilities due to degeneration of pathologies.

The main innovation provided by the MTM is the system itself, in fact there isn't any commercially available system that is cheap, easy-

to-use, that does not require any particular technical back-ground and that provides the full management of the upper limb experimental session, from the protocol parameters definition to the report sheet printing and the National Instruments environment permitted to provide a very friendly-user system by means of its graphical tools libraries. At present the researchers who want to perform similar experimentation have to use several (and in general home made) devices and software, one for each experimental session (i.e. one to crate the task, one to manage a digitizing device, one to analyze and extract relevant parameters, etc). The MTM overcomes these limitations and provides a semi-automated solutions for the analysis of the upper limbs movements.

The MTM let to extract movement parameters such as reaction time, time error, directional error, speed profile, acceleration and jerk profiles, etc. The parameters extractions widely use both National Instruments filtering libraries and mathematical functions. It is possible to create and mange a patients' database. It is possible to customize the number of target, the colour, size, and sound of each target. It is possible to define distortion (plane rotation, gain, etc) in the cursor feed-back. The system is easy-to-use and does not require any particular technical back-ground. It is provided with an exhaustive manual and some examples and requires Microsoft™ Windows 2000 running on a standard commercially available Pentium IV with 1GB RAM at least.

Prodotti utilizzati
NI LabWindows/CVI