Design and Construction of a Computerized Based System for Reaction Time Test and Anticipation Skill Estimation

Azadeh Shadmehr and Shervin Amiri

***Abstract*—Measurement of reaction time and anticipation skill estimation are used widely in therapeutic exercises or sport programs. There is a need for an easy-to-use system that can run reaction time tasks and anticipation skills with no special experiments in rehabilitation clinics. For responses to these needs we designed and constructed a simple, portable and inexpensive system based on software engineering methods. The purpose of the present paper is to investigate the feasibility of using this custom design computer based system for reaction time test and anticipation skill estimation.**

***Index Terms*—Rehabilitation engineering, physical therapy, reaction time test, speed anticipation.**

I. Introduction

Reaction Time (RT) is the total time from the arrival of a suddenly presented and unanticipated signal up to beginning to response to it [1]. In simple RT experiments, there is only one stimulus and one response. In choice RT experiments, the user must give a response that corresponds to the stimulus. In another words, RT for a task in which each response to be made is associated with a different stimulus. Complex RT is a highly sensitive and objective parameter reflecting cognitive and motor function and was used in several studies such as sport settings and rehabilitation programs [2], [3]. RT to be an indicator of good health and can be used to monitor an individual's condition over time, to identify persons with extreme slowing, or to determine the effectiveness of an intervention.

RT measures are also studied extensively in the laboratory as measures of information-processing speed [4]-[7]. It is considered fast RT measures are very common in research on skills, for two basic reasons. First, RT measures are components of real life tasks e.g., sprint starts. A more important reason is that RT presumably measures the time taken for mental events, such as stimulus processing, decision making, and movement programming [8]-[10]. These two motivations for using RT measures differ considerably. In the first case, RT is a measure studied for its own sake. In the second case, RT allows the researcher to understand the kinds of mental processes that lead to movement. Many different types of reaction times can be measured, including responses to visual, auditory, and tactile stimuli [11], [12].

Anticipatory skill is the ability to anticipate a future event based on information and is often regarded as one of the most important perceptual skills which causes effective motor performance.

To measure reaction time and anticipatory skill, there are two methods including: Electromyography (EMG) and computer software. Although EMG setting has got many benefits especially in sport domains, but reaction time can be measured just by a specialist and for one specific muscle and the study of cognition and decision making is impossible. While computer software, consisted of neurocognitive tests, can easily and quickly measure the reaction time and anticipatory skill of individuals in any domains.

As in daily life and sport, people need to have quick visual and auditory reaction time and good anticipatory skill especially in tasks with high levels of temporal and spatial constraints, a simple, portable, and inexpensive method of measuring reaction time and estimation of anticipation skill is needed for use in clinical settings. The purpose of the present study was to design and construction of a custom design computer based reaction time test as an indicator of choice and complex choice reaction time as well as anticipation skill test.

II. Method

The designed system was consisted of the two subsystems. The first one is called Software Programming Controller (SPC), which includes an IBM compatible high speed PC with Windows VISTA platform with developed special software on it. The second subsystem is called Human Machine Interface (HMI), which includes all the required instruments for best interface between examiner and subjects. These instruments are Keypad Box, Joystick, Wide LCD monitor, Video Projector and connection cables. (Fig. 1)

All the subsystem elements are connected to SPC and controlled by it. The software of the system was designed modular. It developed in Lab-View environment and uses all the mathematics and graphical capabilities of MATLAB. The flowchart of the main program is shown in Fig. 2. This software has two modes: Discriminative Reaction Tester (DRT) Mode, for measuring the audio and visual reaction time and Speed Anticipation and Reaction Tester (SART) Mode, for estimating the anticipation skill of subject in high and low speeds.

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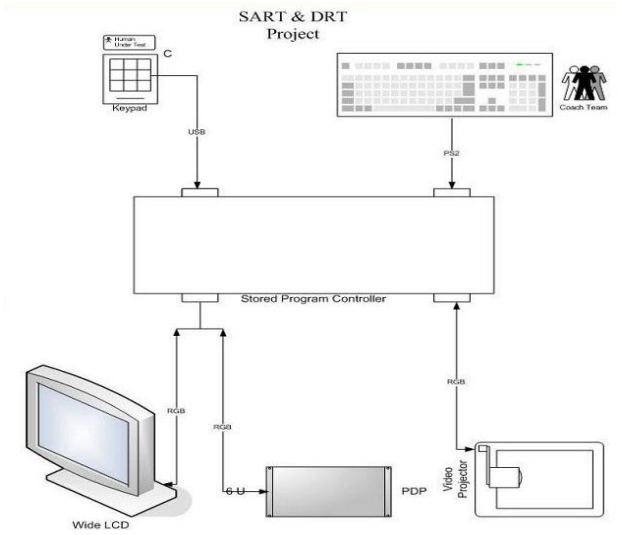

Fig. 1. Schematic view of the system and its HMI.

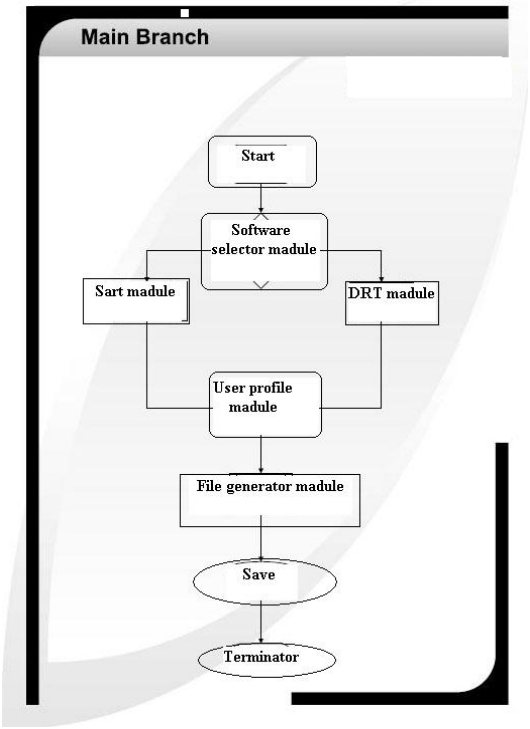

Fig. 2. Flowchart of main body of system software.

In the time of the tests each participant sat on a chair in distance of 2 meter in front of a 24 inch LCD monitor and placed his right forearm on an armrest, maintaining the elbow joint at a 90 degree angle. A display panel with four round colored buttons on it was mounted on the armrest so that the participants could press any of four keys with their thumb. The software of the test was installed on a lap top that located in a situation that subjects could not see its monitor. The lap-top was connected to the LCD monitor and display panel. The tester monitored and selected the tests randomly via the lap-top. The tasks performed in the present study were four visual choice reaction time, four audio choice reaction time, four visual complex choice reaction time and four audio complex choice reaction time. In visual reaction time test, participants had to press one of the corresponding four colored buttons, as soon as a colored circle appeared on the screen. The flow chart of DRT Mode of the software and it's GUI are shown in Fig. 3 and Fig. 4.

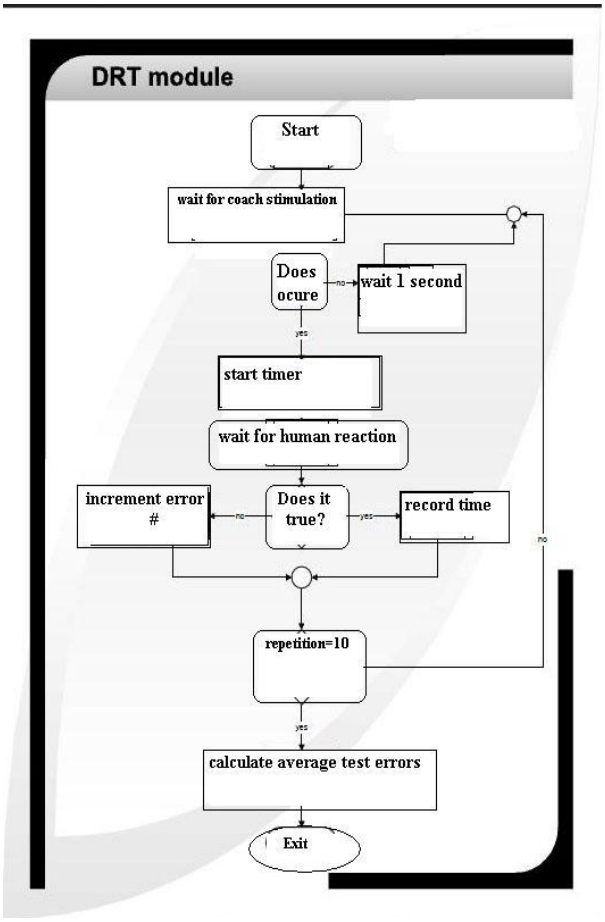

Fig. 3. Flowchart of DRT mode of software.

Fig. 4. GUI of the audio and video reaction time test.

In audio reaction time test, subjects had to press one of the four buttons, as fast as a corresponding audio stimulation with frequencies of 500, 1000, 3000 and 7000 Hz heard.

The reaction time is measured by internal timer of PC with millisecond accuracy. This timer is activated when the stimulation is applied and deactivated when the subject pressed the button.

For anticipatory skill tests, a novel scenario was designed. In this scenario a soccer ball appeared on the monitor screen, moving from right to left toward the gate and before reaching the gate, part of the path was hidden. According to the speed of the ball, subjects should be estimate the reaching time of the ball to the gate and pressed the button of the joystick. The flow chart of SART Mode of the software and its GUI are shown in Fig. 5 and Fig. 6.

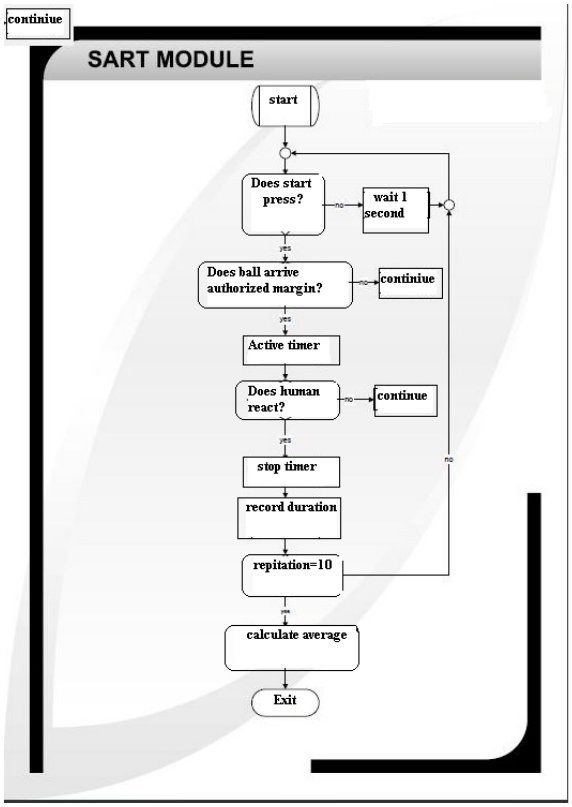

Fig. 5. Flowchart of SART mode of software.

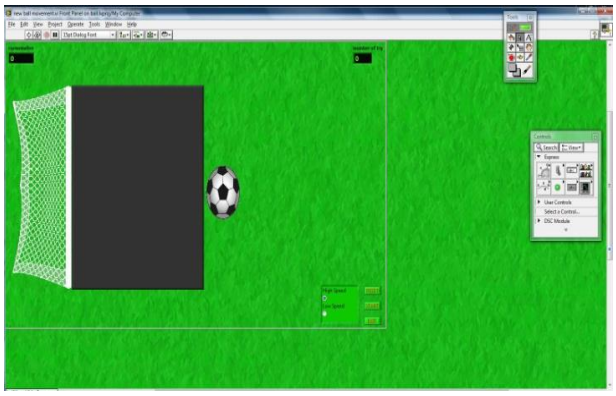

Fig. 6. GUI of anticipatory skill estimation test.

TABLE I: DESCRIPTIVE STATISTICS FOR RT SCORES IN DIFFERENT MODES.

	ACRT	ACCRT	VCRT	VCCRT
Mean	755.80	987.03	569.50	434.86
Median	789.50	1003.00	555.50	422.50
SD	151.62	252.29	110.84	60.91
Range	492.50	998.50	412.50	244.00

ACRT; audio choice reaction time, ACCRT; audio complex choice reaction time, VCRT; visual choice reaction time, VCCRT; visual complex choice reaction time.

TABLE II: ANTICAPATION SKILL SCORES IN HIGH AND LOW SPEED.

	Anticipation High Speed	Anticipation Low Speed
Mean	387.6429	916.5238
SD	250.05652	500.78586
Range	779.00	1708.33
Minimum	78.67	319.33
Maximum	857.67	2027.67

Prior to the commencement of experimental sessions, subjects attended the laboratory where they were familiarized with testing equipment and procedures.

During each experimental session, subjects performed choice reaction time and complex choice reaction time of visual and audio stimulation as well as anticipation skill estimation in high and low speed. Table I demonstrated the sample of test results.

Each block of tests consisted of 3 set of 10 individual trials which were randomly presented. Subjects were instructed to respond to the stimuli as quickly and accurately as possible. Each trial was preceded with a ready signal, which was displayed for a period of 2 second. No feedback indicating the accuracy or response time was provided.

III. CONCLUSION

Neuro-cognitive tests are one of the useful methods for evaluating the cognition level of the people as well as the efficacy of therapeutic approaches in patients or athletes. A computer based user friendly system can be used wildly in sport fields or rehabilitation clinics. One of the efficiencies of the current system in compared to the other methods is to assess the various kind of RT (visual and audio vs. choice and complex choice) as well as anticipation skills in one package and in the minimum time.

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