

# Evaluation of touch technology for the aging population

Michal Elboim Gabyzon

Physical Therapy  
Department, Faculty of  
Social Welfare and Health  
Sciences  
University of Haifa  
Haifa, Israel  
michal.elboim@gmail.com

Lorenzo Chiari

Department of Electrical,  
Electronic, and Information  
Engineering  
University of Bologna  
Bologna, Italy  
lorenzo.chiari@unibo.it

Mattia Corzani

Department of Electrical,  
Electronic, and Information  
Engineering  
University of Bologna  
Bologna, Italy  
mattia.corzani@unibo.it

Shlomi Laufer

Faculty of Industrial  
Engineering and  
Management  
Technion  
Haifa, Israel  
laufer@technion.ac.il

Alexandra Danial-Saad

Therapy Department, Faculty  
of Social Welfare and Health  
Sciences, University of Haifa  
and The Arab Academic  
College for Education in  
Israel  
Haifa, Israel  
saadalexandra@gmail.com

**Abstract**—Optimal and effective hand function is essential for performing activities of daily living. Many modern-day technological advances affect today's environment. A touchscreen is an excellent example of modern technology that requires a wide range of fine motor skills such as tapping, swiping, and virtual pinching. Assessing skill level is essential for the development of appropriate treatment protocols and for determining technological adaptations necessary to make touchscreens accessible to all. The Touchscreen Assessment Tool (TATOO) is a software application developed to comprehensively and objectively assess hand performance abilities necessary for operating touchscreens.

The present pilot study examined the feasibility of using the TATOO application as an assessment tool for evaluating touchscreen manipulation in elderly individuals (aged >75 years). Discriminated validity was examined by comparing the performance of two age groups: elderly individuals and middle-aged adults (age 45–65 years). Correlations between the results of the TATOO and traditional hand assessment tools (grip strength and dexterity) were examined to determine whether traditional tools can predict the ability to manipulate touchscreens. Usability was assessed using the System Usability Scale.

Discriminative validity was demonstrated with elderly individuals showing less accurate and significantly longer performance time. No correlation was found between the TATOO variables and grip and pinch strengths or dexterity skills. Usability was excellent in both age groups.

The TATOO can become an important novel supplement to the toolbox available to clinical professionals who treat the elderly in the modern world.

**Keywords**—Touchscreen Assessment Tool (TATOO), hand assessment, elderly, aging, usability

## I. INTRODUCTION

The fast-growing process of aging is expected to create a demographic shift, with a considerable impact on many aspects of the lives of elderly individuals and on society at large [1]. Almost in parallel to the observed demographic changes, we are also witnessing rapid changes in technological advances that affect almost all aspects of modern society. Owing to these changes, elderly individuals

are obliged to interact safely and successfully with an ever-growing number of technological devices, which can enable them to maintain independence in daily activities, render their participation in leisure activities more meaningful, and generally enhance their self-esteem and psychological well-being.

The ability to operate many of the technological devices present in our modern era is dependent on one's manual capabilities. However, normal aging is characterized by multi-system changes, which may have a direct effect on functional capabilities, including those related to arm and hand functions [2]. Furthermore, joint disorders prevalent with advanced aging may further compromise functional hand capabilities.

Touchscreens are rapidly becoming a key interface in multiple applications necessary for the performance of various daily activities. Thus, for example, touchscreens are used for communication via smartphones, for activities such as ordering food at a restaurant or a ticket at a theater, and withdrawing money from an automatic teller machine.

To devise training protocols for the use of touchscreens and, furthermore, to help improve the design of such screens to match the capabilities/limitations of elderly individuals, tools that are able to assess touchscreen performance capabilities must be developed. Different reliable and valid assessment tools have been developed over the years to determine various aspects of hand function. However, to the best of our knowledge, none of the existing assessment tools provide valid and reliable data regarding the ability to actually operate touchscreen devices.

The Touchscreen Assessment Tool (TATOO) was designed to assess skills required to operate touchscreen devices such as tapping, swiping, pinching, and dragging [3]. The performance of each task is summarized by numeric and graphic reports of temporal and kinematic aspects of performance. While the TATOO was originally developed to assess the performance of children, we are in the process of adjusting the system interface to assess the performance of the elderly population. The objectives of the present study were to examine the correlation between the TATOO and more conventional assessment tools and determine the validity and usability of the TATOO for elderly individuals.

## II. METHODS

**Participants.** The study was approved by the ethical review board at the University of Haifa, and the subjects provided informed consent. Snowball sampling was used to recruit volunteers aged 45–65 and >75 years. The inclusion criteria were the ability to follow simple commands, independent living, and no severe medical conditions that affect performance.

**Procedure.** Demographic and health status information were collected from each volunteer, who then underwent a series of assessments conducted in a fixed order. Assessments included evaluation of cognitive status (using the Montreal Cognitive Assessment [4]); bilateral hand grip strength in three positions using a JAMAR hand dynamometer (Sammons Preston Rolyan, IL, USA) [5]; the functional dexterity test used to assess precision handling of objects; and the TATOO tasks. Analysis of the temporal and movement accuracy variables obtained in the following three of the six TATOO tasks were analyzed for this study: touch all corners, perform a double tap, and drag object in all directions (demonstrated in Figure 1). After completion of the TATOO test, the users' subjective assessment of its usability was determined with the System Usability Scale [6]. Statistical analysis included Pearson correlations and independent *t* tests. Significance was set at *p* values of <0.05. Analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

## III. RESULTS

Sixteen community-dwelling elderly (aged >75 years) and 12 middle-aged individuals (aged >45 years) participated in this study. No significant difference was found between the two groups for the two types of pinch strength tests in either hand, except for the 3-point pinch strength test of the non-dominant hand, in which the strength was significantly lower in the elderly group. The elderly group demonstrated significantly lower bilateral hand grip strength and poorer manual dexterity. No correlation was found between the TATOO results and the hand grip strength measures or the dexterity test results of the elderly individuals. The elderly group demonstrated lower performance ability in the TATOO as was reflected by the temporal measures (e.g., reaction and duration times) and reduced accuracy. The usability of the TATOO application was reported as good by both the elderly and middle-aged groups, as determined by the SUS ( $76.2 \pm 20.7$  and  $80.0 \pm 15.4$ , respectively), with no significant difference between the two groups.

## IV. DISCUSSION

The present study indicates that the TATOO prototype can be used successfully by both middle-aged and elderly adults as a hand performance assessment tool of ability to successfully perform the unique skills necessary for operating touchscreens. Furthermore, the TATOO can differentiate between the performance of the two tested age groups. A non-significant correlation was observed between the TATOO variables, and the measures obtained by traditional hand assessment tools support the claim that

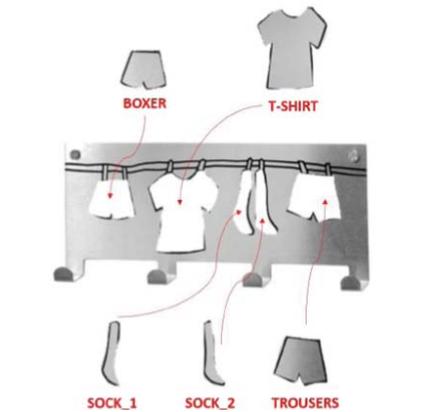


Fig. 1: Example of a screen display of the "drag in all directions" task

traditional tools cannot accurately predict an individual's ability to operate common technological applications that rely on the manipulation of a touchscreen.

The present study results suggest that the TATOO can become an important novel supplement to the toolbox available to clinical professionals who assess and treat the elderly in the modern world.

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