PointAssist and Parkinson’s Disease

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Abstract
We discuss our work with two individuals with Parkinson’s Disease and the role that PointAssist may play in the identification of pointing performance. Our interest is to emphasize the importance of an individual assessment of the difficulties with pointing tasks that motor impaired individuals exhibit. This will help us develop, implement and provide personalized methods of assistance. We also present a list of research objectives that motivates our current and future research efforts.

Keywords
Assistive Technology, Parkinson’s Disease, Pointing Tasks, Sub-Movements

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors, Measurement, Performance.

Introduction
Pointing tasks can be a source of frustration especially for children, older adults and individuals with motor impairments ([1], [2], [7]). To help with pointing task performance, a common approach in the literature is to help the user all the time. We need to consider that
perhaps some users do not need help on certain tasks, or that the user’s skills may change over time as is the case of individuals with Parkinson’s Disease ([8], [9]). To address this challenge, our strategy consists of measuring the performance of pointing tasks by implementing a modified version of PointAssist. PointAssist runs as a background process and helps in pointing tasks by slowing the speed of the cursor when detecting pointing difficulty based on a real-time analysis of pointing sub-movements. There is evidence suggesting it can help children and older adults with difficulties associated with target acquisition ([1],[2]).

In this research, we present our experience working with people with Parkinson’s Disease (PD). PD is a brain disease that impairs motor control, speech, and other functions. It is known to be chronic, degenerating and progressive. Some of the signs and symptoms of PD include impairments in motor dexterity when performing actions that require a high degree of skill and hand coordination, thus making it of particular interest for our purposes [9]. There are effective symptomatic therapies for PD patients that help improve some users’ control over their movements [8]. Different stages of the disease also have different associated levels of motor control. The motor control in PD patients might change abruptly during the course of a day when they are in the on or off periods triggered by medication [9].

PointAssist and Parkinson’s Disease
One reason for us adopting PointAssist is that it provides help to users only when they need it and only after attempting to complete a task without help. People with PD are already encouraged to continue completing tasks such as buttoning shirts for as long as possible, even if they prove difficult, in order to maintain motor skills [9]. Hence, PointAssist’s approach may help PD patients maintain the motor skills necessary to use pointing devices. By only helping when help is needed, PointAssist also makes it easier to share a computer with other people who do not need assistive technology. Another reason for adopting PointAssist is that by running in the background and not needing to know about the location of targets, PointAssist works with all existing applications.

However, PointAssist currently falls short of what is needed by PD patients. First, it currently detects pointing difficulty using heuristics that are the same for all users. With PD patients and others with severe motor impairments though there is a high amount of variability as discussed by Hwang et al. [4]. For this reason, there is a need for PointAssist and for any other approach to help patients with PD to adapt to their individual and changing needs and abilities. In addition, PointAssist is currently setup to help people with difficulty controlling the cursor near a target. While some patients with PD may have similar problems, others face different challenges, such as tremors and difficulty initiating movements that require new algorithms for detection and new strategies for assistance.

We plan to modify PointAssist by first studying the characteristics of the sub-movements of people with PD, in particular when they experience difficulty due to a tremor or to difficulty initiating movement. Based on this analysis, we plan to derive algorithms to identify the types of difficulty that a particular PD user exhibits and their severity. The goal is to enable these algorithms to work in real time in order to facilitate

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Table 1 Accuracy measures comparisons for target diameters of 16 and 32 pixels (first round).

Table 2 Accuracy measures comparisons for target diameters of 8 and 16 pixels (first round).

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Table 3 Number of sub-movements near and away the target center, 8 and 16 pixel target diameters, 512 pixels movement distance.
adoption by avoiding any training of the system, and to best accommodate users who may experience changes in their pointing abilities on a daily bases due to medication.

**Pilot Data from Two PD Patients**

We conducted a study with two participants where we modified the pointing task testing software used in [1] and [2] to gather data remotely and to consider eight different pointing directions (see Figure 1 and Figure 2). We decided to gather data remotely because we want to assist PD patients in the computers they use every day, which in some cases may include customizations to address their needs, as was the case with the two participants we worked with. Our two participants installed the testing software on their own computers. To maintain anonymity we will refer to the participants as Bob and Dave. Bob was a right handed, 64-year-old male with PD who averaged 6 hours per week of computer usage, and uses a touchpad. Dave was a 72-year-old male with PD who uses a two-button mouse an hour per day on average. We took several rounds of data in two testing sessions to better account for individual variability. In the first round of testing, Bob ran the test 3 times with target diameter sizes of 16 and 32 pixels and distances to target of 128 and 512 pixels. Dave ran the test once for same target diameter sizes as Bob but with one distance to the target of 512 pixels. On the second round of testing, the participants ran the test once with target diameter sizes of 8 and 16 pixels, task lengths of 512 pixels.

Pointing tasks examples help us identify pointing strategies employed by our participants (see Figure 1 and Figure 2). Bob and Dave’s movements were relatively controlled suggesting they were consciously making an effort to have aimed controlled movements. During the first round of tests, Bob’s high average task duration suggests he may have difficulty initiating his movements (Table 1). From this, we inferred that Bob may have some level of akinesia that is most prominent in some directions (Figure 1), affecting his movement time and speed, but not his accuracy. Dave had a high number of target re-entries showing his difficulties were mainly near the target (Table 1). We may attribute this lack of control near the target to tremors.

Bob and Dave performed differently from each other. In the first rounds of testing Bob had high movement times, and Dave had lower movement times (Table 1); Dave re-entered targets almost twice as many times as Bob (Table 1); Bob had a high number of sub-movements away from target where Dave could complete a task in approximately 6 sub-movements. A high number of sub-movements were also noted in [4] where individuals with PD took five times as many sub-movements as able-bodied users. We see the variability in their performance in the second round of testing. Bob increased his target re-entry where Dave decreased it (Table 2). Bob took as many as 4 sub-movements to reach the target (Table 3), which was 3 times less than in his first round. Dave was consistent in his number of sub-movements yet his accuracy dropped by 4-6% (Table 2).

Our results show some of the difficulties as well as the variability of both participants between themselves and within themselves. Differences between them can be attributed to different motor impairments and/or levels of motor control. Differences within them can be attributed to unknown factors like on-off periods, strategies employed or habituation effects. The pointing
strategies employed by the two individuals, their performance difference in different directions and the variability showed in both testing rounds, are indicators of the need of a real-time personalized method of assistance.

**Future Work**

We propose the following list of objectives to motivate our future research endeavors:

- Can we identify in real time pointing problems through algorithms that analyze the characteristics of the sub-movements of individuals with Motor Impairments?

- Can the algorithms assess the severity of the pointing problems of individuals with pointing difficulties?

- What is the best way to implement an automatic, real-time detection and assistance method that takes into account the variability in performance of people with PD due to medications and the fact that computers may be shared with people who do not need assistance?

It is our goal to implement an effective way of identifying the varied range of computing abilities exhibited by different individuals and adapt in an automatic manner. We are working with 10 individuals with a variety of motor impairments to help us identify pointing difficulties and their severity through an analysis of their sub-movement characteristics. We are again gathering data remotely from the participants’ own computers (similar to [3]). We plan to implement algorithms to identify pointing difficulties and their severity and incorporate them into PointAssist together with strategies to help with each of these difficulties. We intend to assess the help that these strategies may provide in the participants’ own computers.

**Citations**


