Disabled 'R' All: Bridging the Gap between Health and Situational Induced Impairments and Disabilities

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ABSTRACT
More and more people interact with mobile devices whilst walking. This new interaction paradigm imposes a novel set of challenges and restrictions to mobile users, denominated Situationally-Induced Impairments and Disabilities. The tremor originated of such contexts results in inaccurate movements and erroneous actions. These difficulties are particularly visible in recent touch interfaces that lack the tactile cues and physical stability provided by their keypad-based counterparts. Nevertheless, these difficulties are not new to the accessibility community, particularly for those studying motor impaired users. In fact, both user populations (situationally and physically impaired) seem to share similar interaction problems. This work aims to thoroughly understand to what extend technology can be transferred between those domains. Unlike the embryonic stage of mobile research, the accessibility community has the accumulated knowledge of more than two decades of research. Building a relationship between these domains will contribute towards a more inclusive and universal design approach, which will benefit and bring closer two distinct research communities.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces - *Input devices and strategies, User-centered design*.

General Terms
Design and Human Factors.

Keywords
Motor Impairments, Situational Impairments, Tremor, Mobile Accessibility, Universal Design, Touch Screen, Text-Entry.

1. INTRODUCTION
Over the last decades mobile devices have become increasingly personal and ubiquitous, thus altering our lifestyle in several domains: work, entertainment, shopping, communication, leisure, transportation, etc. Indeed, these small, yet powerful tools are always near us and therefore, used on many different contexts. These have evolved from the static and controlled environments of our offices to the increasingly complex and dynamic contexts of our daily lives.

Indeed, both the environment and users' activities can hinder the interaction process, leading to the so called Situationally-Induced Impairments and Disabilities (SIID) [6]. Particularly, motor abilities are often the target of situational impairments, for instance whilst mobile or in a subway train. The tremor originated from speed changes hinders the users' performance with mobile devices, resulting in inaccurate movements and erroneous interactions. These difficulties are even more evident in recent touch-based devices, which lack both the tactile feedback and physical stability provided by their keypad-based counterparts.

1.1 Understanding SIID
Several works have studied the impact of mobility on users' performance with mobile devices. Mizobuchi et al. [4] showed that walking adversely affects text-input speed and error rate. Additionally, it appears that text-entry tasks also affect mobility tasks, as it generally requires people to slow down. More recently, Schildbach and Rukzio [5] studied target selection tasks within an navigation course, showing that cognitive load increases when walking, while performance decreases, reaching 30% error rates with standard target sizes.

This body of work suggests that motor abilities are affected by mobility conditions, resulting in a loss of precision and accuracy. However, these challenges are not new to the accessibility community. Movement, precision and dexterity difficulties have been studied for more than a decade on motor impaired users [7]. In fact, both user populations (situationally and physically impaired) seem to share similar interaction problems [2]. Therefore, we believe that similar solutions can be transferred with minor adjustments between domains.

2. AN UNIFYING APPROACH
To deal with SIID, we will study the feasibility of transferring technology designed for motor impairments users. Particularly, we will focus on walking conditions and tremor disorders [1] (e.g. essential tremor, intention tremor or Parkison's disease). By modeling users as a set of abilities, independently of their impairment, will allow us to see if situational and health induced impairments affect them in similar ways. However, despite their apparent similarities, it would be also interesting to identify their main differences. Depending on the results achieved in this phase, solutions previously designed for motor impairments could be transferred with minor adjustments to users of mobile technologies, creating a relationship between both domains.

Some of the advantages of this approach are: 1) encourage the reuse of knowledge between research domains; 2) avoid the duplication of work; 3) leverage more and better research on assistive technologies; 4) motivate designers to gain interest in accessibility; 5) reduce the costs and increase the availability of accessibility solutions.

Thus, my research hypothesis is:

Solutions designed for health-induced impairments can be applied to situational-induced impairments, increasing the users' performance, by assessing their capabilities within real mobile contexts.

2.1 Similar Problems?

In order to people with health or situational induced impairments can benefit from similar solutions, there must be a thorough understanding of what problems they face when interacting with traditional touch interfaces. Therefore, the first step of our research plan is to characterize the users' abilities. To achieve our goal, we will focus on observing users performing text-entry tasks, since this is a common and essential task on many mobile applications, however one of the most demanding on touch-based devices. Indeed, previous work has shown that there are some similarities between situational and motor impaired users when interacting with keypad-based devices [2]. Nevertheless, touch interfaces, particularly virtual keyboards remain unexplored. Moreover, the proposed research will focus on a specific impairment factor, i.e. tremor.

We will study both user populations performing text-entry tasks and assess their main similarities and differences through the type and magnitude of committed errors (e.g. long key press, additional key, missing key, dropping, bounce, and transposition [7]). The results gathered from this experiment will allow us to answer crucial questions: "Do both user populations experience similar problems?" Furthermore, "When does this happens?" Depending on the answers to these questions, similar solutions may be transferred between domains, empowering a true universal design.

2.2 Leveraging Accessibility Solutions

After identifying the main problems experienced our target users, we will be able to choose a set of solutions that can fit the users' needs. Different types of text-entry solutions can be chosen: 1) filters (language independent) [8], 2) word correction algorithms [3], 3) adaptive keyboards, and 4) alternative methods.

Additionally, with all the data gathered in the previous stage of our research, and through an informed design, we will have the opportunity to provide a novel and enhanced text-entry solution that can benefit both user populations.

2.3 Similar Solutions?

Our main goal in this phase is to answer our research hypothesis and see if there is a gain of transfer accessibility solutions to mobile contexts. Several approaches will be evaluated with both user populations, contributing to a rare comparison between text-entry methods. Moreover, we will perform an *intra* (within user domain) and *inter* (between solutions) analysis, allowing us to understand what solutions are more adequate and when they should be applied.

3. TEXT-ENTRY WHILST MOBILE

In order to complete the first phase of our work, a study was performed to understand how walking conditions affect text-input. Participants were submitted to three different walking conditions: control (seated), walking at normal pace (2 steps per second), and walking at slow pace (1.3 steps per second). Also, this study featured 3 hand postures: one-hand portrait, two-hand portrait, and two-hand landscape. All interactions with the QWERTY keyboard were logged for later analysis. Also, data from accelerometer sensor was gathered in order to characterize motor demand (i.e. experienced tremor) and create possible correlations with participants' performance. We intend to present these results within the consortium, and discuss them with fellow students and expert researchers. Particularly, we are very interested in the feedback of those who work closely with motor-impaired people, so we can identify probable similarities and differences between these two domains.

4. CURRENT AND FUTURE WORK

The next stage of our research plan is being prepared, which will focus on studying users with tremor disorders. Following this, we will chose and design text-entry solutions that fit both user populations' needs. This doctoral consortium may be a great opportunity to discuss some ideas and create professional relationships for future collaborations. Finally, in order to assess the feasibility of technology transferring between the accessibility and mobile research fields, we will evaluate several solutions with both users.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Anouti, A. and Koller, W.C. 1995. Tremor disorders. Diagnosis and management. In *Western journal of medicine*, 162, 6, 510-513.

[2] Chen, T. and Yesilada, Y. and Harper, S. 2009. Investigating Small Device Users' Input Errors under Standing & Walking Conditions. Technical report, School of Computer Science, University of Manchester.

[3] Kane, S.K. and Wobbrock, J.O. and Harniss, M. and Johnson, K.L. 2008. TrueKeys: Identifying and correcting typing errors for people with motor impairments. In *Proceedings of IUI'08*, 349-352.

[4] Mizobuchi, S. and Chignell, M. and Newton, D. 2005. Mobile text entry: relationship between walking speed and text input task difficulty. In *Proceedings of Mobile HCI'05*, 122-128.

[5] Schildbach, B. and Rukzio, E. 2010. Investigating selection and reading performance on a mobile phone while walking. In *Proceedings of Mobile HCI'10*, 93-102.

[6] Sears, A. and Young, A. 2003. Physical disabilities and computing technology: An analysis of impairments. In *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*. Lawrence Erlbaum, USA, 482-503.

[7] Trewin, S. and Pain, H. 1999. Keyboard and mouse errors due to motor disabilities. In *International Journal of Human-Computer Studies*, 50, 2, 109-14.

[8] Trewin, S. 2002. An invisible keyguard. In *Proceedings of ASSETS'02*, 143-149.