ATLab: An App-Framework for Physical Disabilities

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Abstract

New touchpad- or tablet-devices are available at a reasonable price and have the potential to grant access to digital learning contents for training and therapy also for disabled people. In particular, these new technologies and interaction concepts offer possibilities to realize a better and more efficient access to digital teaching contents for people with learning disabilities, limited motor skills and speech impediment. In this paper we describe the ATLab Project which is funded by Research Studios Austria. The main goal of this project is the development of a flexible and easy system for the specific production of applications on current available tablets (ePads) for disabled people.

Keywords

Physical Disability, Graphical User Interface, Alternative Input devices

Introduction

The WHO estimates that about 15% of the human population suffers from disabilities. Most of these disabilities are limiting a person's effectiveness and/or efficiency of interacting with objects in general. Nowadays, the majority of inhabitants in developed countries use electronic devices such as cell phones or computers in their everyday lives to achieve their tasks easier and faster. Therefore, these days effective interaction with this type of device is an obligatory requirement in working life as well as in private life.

Applications running on tablets show considerable potential to support the needs for this group:

- Natural input: new learning content through multi-touch, advantage of gross motor activity
- Mobility: not fixed, low battery consumption
- Application domains: Learning, communication, games, controlling of environmental systems
- Variety of hardware: hardware suiting the person's special needs, easy inclusion of alternative input devices like external switches, eye-tracking, gesture recognition, etc.
- Costs: Low price and purchase costs

Touch-based interaction in many aspects and situations can also simulate AT devices or provide flexible and affordable alternatives to AT devices mentioned above. Furthermore, a huge amount of various tablets are available and even more with an increased level of features will come on the market in the near future. According to *The Guardian*, tablet computers will see an explosion in sales over the next years, selling 60% as many units as PCs by 2015 (Platus Learning System).

Today's common mobile devices offer built-in accessibility features like multi-touch screens, screen magnification and speech output functions, which are intended first to support people with disabilities but also support all users in varying contexts and situations on the move. However, often the built-in accessibility functions are not sufficient. Especially people with motor disabilities are often incapable of operating applications on mobile device with the built-in touch functionality.

This is the point where the research project Assistive Technology Laboratory-short ATLab-comes in. The main goals of this project are a) the inclusion of AT pointing devices in tablet interaction by motor and/or cognitive disabled people and b) the development of a flexible and easy-to-use framework for the design of specific applications for disabled people on currently available tablets.

State of the Art

Today, we can find only a rather limited offer of applications on mobile devices like tablets which are accessible and provide support for alternative input methods. Back in 2002, Myers et al. used the Palm handheld as input devices for motor impaired people. They modified some hardware (e.g. stylus) and software (e.g. onscreen keyboard) and collected data in a user study. As time has gone by, other applications have enabled users to access small onscreen keyboards available on smart-phone technology by allowing touch to pass through the letters of a target word. Many smart phones incorporate voice control and screen reading programs to increase accessibility for those with fine-motor and/or visual and literacy deficits (Jackson and Mappus).

For people with severe physical disabilities, switch scanning access for mobile applications is beginning to emerge. Switch scanning is a special method of Human-Computer

Interaction (HCI) where the focus of the application moves automatically in a predefined order and predefined or user defined time span (e.g. using a hardware-switch) from one control to the next. Pressing another switch triggers an action on the currently focused control. On the iPad some applications like Sounding Board support switch scanning already (AbleNet Inc.).
Other popular alternative input methods for people with motor disabilities like head- and eye-tracking or a brain-computer interface are not yet possible on these devices (Jackson and Mappus; Myers). If all the above mentioned input methods were supported in these applications, complexity and effort would increase accordingly (Farrall). Due to the lack of a framework supporting the process of development of these kinds of applications, standard apps need to be enhanced or rewritten.

ATLab-Framework Overview

ATLab implements a software framework for an easier and quicker development of accessible applications for people with disabilities on the most common mobile platforms: iOS, Android and Windows 8.

The framework expands the normal way of touch interaction and allows building applications that offer the user a wide range of different and adjustable input methods:

- Natural input: Multi-touch gestures in touch-up or touch-down mode
- Switch Scanning: External input device with one or two buttons connected via Bluetooth or USB
- Touch Scanning: Divides the touch screen into one or two parts that are used as switches

This enables the user to select the best way of interaction with the application. As an example, normally when the user touches the screen, an application instantly triggers an action, which makes it hard to operate for people that suffer from a disability that causes unintended movements of the hand like tremors. To deal with this issue the framework also allows configuring a hold-timer and blocking-timer. The hold-timer triggers the action only when the finger touches the screen for a user-defined period of time. User interactions which might be caused by unintended touches are filtered out. The additional blocking-timer defines a period of time where any user input is blocked.

The framework also defines a scan-matrix, which enables the user to control the application by scanning controlled with Bluetooth-or USB-Switches. At the moment the framework supports 1-and 2-Button scanning. There are plans to extend to more buttons. Besides the standard way of scanning, the framework also introduces a new way of switch scanning called “touch scanning.” This concept uses the whole screen of the mobile device as a switch. A touch on the right-side of the screen moves the current focus to the next scan-object whereas a touch on the left-side of the screen triggers an action on the currently focused object. This allows switch scanning without the need of extra hardware.

Due to the component-based design of the framework, new methods and tools of Human-Computer Interaction (HCI) employing other input devices like the Microsoft Kinect and the upcoming LEAP can easily be integrated in the Microsoft Windows version of the framework (LeapMotion Inc.; Fager et al.).

Another component of the framework is the ScreenNavigator, which is in charge of the construction and deconstruction of the screens and handles the flow through the application. Therefore it uses a predefined XML document which describes all available screens and offers logical statements as sequences and switch-by conditions. It is also possible to modify the screen list on the fly.

The framework also hosts an editor that allows an easy creation of new game content with a user friendly interface. With this, persons without experience in programming are also able to create game content for everybody.

Cloud services integrated in the framework provide user account management which allows users to create a cross-application user account. A user profile which contains input device settings and other configurations is bound to that account. Once the user profile is created, it is available on all applications and all devices, which makes life easier for care attendants. In addition, the cloud services provide data exchange and storage consumption management to keep track of cloud user data storage and multimedia data sharing. The services also allow controlling data access by means of different roles to map a teacher-pupil relationship.

First Application and User Study

The goal of one framework-based application, SwitchTrainer, is to learn handling the one- or two-button switches. It supports switch scanning and touch scanning as implemented in the framework. Furthermore, it provides a game-like learning application supporting the development of skills in touch up/down mode with the touch screen.

Fig. 1. Some Screenshots of Switch Trainer

The target group of the game is children with motor disabilities and perhaps also cognitive disabilities. The screen-by-screen game without opponents and time restrictions contains multiple mini games inviting the user to get to know the input devices by one own's initiative using a trial and error approach.

We used this application as the basis for the first user study of our framework. A group of 9-16 year olds with certain disabilities were selected as test participants. The tests in this user study were based on the methods of the qualitative content analysis by Philipp Mayring, and the description for data analysis described by Sharp et.al. should prove the usefulness of the different input methods which are currently implemented in our framework. Depending on the user's disability a consultant helped the user to find his or her preferred input method.

A first conclusion of the study was that all input methods are suitable for the respective group of people with disabilities. Depending on the user's disability some input methods are more suitable. Users that were able to touch the screen but did not possess the accuracy to hit a button exactly favored touch scanning as it is a more intuitive and direct approach than scanning with external hardware-switches.

Another result of the user studies was that some users preferred different input methods depending on the task they had to fulfill within the application. For tasks where less touch precision was needed some users preferred to operate the application with touch input. For tasks where a high level of precision was required, users preferred scanning to control the input. A further research question would then be whether the framework could automatically detect the user's abilities with respect to the precision needed for a specific task and would then automatically switch to the preferred input method and settings.

The overall feedback of the participants in the user test about the framework and the application based upon it was quite promising and encourages us for our future work.

Conclusion and Outlook

The proposed framework focuses on integrating different input devices including Assistive Technologies (AT) and intense developer support for tablet games for people with disabilities. ATLab supports i) an easy integration of various input devices, and ii) game and content design.

In the next steps, more features will be added to the framework and another game will be implemented. Those features include a user management system containing roles and access control e.g. for teacher-pupil or advisor-client constellations. The management features are part of the cloud implementation which stores the application data together with the user and device profiles/configurations. This enables the user to employ the same settings and profiles for different games and applications. The cloud service also supports sharing and distributing content, images and videos between users, teacher and pupils, or advisor and clients. As a long-term goal, we intend to implement multi-player functionalities allowing competition and cooperation amongst users.

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