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CASUAL INTERACTION WITH A SMARTWATCH

A Thesis presented for the degree of Master of Science

by
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ABSTRACT

This thesis investigates which and how user interfaces allowing for *Casual Interaction* should be implemented. A mobile music player as a representative application is implemented on an android handheld device, which is fully controllable by an android smartwatch. Interactions between user and music player can happen via touch input, speech commands or arm gestures. Subsequently a case study investigates which interaction techniques are preferred by users depending on task and context. For this purpose the participants are put in 6 different scenarios in which they have to follow predefined actions regarding the music player.

ZUSAMMENFASSUNG

Diese Arbeit untersucht welche und auf welche Weise Nutzerschnittstellen, die *Casual Interaction* nutzen, implementiert werden sollten. Als Beispielanwendung wird ein mobiler Musikplayer auf einem Android Smartphone implementiert, der vollständig per Android Smartwatch gesteuert werden kann. Touch-Eingabe, Sprachbefehle und Armgesten stehen dem Benutzer dabei als Interaktionsmöglichkeiten zur Verfügung. In einer Studie wird anschließend untersucht, welche Interaktionsmöglichkeiten, abhängig von Aufgabe und Kontext, von den Benutzern bevorzugt werden. Dazu werden die Teilnehmer in 6 verschiedene alltägliche Situationen versetzt, in denen sie Vorgaben erhalten, welche Funktionen des Musikplayer sie steuern sollen.

CONTENTS

1 MOTIVATION

Electronic devices connected to the internet play a big role in almost everyone's life. According to a survey[1] two thirds of the global population have access to the internet and almost every third human owns a smartphone in 2016. People not being bound to stationary computers anymore has numerous advantages and opens up for manifold possibilites of applications. However most applications are exclusively touch based and hence draw a user's attention from her environment to the screen in a large extent. Depending on the context, this inobservance c various levels of adverse impact – one merely could have to reread a passage of a book or in fact cause a serious car accident with lethal consequences. Furthermore, a user is not always able to interact with a handheld device as intended due to physical or mental barriers.

Casual Interaction addresses this issue by introducing additional input techniques and interactions which offer the required flexibility in terms of control over an application, such that the user can limit the required amount of focus to a minimum [3]. The music player implemented in this thesis offers a speech and armgesture interface for input in addition to the typical touch based user interface. This enables the user to leave her handheld device in the pocket and interact with it even when her hands are not available. A typical daily life scenario might look like the following:

> Programmer Bob is a passionate music listener. At work he starts the day with his favorite playlist with shuffle mode enabled to boost his coding efficiency. Occasionally some songs hit his ears that he heard enough of in the last days so he performs a short arm swing to the right to skip to the next song without loosing track of his current programming task.
>
> After work he rides his bike home, still listening to music, to have a physical compensation for sitting in a chair half the day. In order to hear other traffic participants and emergency sirens he decides to turn the volume of the music down a bit by raising his smartwatch to his mouth and saying "*volume down, please*". Arriving at home he switches from listening with headphones to his brand new sound system that is spread around his

1 http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/

> entire house. During dinner preparations he gets a phone call from a friend. His phone resides one the table, however Bob's hands are still dirty from cooking so he tells his watch to pause the music and answer the call. They arrange on having dinner together today at Bob's place. It strikes Bob that his music library is not prepared for such a dinner but he is able to delegate the creation of a playlist to his music player by simply specifying suitable audio features. Not having to bother about finding the right music enables Bob to finish cooking just before his guest arrives.

This fictive scenario reveals the necessity of alternative input techniques to perform *Casual Interaction* in situations where users are physically or mentally obstructed. In order to decide which additional input techniques an application should provide and how the corresponding user interfaces should be designed one has to consider the possibilities these techniques offer as well as how users approach them. The last aspect particularly depends on the user's preferences and perception performing the interactions. On the one hand, the perceived amount of control for a particular level of engagement is important. *Is she able to achieve the desired reaction of the application or does it feel like the application has developed it's own life?* On the other hand, users often times get influenced by how interactions appear to the environment. *Can i perform an arm gesture right now or will people stare at me if i suddenly wave my arm through the air?* These and related concerns need to be kept in mind in order to be able to develop useful and effective casual user interfaces.

However, devices require certain hardware features to enable such interactions in the first place. First, it should stay where it is needed without encumbering the user. Typical remotes or smartphones occupy at least one hand for every interaction they offer. Since this is not beneficial a wearable device is needed that is attached to the body without obstructing everyday activities. Second, the device should offer touch-free interaction. This can be realised by adding movement sensors (e.g. accelerometer or gyroscope) and a microphone.[2]

This thesis builds on the previous work of Karoline Busse [2] who developed a wrist-worn silicone bracelet intended for usage with lighting systems. The bracelet is missing on some important components, though, to gain more potential, namely a microphone and a display. Smartwatches basically offer the most important hardware components needed for creating a comfortable and enjoyable *Casual Interaction* experience thus being a perfect device for the further studies of this thesis.

A music player is chosen as a representative everyday application. The music player is connected to a private Spotify account via the

Spotify Android Software Development Kit (SDK) [2] which serves the music library. Touch, speech and arm gesture input for player control realize different levels of engagement.

Chapter 2 first outlines the related work and Chapter **??** then teaches the fundamentals to speech and gesture recognition as well as some important terminology from music retrieval. Chapter **??** then gives an insight into implementation details of the music player's core features. Subsequently the user study design is addressed in chapter **??** and the resultant data is evaluated in chapter **??**.

Finally, chapter **??** sums up the findings, draws a conclusion and provides ideas for future improvements to *Casual Interaction*.

2 `https://developer.spotify.com/technologies/spotify-android-sdk/`

2 RELATED WORK

- Casual Interaction Henning Pohl, focused-casual continuum
- Karo Busse, Light control bracelet, silicone cast, teensy microcontroller, accelerometer, bluetooth, capacitive touch panel, material and design is important, users should be able to wear the device a lot
- Vatavu User-Defined Gestures for Free-Hand TV Control, Agreement Analysis on 12 user defined tv control gestures, simple free-hand gestures found
- ShoeSense, Depth-sensor mounted on shoe pointing upwards, discreet and demonstrative hand gestures possible, investigated social acceptability, physical and mental demand, and user preference
- Gestural and Audio Metaphors as a Means of Control, mobile music player controllable by touch-gestures and non speech audio
- Blumendorf, Multimodal smart home user interfaces, interaction commands must be learnable easily and quickly, user prefers short commands over complex sentences in speech interaction
- I'm Home: Smartphone-enabled gestural interaction with multimodal smart-home systems, accelerometer based gesture control of tv hifi-system, lamp and window-shutter
- A Gesture Based System for Context - Sensitive Interaction with Smart Homes, 3D acceleration gestures, wiimote, gestures have different meanings in different contexts, reducing gesture set size
- Can user-derived gesture be considered as the best, 30 participants, created own gesture set for controlling tv and air conditioning, in second test every user was presented all other gestures, highest agreed gesture from first test was not highest in second, since most users did not come up with some creative gestures.
- Engaging with Mobile Music Retrieval, Touch-based user interface for music retrieval,

Casual interaction has become a big research topic in human-computer interaction (HCI) nowadays.

Pohl and Murray-Smith [3] have described the *focused-casual continuum*, which is a control-theoretic framework that characterizes input techniques in regard to how much flexibility, in terms of thinking and effort, they allow a user to invest into interactions. They showed in a user study that users adjust their level of engagement to the task's complexity.

On this basis, [2] constructed a wrist worn silicone bracelet. When worn, a user could casually interact with a light source. Simple actions like turning the light on and off up to picking individual colors with a capacitive touch stripe. Accelerometer based gestures could be used to activate previously defined and memorized light settings. Despite being highly accessible on the wrist, a user would still have to utilize the hand without the bracelet to activate it's features making interactions rather impractical in certain situations.

Another approach places a depth camera for capturing hand gestures on the user's foot pointing upwards [1]. This allows for discreet interactions thus neglecting concerns of social acceptability of performing gestures as they found out. In a lab study they compared physical and mental demand, user preferences and demonstrated a 94-99% recognition rate.

An alternative input technique is shown in [**?**]. They introduce around-device devices. Input is received by observing position and rotation as well as arrangement or absence of the around-device devices. To capture this information they propose placing a smartphone equipped with a depth camera nearby. In contrast to the aforementioned approaches, this technique is limited to stationary contexts automatically excluding any in-motion-situations.

3 MATH TEST CHAPTER

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3.1 SOME FORMULAS

Due to the statistical nature of ionisation energy loss, large fluctuations can occur in the amount of energy deposited by a particle traversing an absorber element[1]. Continuous processes such as multiple scattering and energy loss play a relevant role in the longitudinal and lateral development of electromagnetic and hadronic showers, and in the case of sampling calorimeters the measured resolution can be significantly affected by such fluctuations in their active layers. The description of ionisation fluctuations is characterised by the significance parameter κ, which is proportional to the ratio of mean energy loss to the maximum allowed energy transfer in a single collision with an atomic electron:

You might get unexpected results using math in chapter or section heads. Consider the `pdfspacing` option.

$$\kappa = \frac{\xi}{E_{max}} \tag{1}$$

E_{max} is the maximum transferable energy in a single collision with an atomic electron.

$$E_{max} = \frac{2m_e\beta^2\gamma^2}{1 + 2\gamma m_e/m_x + (m_e/m_x)^2} \,,$$

where $\gamma = E/m_x$, E is energy and m_x the mass of the incident particle, $\beta^2 = 1 - 1/\gamma^2$ and m_e is the electron mass. ξ comes from the Rutherford scattering cross section and is defined as:

$$\xi = \frac{2\pi z^2 e^4 N_{Av} Z\rho\delta x}{m_e\beta^2c^2A} = 153.4\frac{z^2}{\beta^2}\frac{Z}{A}\rho\delta x \quad \text{keV},$$

where

z	charge of the incident particle
N_{Av}	Avogadro's number
Z	atomic number of the material
A	atomic weight of the material
ρ	density
δx	thickness of the material

1 Examples taken from Walter Schmidt's great gallery:
`http://home.vrweb.de/~was/mathfonts.html`

κ measures the contribution of the collisions with energy transfer close to E_{max}. For a given absorber, κ tends towards large values if δx is large and/or if β is small. Likewise, κ tends towards zero if δx is small and/or if β approaches 1.

The value of κ distinguishes two regimes which occur in the description of ionisation fluctuations:

1. A large number of collisions involving the loss of all or most of the incident particle energy during the traversal of an absorber.

   As the total energy transfer is composed of a multitude of small energy losses, we can apply the central limit theorem and describe the fluctuations by a Gaussian distribution. This case is applicable to non-relativistic particles and is described by the inequality $\kappa > 10$ (i. e., when the mean energy loss in the absorber is greater than the maximum energy transfer in a single collision).

2. Particles traversing thin counters and incident electrons under any conditions.

   The relevant inequalities and distributions are $0.01 < \kappa < 10$, Vavilov distribution, and $\kappa < 0.01$, Landau distribution.

3.2 VARIOUS MATHEMATICAL EXAMPLES

If $n > 2$, the identity

$$t[u_1, \ldots, u_n] = t\big[t[u_1, \ldots, u_{n_1}], t[u_2, \ldots, u_n]\big]$$

defines $t[u_1, \ldots, u_n]$ recursively, and it can be shown that the alternative definition

$$t[u_1, \ldots, u_n] = t\big[t[u_1, u_2], \ldots, t[u_{n-1}, u_n]\big]$$

gives the same result.

LIST OF FIGURES

LIST OF TABLES

LISTINGS

ACRONYMS

HCI human-computer interaction

SDK Software Development Kit

A
APPENDIX TEST

Lorem ipsum at nusquam appellantur his, ut eos erant homero concludaturque. Albucius appellantur deterruisset id eam, vivendum partiendo dissentiet ei ius. Vis melius facilisis ea, sea id convenire referrentur, takimata adolescens ex duo. Ei harum argumentum per. Eam vidit exerci appetere ad, ut vel zzril intellegam interpretaris.

Errem omnium ea per, pro congue populo ornatus cu, ex qui dicant nemore melius. No pri diam iriure euismod. Graecis eleifend appellantur quo id. Id corpora inimicus nam, facer nonummy ne pro, kasd repudiandae ei mei. Mea menandri mediocrem dissentiet cu, ex nominati imperdiet nec, sea odio duis vocent ei. Tempor everti appareat cu ius, ridens audiam an qui, aliquid admodum conceptam ne qui. Vis ea melius nostrum, mel alienum euripidis eu.

A.1 APPENDIX SECTION TEST

Ei choro aeterno antiopam mea, labitur bonorum pri no. His no decore nemore graecis. In eos meis nominavi, liber soluta vim cu. Sea commune suavitate interpretaris eu, vix eu libris efficiantur.

More dummy text.

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A.2 ANOTHER APPENDIX SECTION TEST

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LABITUR BONORUM PRI NO	QUE VISTA	HUMAN
fastidii ea ius	germano	demonstratea
suscipit instructior	titulo	personas
quaestio philosophia	facto	demonstrated

Table 1: Autem usu id.

Listing 1: A floating example

```
for i:=maxint to 0 do
begin
{ do nothing }
end;
```

Ei solet nemore consectetuer nam. Ad eam porro impetus, te choro omnes evertitur mel. Molestie conclusionemque vel at, no qui omittam expetenda efficiendi. Eu quo nobis offendit, verterem scriptorem ne vix.

BIBLIOGRAPHY

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[2] Karoline Busse. Casual interaction with a bracelet. Master's thesis, Leibniz Universität Hannover, 2014.

[3] Henning Pohl and Roderick Murray-Smith. Focused and casual interactions: allowing users to vary their level of engagement. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 2223–2232. ACM, 2013.