Distributed User Interfaces: Collaboration and Usability

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Abstract
This document describes the most relevant issues regarding collaboration and usability when using distributed user interfaces (DUIs). The goal of this workshop is to promote the discussion about the emerging topic of DUIs, answering a set of key questions: how can collaboration be improved using DUIs? When are DUIs suitable to perform collaborative work? How can usability standards be employed to evaluate the usability of DUIs? How do μ7 concepts influence on DUIs regarding collaboration, usability and cognition?

Author Keywords
Distributed User Interfaces; Collaboration; Usability

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interface - Input devices and strategies; H.5.2 [Information Interfaces and Presentation]: User Interface - User-centered design; H.5.2 [Information Interfaces and Presentation]: User Interface - Graphical user interfaces (GUI); H.5.2 [Information Interfaces and Presentation]: User Interface - Interaction styles; H.5.2 [Information Interfaces and Presentation]: User Interface - Theory and methods.

Introduction
The low cost of mobile devices and large displays have made them very popular nowadays. Due to this fact,

and the growth of the communication infrastructure, users are able to interact with other users almost anywhere (i.e. using social networks and collaborative applications).

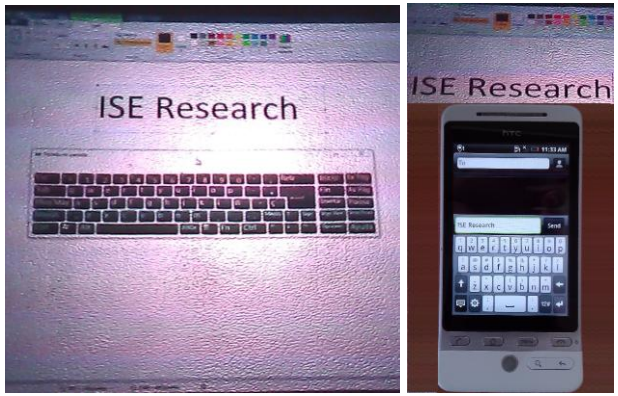
However, most of the interactions among different users are focused on the use of mobile devices (smartphones, tablets, laptops, etc.) leaving aside other environmental interaction resources like large screens, multi-tactile displays, or tablets. In a DUI scenario, the user takes advantage of these resources to improve the user experience [1].

The emergence of new interactive resources affects the development and evaluation of distributed user interfaces (DUIs) and introduces new aspects that should be taken into account in regards of software engineering methods, usability, collaboration and distributed cognition on DUI scenarios.

Collaboration scenario and usability

The distribution of the UI may be carried out among coupled or decoupled devices [2] than can be used by more than one user at the same or different time. Under this collaborative scenario, users sharing a common goal may take advantage of DUIs to carry out their tasks because they provide larger, and physically independent, interaction surfaces. For instance, in a shared drawing editor (a canonical example of a synchronous face-to-face collaborative scenario), users have to deal with local and shared information.

In a traditional scenario, shared and local information should be displayed on the same (unique) display causing the "the pollution of the user interface" with objects that may be relevant to one user (or a small set of them), but leading to the obstruction of the user interface to the others. A concrete situation arises when introducing text where a keyboard is displayed on the screen to type the text. The keyboard is relevant to the user introducing the text, but it is not to the rest of them (see Fig. 1a).



(a) (b)

Fig. 1. DUI and non-DUI text entry example

However, in a DUI environment, independent interaction surfaces such as smartphones, tablets or even laptops may be employed to deal with local and shared information [3]. Following the entry text example, a user can simply select the place to locate the text, and then type it using a mobile device. Thus, the keyboard is not displayed on the shared surface avoiding the pollution of the shared UI and disturbing other users (see Fig.1b).

DUI technical challenges

The μ7 concept summarizes the essential aspects of DUIs [4]. These aspects are the multi-device, multi-platform, multi-user, multi-language / culture, multi-

organization, multi-context and multi-modality of DUIs development.

Multi-device and Multi-platform usage
A single user employs different devices at the same time, whether they are running the same operating system (OS) or not. For instance, a user controls a music player using a remote control running on a Personal Digital Assistant and/or on a physical device. Besides, multi-device usage subsumes a multi-platform usage (since there are different machines) but the reciprocal does not hold: a user could use several computers (hence, multi-platform) that are similar (hence, no multi-device).

Multi-user and organization support
One or many users may want to distribute parts or the whole UI among several monitors, devices, platforms, or displays. For instance, in a control room setup, users may want to direct portions of a UI to other displays of others users depending on the context of use. Besides, DUIs distribution in space may lead to the use of the same UI across different organizations leading to new security and privacy scenarios that should be taken into account.

Multi-language / culture support
The distribution of the UI among different users leads to the cultural adaptation of the UI. The distribution of the elements according to the cultural and the language aspects of the user is an important issue to take into account. For instance, the layout of the controllers for Chinese users differs from the English users.

Multi-context of use
The distribution of the UI depends on different aspects regarding the context the UI is being executed. These aspects may be related to the proximity of the environmental resources (i.e. the distance to displays), or may be related to the user profile (i.e. capabilities, role in the session, etc.) among many others.

Multi-modality implementation
The distribution of the UI is not limited to GUIs since vocal user interfaces may be directional. For instance, games developed for the Kinect platform are controlled using vocal and gesture –based UIs.

DUI usability challenges

In the text input example exposed in the Collaboration scenario and usability section of this document, we described how DUIs could be employed to improve the user experience [5]. However, introducing new displays into the environment may not be always a good solution. When users have to interact with different interaction surfaces, the information should be organized in such a way the user doesn't "miss it".

Fig. 3 depicts an example where the layout organization of the DUI affects the usability of the system. In this case the horizontal flow layout organization works clearly against the usability of the system compared to a grid layout.

In order to measure the usability of the system, the software product quality model presented in the ISO/IEC 25010 [6] categorizes software quality attributes into eight characteristics (*functional suitability, reliability, performance efficiency, operability, security, compatibility, maintainability and transferability*).These attributes should be analyzed when dealing with DUIs.

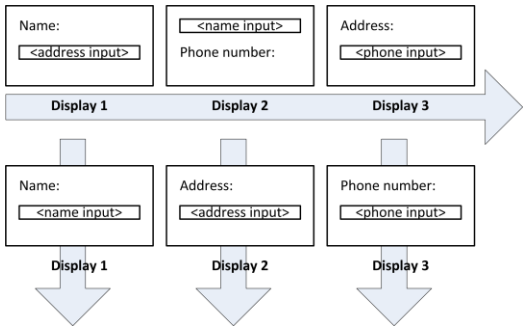


Fig. 3 Horizontal (upper) and grid (lower) layouts DUIs

Conclusions

The aim of this workshop is summarized in Table 1 where we try to find out the answer on how the application of characteristics such as collaboration, usability and cognition are influenced by the µ7 concepts. For instance: how can collaboration be improved using DUIs? When are DUIs suitable to perform collaborative work? How can usability standards be employed to evaluate the usability of DUIs? How do µ7 concepts influence on DUIs regarding collaboration, usability and cognition?

	Collaboration	Usability	Cognition
Multi-device			
Multi-platform			
Multi-user			
Multi-culture / language			
Multi-organization			
Multi-context			
Multi-modality			

Table 1. DUI concepts / Application characteristics

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References

[1] Gallud, J. A., Tesoriero, R., Penichet, V. M. R., Distributed User Interfaces: Designing Interfaces for the Distributed Ecosystem. Springer HCI Series, Berlin, 201.

[2] Terrenghi, L., Quigley, A., and Dix, A. A taxonomy for and analysis of multi-person-display ecosystems. Personal and Ubiquitous Computing 13 (2009), 583–598.

[3] Villanueva, P. G., Tesoriero, R., Sebastian, G. and Gallud, J. A. WallShare: Using Multi-touch Technologies to Perform Collaborative Map Exploration. Proc. of 1st Workshop on Distributed User Interfaces in conjunction with CHI 2011, May 7th, 2012. Vancouver, Canada (2010), 31-34. ISBN 978-84-693-9829-6.

[4] Vanderdonckt, J. Distributed User Interfaces: How to Distribute User Interface Elements across Users, Platforms, and Environments. Proc. of XI Interacción 2010. 20-32.

[5] Aquino, N., Vanderdonckt, J., Condori-Fernández, N., Dieste, Ó., Pastor, Ó. Usability Evaluation of Multi-Device/Platform User Interfaces Generated by Model-Driven Engineering, Proc. of 4th Int. Symposium on Empirical Software Engineering and Measurement ESEM'2010 (Bolzano, 16-17 September 2010), ACM Press, New York, 2010, Article #30.

[6] ISO, ISO/IEC 25000. Software engineering – Software product Quality Requirements and Evaluation (SQuaRE) – Software and quality in use models.