

Chapter 7

General Conclusions

The work presented in this thesis has focused on the topic of implicit interaction in HCI. An implicit interaction is an action a user performs with little (or no) awareness but which a computerized system can understand as input. As such, the role of implicit interaction consists in leveraging as much information as possible derived from a natural user input, without requiring the user to be aware of the data the system needs to operate, i.e., in a completely transparent procedure. By leveraging these implicit interactions, we can increase the richness of communication and make it possible to produce more useful applications and/or services. Implicit interaction can be considered as a consequence of ubiquitous computing, with the notable difference that is the user who takes the initiative to interact with the system. Implicit interaction, therefore, enables the ability to serve a person's information (or interaction) needs without becoming a burden. Finally, implicit interaction requires no training and provides context for actions. As such, it sets an interesting theoretical basis for a systematic approach to analyzing, optimizing, and enhancing a wide variety of computer applications.

7.1 Summary

Five chapters have illustrated the value of implicit interaction in a series of scenarios, namely activity tracking and video visualization ([Chapter 2](#)), behavioral clustering ([Chapter 3](#)), multitasking and task interruptions ([Chapter 4](#)), UI adaptation and redesign ([Chapter 5](#)), and interactive pattern recognition ([Chapter 6](#)). The main contributions of this thesis, thus, include:

1. A tracking plus hypervideo tool to understand user behavior through implicit interactions.
2. A method to classify web pages according to implicit interactions, together with a novel algorithm for clustering sequential data.

3. A method to ease multitasking that is based on implicit interaction cues as a visual remainder.
4. A method to transparently adapt a UI to the capabilities of the user (or a group of users) by mining implicit interactions.
5. A series of prototypes that implement a novel IPR framework that is guided by implicit interaction principles.

In sum, virtually any application can benefit from an implicit HCI framework. The main advantages include:

- Every user interaction may contribute to enhance system utility.
- Implicit interactions are a useful complementary tier.
- Implicit interactions can be gathered for free, without burdening the user.
- Implicit interactions are valuable to understand how people interact with computers.

Finally, the main drawbacks of dealing with implicit interactions can be summarized as follow:

- Implicit interactions do not provide always clear information.
- Some assumptions need to be made.

7.2 Future Outlook

While this thesis has researched implicit interaction in the context of web-based HCI applications, we have just barely scratched the surface when it comes to exploiting its truly potential. Invisible (or pervasive) computing is already all around us, making computers that fit the human environment and not the other way round [Kaushik, 2012]. Implicit interaction can only help to contribute in this regard by providing novel sources of perception and interpretations of the users within their computers and devices.

Tennenhouse [2000] claimed that, over the past 40 years, computer science has addressed only about 2% of the world's computing requirements. As stated by Cadez et al. [2003], arguably one of the great challenges in the coming century will be the understanding of human behavior in the context of "digital environments". In such a context, implicit interaction is certainly an important starting point. Devices that have (sometimes very limited) perceptual capabilities have *already* started the shift from explicit HCI toward a more implicit interaction with machines [Schmidt, 2000]. This being so, implicit interaction

will definitely gain more interest in HCI research, to make computers more useful and tailored to our needs.

It is clear that explicit interaction will continue having a primary presence in software applications, and that implicit interaction will be used as an additional source of (otherwise valuable) information. Nonetheless, probably in a (not so far) future, desires and intentions would be enough to get computers to act on our behalf.

Additional References

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