Social Intelligence as the Means for Achieving Emergent Interactive Behaviour in Ubiquitous Computing Environments

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Abstract. This work introduces a framework for modelling the main actors (human, artefacts and services) in a symbiotic Ambient Intelligence environment. It, also, proposes an architectural scheme that associates the social behaviour, which is not an inherent characteristic of the participants, during interaction with the functional behaviour of the participants of a Ubiquitous Computing application. The overall approach is demonstrated by a specific example of application which illustrates its concepts through a more technical point of view.

Keywords: Ambient Intelligence, Emergent Behaviour, Human-Computer Interaction, Social Intelligence, Ubiquitous Environments.

1 Introduction

As computational power diffuses in our living/working environment and the everyday devices that are capable of sensing, processing and communicating continuously grow in number, the potential use of the objects emerges mainly from the interactions of the humans with the digital devices and these interactions are not only time-dependent but also space- or context-dependent. A further consequence is that the nature of the human activities eventually assisted by artefacts is rapidly changing. Execution of tasks involving the use of (collections of) artefacts may become difficult due to the inherent systemic complexity of Ubiquitous Computing (UbiComp) applications, which, among others, results from device incompatibility, and the huge number of interactions among visible and non-visible actors.

There is a pressing need for a design framework that will act as a common referent between designers and users (i.e. ordinary people) of UbiComp applications that exist within an Ambient Intelligence (AmI) environment. This framework should support not only the representation of user's interactions with artefacts or predefined collections of artefacts (such frameworks already exist today, see [8]), but would also

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cater for the design of adaptive interactions, as artefact ecologies will be evolving to encompass changing user requirements. Finally, the supported interactions should be people-centred, because with an AmI environment (according to ISTAG vision of AmI [7]) people will be acting as naturally as possible (while now they are interacting with a computer).

In this paper, we provide a new perspective by enabling socially intelligent interactions among people and artefacts and we claim that by subsuming task optimization to social intelligence, people interactions with artefacts will become more natural. This work adopts and extends the framework proposed in [15] which deals with different perspectives of the interrelations developed in symbiotic ecologies where people and artefacts coexist. We propose a subsumption architecture that supports the integration of social behaviour with functional behaviour of UbiComp applications. Our approach is bottom-up, in the sense that it considers social and functional elementary "behaviours" as basic building blocks of complex and emerging UbiComp behaviour.

The main innovation introduced by the proposed framework is that we do not aim simply at autonomous systems; instead, we aim at systems that although consisting of largely reactive parts, they exhibit a pro-active behaviour in a social level. Furthermore, the social behaviour is not an inherent characteristic of the participants but it is a result of the interactions among participants.

The next section details on the proposed framework integrating people, artefacts and services into a symbiotic AmI environment. The section 3 focuses on interaction with UbiComp applications and on how the social and the individual behaviours are reflected by the participating artefacts and the provided services. Finally, the section 4 puts our approach into an example scenario and demonstrates a realisation of the proposed concepts through a more technical portion.

2 Proposed Framework

Technically, the reproduction of social behaviours and the handling of complex tasks with an equal agility as the one exhibited by natural intelligent systems could be achieved by i) considering that all the necessary information lies out the environment and surrounds the participants (according to R. Brooks [2, 3, 4]) and ii) using bio-inspired approaches in designing intelligent systems, in which autonomy, emergence, and distributed functioning are promoted [1, 10].

We propose to distribute the individual physical/computational/cognitive capabilities over the entire ecology and then immerse the ecology into a UbiComp environment, aiming to generate theory and technology for the understanding of the own self and its relation with the surrounding world. We deal with this consideration by i) attributing AmI objects with physical expression (dimensions, shape, texture, colour, plugs, sockets, connectors, etc) and ii) dealing with the provided services as basic behavioural building blocks of the overall system behaviour.

According to our approach, a living/working AmI space is populated of many heterogeneous objects with different capabilities and provided services. All these objects and services are regarded as basic building blocks having an internal part that encapsulates the internal structure and functionality, and an external part that