On the Potential of Using Conventional Mobile Communication Technology for Human Context Awareness in Ubiquitous Computing

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Abstract. Human context acquisition is an important aspect of human computer interaction (HCI) for context aware ubiquitous computing. There are many state-of-the-art relatively obtrusive and unobtrusive approaches to accomplish the task of human context extraction. This paper surveys the state-of-the-art approaches and establishes the possibility of using the conventional mobile communication as an enabler for nearly unobtrusive human context acquisition in a smart ubiquitous environment. This paper studies the technical intricacies behind using the mobile communication technologies for such purposes and proposes how it can be used for such an ‘augmented’ utility in smart spaces.

Keywords: Bluetooth, Context Awareness, Face Recognition, HCI, Human Context, Mobile Communication, PDA, RFID, Ubiquitous Computing, WiFi.

1 Introduction

The aim of ubiquitous system is not just to support ubiquity in its literal meaning by interlinking all systems into an omnipresent domain, but to support ‘context based ubiquity’ as per the objectives set by Weiser in his seminal paper [1]. So, a system needs to be context aware such that it fits into a human-centric personalized environment, interacting less obtrusively with humans and become part of the physical environment by sensing more of it [1][2]. Ref. [3] provides a good exemplary vision on personalized smart environment services. Ref. [4] provides a good account of the different efforts to define ‘context’ and provides a broad definition of ‘context’ and ‘context aware system’. In terms of practical usage this broad definition of ‘context’ can be classified into three categories [2]: ‘physical environment context’, ‘human context’ and ‘virtual environment context’. ‘Human context’, the topic of this paper, helps to personalize a service based on user presence, user identification and task preferences set by prior user experience.

There are many proposed and in-use techniques for achieving the purpose of human context acquisition which is the key in terms of personalization of services. These techniques span a wide range of technologies. However, all these approaches have some advantages and some disadvantages when we try to evaluate them in terms of real life aspects which essentially involve human factors. What we find interesting
is that mobile phones can be a very good choice for such a purpose by virtue of its normal course of operation in the very basic form without relying on convergence with other associated technologies like Bluetooth, WiFi, etc. However, conventional mobile phone operation has not found much mention in the relevant researches in personalization of smart environment services compared to other approaches.

In this paper, we first perform a survey of the state-of-the approaches starting from computer vision to short range wireless communications and compare them against some real life issues around the human factor. Then we shall do a technical feasibility study for using mobile phones for the given purpose followed by the researches done in this area which can help as the launching pad. Next we shall evaluate the proposed approach against similar factors as we have done for other state-of-the-art technologies.

## 2 State-of-the-Art Approaches

The problem of mechanized presence detection and identification in a premise / system to perform some predefined task relevant to the identified person is not new. A very common example is the access control system in an office entrance where the user has to swipe an access card through an access controller for opening the door. Again, consider a software system which gets unlocked only when a user types the right user ID and password leading the system to activate with the settings specific to the current user profile. There can be many such examples. However, these conventional systems, though context aware in true sense, are not ‘unobtrusive’ so far as the HCI is considered as they require explicit human interaction to initiate the process. Following part concisely presents a survey of different dominant technologies proposed in different literatures.

### Active Badge using modulated infrared beacon:

One of the earliest approaches is to create an “active badge” which emits a periodic unique code in the form of a beacon by way of pulse-width-modulation of infrared signals as described in [5]. The users wearing these badges can be picked up by a network of sensors placed around the host building.

### RFID based detection:

RFID has been proposed as a very popular technology for identification of objects for smart applications and future Internet of Things (IoT) [6][7][8]. It uses electromagnetic coupling in the radio frequency (RF) portion of the electro magnetic spectrum to uniquely identify an object or a person with an RFID tag. Ref. [7] discusses about several prototypes of smart identification based UbiCom applications which use RFID for identity acquisition. RFID tags are passive or active. Passive RFID tags receive their power to exchange from the signal sent by the RFID reader itself. Active RFID tags are battery powered.

### Detection using short range wireless communication – Bluetooth and WiFi:

Short range wireless communication like Bluetooth and WiFi have become a very popular choice for human presence detection [9][10][11][12][13]. This works on a simple idea. The Bluetooth and WiFi devices transmit their unique MAC addresses which the detectors detect. The devices are usually personalized and thus their addresses can

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1 Approximately a tenth of a second every 15 seconds.