A Semiotic Analysis of a Model for Understanding User Behaviours in Ubiquitously Monitored Environments

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ABSTRACT

Improvements in electronics and computing have increased the potential of monitoring and surveillance technologies. Although now widely used, these technologies have been known to cause unintended effects, such as increases in stress in those being observed. Further advancements in technology lead people towards the 'pervasive era' of computing, where a new means of monitoring ubiquitously becomes possible. This monitoring differs from existing methods in its distinct lack of physical boundaries. To address the effects of this kind of monitoring, this paper proposes a model consisting of a series of factors identified in the monitoring and pervasive literature believed to influence behaviour. The model aims to understand and predict behaviour, thereby preventing any potential undesirable effects, but also to provide a means to analyse the problem. Various socio-technical frameworks have been proposed to guide research within ubiquitous computing; this paper uses the semiotic framework to analyse the model in order to better understand and explain the behavioural impact of ubiquitous monitoring.

Keywords: Behaviour, Modelling, Monitoring, Organisational Semiotics, Pervasive Spaces, Ubiquitous

INTRODUCTION

Being watched or monitored has always been a part of human life to assist and enhance security, safety, health and even productivity assessment. Over time, advancements in electronics and computing have seen improvements to monitoring technologies, resulting in an increase in their adoption and application. *Even though these technologies are now widely used and easily accessible, they have been often known to cause undesirable effects* (Vorvoreanu & Botan, 2000), *such as increases in stress and distrust in those being observed.*

Advancements in mobile and wireless technologies have led towards what can be referred to as the 'pervasive era' of computing. This brings intelligent pervasive spaces (IPSs) and their manifestations, such as 'intelligent buildings', closer to reality, as they will be

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some of the first adopters of the technology. The principle of pervasive or ubiquitous computing is to embed computers into the environment, removing them from the focus of our daily lives. In order to function as intended, the embedded devices need to continuously collect significant amounts of data regarding user behaviours (Albrechtslund, 2007).

While existing monitoring technologies can be used to achieve this level of data collection, in order to accomplish true pervasiveness, the monitoring devices themselves must act ubiquitously. This new Ubiquitous Monitoring (UM) differs from existing methods mainly due to the absence of physical restrictions such as walls and other physical attributes of the environment.

Insufficient research has been applied to the study of the effect of UM on human behaviour (Jonsson, 2006). In light of this, a model has been created, consisting of a series of factors drawn from the pervasive/ubiquitous computing and monitoring literature which are believed to influence behaviour. The model is augmented by the Theory of Planned Behaviour (TPB) (Ajzen, 1991), and could allow user behaviours to be understood and possibly predicted in an IPS.

The purpose of this paper is to analyse how these behaviour-influencing factors can be understood in terms of how they relate to the data collected, how data is processed and assigned meanings, and what social and behavioural effects are expected as a result. To this end, a semiotic analysis is applied to analyse the factors identified and the proposed model, which enables us to further examine how these factors contribute to the understanding of problems related to UM.

This paper is structured as follows. First, we review the background and related work in this topic, including discussion of the behaviour influencing factors related to monitoring. In the following section, we propose a model that relates the identified factors to one another and to the TPB. This is followed by an analysis of the factors from three levels—physical, technical, and social. The model is then analysed from a semiotic perspective of the problem using the semiotic ladder, followed by a discussion on these analyses in relation to the information field paradigm, and a conclusion.

BACKGROUND

Monitoring

The current application of information technology for monitoring has been known to result in unintended effects on users (Vorvoreanu & Botan, 2000). These undesirable effects are often found to outweigh the benefits of such systems, creating an overall negative impact (Botan & Vorvoreanu, 2005). Simply having awareness of the monitoring changes behaviour, and a well known, but often contested example of this, is the Hawthorne effect (Roethlisberger & Dickson, 1939). Employees in the Hawthorne works were monitored as part of an experiment to establish a relationship between their productivity and lighting levels. The employee's productivity was unexpectedly found to increase regardless of the light intensity; this was attributed to the fact that they were aware that they were being observed. Awareness of monitoring has even been shown to cause changes in a person's writing style and internet browsing habits (Botan & Vorvoreanu, 2005). While previous studies provide an insight into the likely effects of UM (Hayes et al., 2007; Zweig, 2005), its pervasiveness remains an area that has had little attention. This may result in an overall increase in the negative effects found in existing monitoring systems, or even generate previously unseen effects.

Ubiquitous Monitoring

In this paper we use a working definition of an IPS as an adaptable and dynamic environment that optimises user services and management processes using intelligent systems and ubiquitous technologies. IPSs are often controlled by software known as intelligent agents, who monitor the users and alter the environment according to 'perceived' or stated preferences, such as those related to temperature, lighting and humidity. Once sufficient data has been

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