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# PIViTa: Taxonomy for Displaying Information in Pervasive and Collaborative Environments

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**Abstract.** In the years ahead, there are increasing demands for ubiquitous and continuous access to information and interactive devices embedded into a physical context are proliferated. Users need support for getting required information anywhere and anytime, therefore, we cannot study advances in Ambient Intelligence and Information Visualization separately, it is necessary to consider the relevant features for displaying information into intelligent environments. A taxonomical approach can make another step towards understand the design space of information visualization in intelligent environments by extracting crucial characteristics.

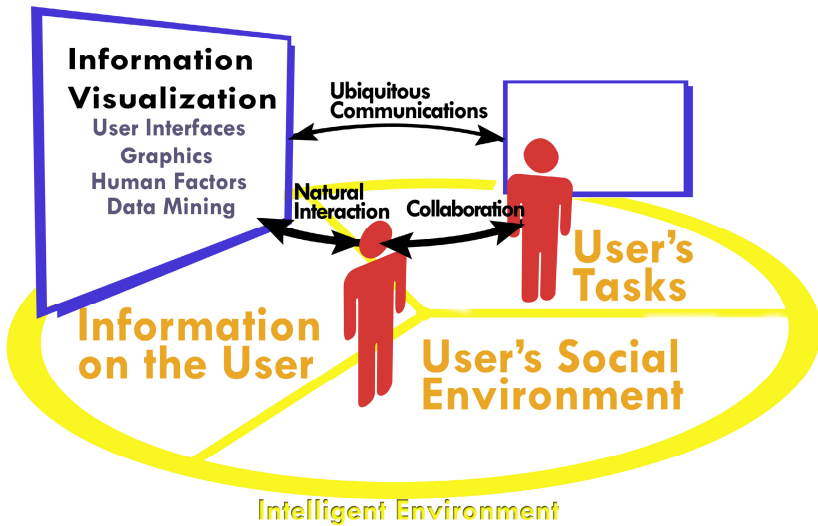
**Keywords:** Ambient Intelligence, Information Visualization, Pervasive Displays, Context-Awareness, Taxonomy.

## 1 Introduction

Substantial advances in ubiquitous computing and communications, natural interfaces and pervasive displays have enable intelligent environments that are responsive and sensitive to the presence of people, adaptative to their needs, habits and emotions. In general, Ambient Intelligence (AmI) is the vision in which technology becomes invisible, embedded, present whenever we need it, enabled by simple interactions, attuned to all our senses and adaptive to users and contexts [1].

Visualization provides a powerful mechanism for assisting immersed users in Ambient Intelligence. Context-sensitive environments can respond to changes in visualization by accommodating techniques to change the interface in displays (varying from cell-phones, desktop computers to high-resolution displays) at run-time [2]. However, it is not possible a direct transition from the desktop screen to this wide range of display devices. This transformation brings up numerous research questions in the space of user interfaces, so an attempt to apply user interfaces designed for the desktop to screens embedded in the environment leads to problems [3].

The key goal of this paper is to offer a taxonomy in order to consider the relevant characteristics for displaying information in intelligent environments, distinguishing



**Fig. 1.** Relationship between information visualization and user integrated into a context-aware and intelligent environment

information visualization details and context-awareness attributes (Figure 1). Recognition of these issues has given rise to work in automated visualization in Ambient Intelligence.

Section 2 deals with information visualization issues, specially focused on general aspects concerned to visualization in pervasive environments. If information is displaying in an intelligent and context-awareness environment, we can identify the environment characteristics to improve the information visualization. In section 3 we analyze these characteristics, i. e. which attributes, related to the environment around the displays, are significant to pervasive visualization. Next section presents the proposal of the taxonomy PIViTa (Pervasive Information Visualization Taxonomy).

## 2 Information Visualization

In everyday life, people have to access and analyze a variety of personal information such as agendas, news, emails, and digital documents. In the office, usually we need to share information between partners and access digital repositories. In our free time, we continuously manage information, for example, we make decisions among a variety of products, models, prices and characteristics when we go to shopping. In general, many decisions and actions are based on information that is gathered from a diversity of sources, in fact, information is becoming a ubiquitous and everyday task. Consequently, advances in information visualization can enhance Ambient Intelligence by analyzing high level design issues.

Regarding the purpose of the visualization, it is possible to recognize the role of the displays by identifying frequent situations with similar characteristics. A display role is a visual structure with a specific functionality in a usual situation. In [4] three key roles in pervasive and collaborative environments are proposed: (a) presentation: The visualization has the main function of displaying formatted information that has