

# Geoinformation and Cartography for Small-scale/Indoor Environments using Ubiquitous Computing and Ambient Intelligence

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## **Abstract**

The aim of this paper is to focus on the most important (existing and forthcoming) applications of Geoinformatics and Cartography for the advancement of Ambient Intelligence.

A wide range of applications of GIS and Geoinformatics has extended from large to small scale environments, particularly to indoor environments, and among the factors that have favored this evolution are the developments in ambient intelligence and ubiquitous computing.

Ambient Intelligence is a vision of a future Information Society, where people will be surrounded by integrated, responsive and personalised electronic environments, sensitive to their actions, movements and needs. It emphasizes user-friendliness and access to information by any user, anytime, anywhere, from lightweight and portable devices.

Ambient Assisted Living and Public Surveillance are only two domains of applications of Ambient Intelligence in the context of Geoinformation.

It is concluded that Ambient Intelligence and Ubiquitous Computing will have much to profit from GIS and Geoinformation Technologies: Geoinformation Technologies endowed with Ambient Intelligence will become an indispensable asset to all future cartographic applications.

Keywords: Geoinformation, Ambient Intelligence, Ubiquitous Computing, Small scale GIS.

## **1. Applications of AmI and UbiComp and GIS**

The applications of Ambient Intelligence (AmI) and Ubiquitous Computing (UbiComp) are manifold: from guiding blind people and helping parents to keep track of their children to environmental applications, where with the use of sensors it is possible to detect i.e. fires of oil spills at the very first stages of the accident. Many applications have emerged in toys, in clothing, in furniture and other everyday objects of indoor environments.

The main characteristics of these systems is that they are (mostly) invisible to the naked eye, small, inexpensive and integrated to a broader network (Weiser, 1991; Weiser, 1993). AmI makes use of Nanotechnology and a wide range of sensor types and sizes, although RFID tags are most common (Hightower & Borriello, 2001). These tags are of area  $<1\text{mm}^2$  and thinner than a sheet of paper, obtaining their energy from the surrounding environment.

Other devices are sensor chips, wireless data trancivers, piezoelectric transmitters, often integrated with thermogenerators and flexible washable solar cells. In this way, we can create "smart environments", sometimes called AWSANS (Adhoc Wireless Sensor and Actuator Networks).

It is at this point that GIS becomes important, as we need to keep track, with a very high precision, of the positions of all sensors over the Aml Landscape. This is particularly important for environmental and ecological applications, such as monitoring forest fire and water or sea pollution. When the sensors are visible and with more complex functions, positioning is usually made with GPS. When they are smaller and, then it is more likely that a GIS would be enough.

### **3. Applications of GIS to Smart Home Applications and Indoor environments**

These include ambient energy harvesting systems, with the aid of wireless sensors implanted or attached to furniture, such as chairs, computers, electric devices, walls, etc. These sensors could measure, for instance, air temperature and motion at the local microclimate, or could filter out noise and unwanted sounds, and can self-locate. As most CAD-drawings of buildings are often inaccurate, GIS plans of building interiors become increasingly necessary.

Thus, “smart buildings” can be created (some can be visited at University laboratories). Most common are Smart Home applications.

However, several theoretical problems arise related to the software of these systems. These problems relate to Spatial Qualitative Reasoning, as encountered in most cases of applications of Geoinformatics to Ambient Intelligence (e.g. Topological Calculus, Region Connection Calculus, Dipole Calculus, “Opram”, etc).

### **4. Conclusion**

GIS for Indoor Environments is one of the forthcoming GIS developments. Ubiquitous Computing and Ambient Intelligence are the next step in the evolution of indoor lifestyles. Hence, GIS will be an essential component of these lifestyles. This means an unexpectedly large field of GIS applications, as well as a number of theoretical problems to be resolved, related to the representation of geoinformation.

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