BDI Intelligent Agents for Augmented Exploitation of Pervasive Environments

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Summary

1. Introduction
   - Application context
   - A Real Scenario

2. The Framework
   - Problem modeling
   - Software Architecture
   - Implementation details

3. Conclusion
   - Conclusion and future work
Pervasive environments are really dynamic and enable software applications to access to large amounts of information from anywhere.

Pervasive applications are characterized by:

- **Ubiquity**: the interaction with the system is available anywhere you need it;
- **Transparency**: the system is not intrusive and is integrated in the environment;
- **User mobility**: the user can freely move while interacts with the system.
Mobile devices can support the user to:

- follow particular itineraries and interact with the environment;
- discover and utilize available resources in relation to its position, the characteristics of its devices, etc.;

Context awareness improve user’s satisfaction by personalizing exploitation of mobile services.
Museums, archaeological parks and historical cities represent environments within which visitors move and are rich of points of interest.

Exploitation of some archaeological sites can be very difficult because of:

- a lack of supporting infrastructures;
- the complex recognition and comprehension of the relevant ruins, artworks and artifacts.

Pervasive artworks, buildings, monuments and general points of interest must be perceived and recognized by applications: they are joining the *Internet of things*. 
Personal devices can be used to plan and support the tourist:

- as a touristic guide,
- by collecting information to improve awareness of services,
- by suggesting him the points of interest,
- by providing multimedia contents which can semantically augment the perceived reality.

According to the capabilities of the client device the user will be able to exploit a different number of value added facilities based on semantics and localization.
Goals

We aim at designing and implementing an agent based framework to optimize user’s exploitation of pervasive environments by:

Use of ontology for the knowledge representation, user’s profile’s description, the annotations of digital resources and software.

Use of semantic techniques for intelligent content and application discovery, adaptation and delivery.

Algorithms to manage constraints such as user’s position, device technology and available time for exploitation.
Problem Model

Maps and landmarks

Perceptions

Agent Student

Agent Teacher

Repository

Beliefs

Plan
Agents’ Role

- BDI agents with the common goal of maximizing the expected satisfaction of the user,
- acting according to a learning by teaching approach;
- simple agent on user’s device: perceptions of the environment, communication with remote agent and content delivery,
- intelligent agent on remote: content retrieval, planning (perform a more complex reasoning), storing.

According to the capabilities of the client device the user will be able to exploit a different number of value added facilities based on semantics and localization.
The Project 1/2

Technological framework that supports the experts in the domain of the Cultural Heritage

- to augment the archaeological site with a set of multimedia contents,
- which are delivered by innovative services to the visitors through their mobile devices,
- in order to guide their tour and to enhance their perception of the reality and learning.

In this context a relevant issues are:

- the profiling of the user,
- intelligent selection and the presentation of the contents which can improve the user’s satisfaction,
- augmenting and improving user’s perception of the reality.
Environment Map

The environment within which the user is moving is described using a geo-referenced map that:

- describes buildings, roads, bans, itineraries and POIs;
- is designed using OpenStreetMap format;

The maps are designed by experts of the domain.
Ontology and annotation

An ontology has been designed by experts of the domain to:
- describe the domain of interest and general concepts of our application model;
- annotate the related media and the multimedia contents;
- describe user’s profile;
- enable knowledge sharing among different agents.
Digital Objects

A set of different components, identified by a persistent identifier (PID) and containing a set of metadata.
Fedora

Flexible Extensible Digital Object and Repository Architecture architecture to archive, manage and access to “digital contents” represented as digital object
The navigator 1/2

The navigator is obtained as an extension of NAVIT with the add of functionalities to:

- access to device peripherals to sense the environment;
- access to remote services to update the user knowledge and to ask for available contents;
- a local cache of objects for exploiting the visit without connection;
- a limited reasoner that is able to organize the content by itself even if the connection does not work;
The navigator 2/2

Perceptors are implemented by:

- GPS positioning to localize the user in open spaces and to guide him on cultural itineraries;
- RFID for positioning and detection of nearby POIs. This technology can be used to alert the user but also for his positioning in indoor environments;
- CODBAR recognition to get information about artifact, monuments, ... when a RFID reader is not available;
- image recognition by search by sample techniques which are speed-up and improved using a position based filtering;
- monitoring of device resources and configuration;
- collection of user interest by feedback and by an analysis of his behavior;
- time monitoring.
Agent Student

The agent student

- discovers surrounding objects,
- uses them to update the representation of user’s knowledge,
- reacts using the local knowledge to organize and propose the available contents and facilities by an interactive interface,
- access remote services to look for additional contents and applications

Executes autonomously and proactively in order to support the users’ activity within the environment he is moving.
Agent Teacher

The agent teacher:

- runs different reasonings,
- according to user’s profile,
- that make queries to the Fedora repository and returns the selection of contents that best fit user’s needs of information.
Interaction Between Agents

Diagram:
- Fedora
- Beliefs (Knowledge)
- Deliberation Process
- Intentions (SPARQL queries)
- SPARQL Client
- Structured Media Contents
- Student Plan (Itinerary)
- Student Agent
- Perceptions
- Belief Revision
- Desires
- Executor
Search by Sample Georeferenziato

User send:
- the picture shoted;
- his position to select all the picture which represent the subjects he shoot;

The system suggest a new set of contents which are relevant to what the user is looking at.
Synchronized Video

An example of original content model, by which reality is augmented, is a virtual reconstructions that is synchronized with the camera output;
Conclusion

- Research results about the aided exploitation of pervasive environments by mobile devices.
- Augmented visit of complex archaeological sites has been used as a real case study.
- Solution is designed using a BDI agents based learning by teaching approach.
- Technology and tools have been extended and are being integrated.

Works in progress are:

- Definition and implementation of algorithms that optimizes the selection and organization of contents;
- Integration of technologies.
- Development and integration of innovative services.
- Jadex implementation and integration of the agent model.