Towards Ambient Intelligence in Education

George Margetis
Institute of Computer Science
Foundation for Research and Technology - Hellas
Introduction (1/2)

- Ambient Intelligence (AmI)
  - Information and communication technologies interweaved into “the fabric of everyday life”
  - They can sense and respond to human needs and requirements
Introduction (2/2)

- Ultimate objective
  - Full integration of AmI technologies in everyday living environments
  - Technology is pervasive but invisible and unobtrusive
  - In a “smart world” of the future people will distinguish much less “technological artifacts” than today
ICS-FORTH
Aml Programme (1/2)

- Horizontal interdisciplinary R&D Programme
- Links the focused R&D activities of ICS laboratories
- Platform for cooperative research towards:
  - developing and studying Aml-related technologies
  - assessing their impact on the individual, as well as society as a whole
ICS-FORTH
Aml Programme (2/2)

- Showcase for demonstrating the potential, added-value and benefits of Aml technologies in different aspects of everyday life and activities
- Link for technology transfer and know-how dissemination to industrial actors
- Particular emphasis is given on the simulation and experimentation with several indoors and outdoor environments of key importance
Aml Sandbox

- An experimental space within ICS-FORTH
- Installation, testing and integration of a large variety of technologies and applications
- Allows researchers from different domains to bring together and share their know-how and resources
New Aml Facility

- New building (~ 3,000m²)
  - Basement, ground floor, 1st floor
- Fully accessible by people with disabilities
- Includes:
  - Simulation spaces
  - Laboratories for R&D in Aml technologies
  - Offices
    - Permanent research staff & visitors
Technology Components

- Middleware for AmI environments
  - Provides libraries and tools to enable software developers to create services in a variety of programming languages

- User localization
  - Collects images from multiple viewpoints and reconstructs 3D models of the persons, their location and attributes

- Visual recognition of images and book pages
  - Facilitates "smart", context based interaction at desk and office workspaces

- Visual 3D tracking of non-technological props, a wand or a stylus
  - Provides intuitive, yet unobtrusive, interaction aids

- Speech recognition and sound localisation
Aml in Education

- Aml brings a significant potential in the domain of education
  - increasing students’ access to information
  - enriching the learning environment
  - allowing students’ active learning and collaboration
  - enhancing their motivation to learn
Main objective
- investigate the role of Ambient Intelligence technologies in the educational context and in the classroom environment

Pupil-centric approach

Classroom communication infrastructure, context-aware application manager

Adaptable widget toolkit, UI migration among classroom devices

Integration of physical and digital world (e.g., page recognition)

Examples of applications
- Personal Area
- Exercises in electronic form
- Exercise hints
- Dictionary application
- Multimedia application
Aml Classroom (2/2)
Smart School Desk (1/3)

- A smart add-on component that:
  - augments pupils’ desk aiming to integrate AmI technologies
  - enhances their learning skills
  - monitors their progress
  - provides the means for real time personal assistance
Smart School Desk (2/3)

- is an additional piece of furniture capable to “plug-in” typical school desks of standard dimensions
- including
  - a custom plexiglass 27 inches diagonal wide screen
  - an Intel Core 2 Quad Core PC
  - 2 DLP mini projectors located behind the screen
  - 1 mirror for reducing the projection distance
  - 2 cameras located behind the screen
  - 4 infrared projectors located behind the screen
  - 3 cameras located on top of the screen and capturing images of the conventional desks
Smart School Desk (3/3)

- Features:
  - Multitouch screen able to recognize shapes
  - Unobtrusive monitoring of the font desk:
    - Books and pages recognition and localization
    - Stylus pose estimation
    - Handwriting and gestures recognition
ClassMATE (1/4)

- A framework for the AmI Classroom that:
  - addresses heterogeneous interoperability needs of services and devices
  - supports user profiling and behavioral patterns discovery
  - provides efficient content classification
  - applies appropriate reasoning strategies for AmI Classroom orchestration

- Architecture
  - Context Manager
  - Device Manager
  - User Profile Manager
  - Data Space Manager
  - Security Manager
ClassMATE (2/4)

- Architecture:
  - Context Manager
    - controls and orchestrates every aspect of the classroom in a top-level
    - provides context aware modules that orchestrate each artifact
    - manages AmI Classroom applications’ state serialization and deserialization
    - facilitates the application migration from the current local artifact to a remote node
Architecture (cont.):

- **Data Space Manager**
  - Provides distributed storage
  - Encapsulates filtering mechanisms for personalized content delivery

- **User Profile Manager**
  - Collects personal data associated with a specific user (both static and dynamic)
ClassMATE (4/4)

- Architecture (cont.):
  - Device Manager
    - controls and integrates AmI services (e.g. book localization) to the ClassMATE system
  - Security Manager:
    - handles user or system access-related requests
A UI design and development framework that:

- provides pervasive UIs for the Intelligent Classroom
- is able to automatically transform according to each artifact’s characteristics (input and output)
- includes tools and mechanisms for modeling every single interface of an application in an AmI artifact - independent manner
Pilot applications (1/3)

- Three applications were implemented as the front-end of ClassMATE and PUPIL frameworks
  - **ClassBook Application**
    - provides the electronic version of the physical book, displaying the currently open book page
    - images and exercises displayed on any page are selectable
    - upon selection the appropriate applications are launched to display relevant content
Pilot applications (2/3)

- Multiple-Choice Exercise Application
  - is the online representation of a multiple-choice exercise
  - the student can solve the exercise electronically by just selecting one of the possible answers
  - hint button is offered next to each sentence, in case the student requires help to find the correct answer
Pilot applications (3/3)

- **Hints Application**
  - is launched only when the student explicitly asks for help about a specific exercise
  - three kinds of hints that are presented to the student gradually
Aml Classroom video
SESIL

- A system targeted to enhance studying and writing activities on physical books through
  - unobtrusive monitoring of users’ gestures and handwriting and
  - the display of information related to the current users’ focus of attention
- SESIL innovatively combines book and page recognition, stylus position identification, and handwriting recognition without requiring any special device apart from cameras
- exploits educational metadata on the book’s content to decide at run-time the type of additional information and support that needs to be provided in a context-dependent fashion
SESIL video
Aml Playfield

- An Aml educational environment
  - grounded on contemporary learning principles
  - natural playground enriched by computational vision techniques
  - kinesthetic collaborative play and performance measurement
  - Integrates visual displays, mobile controllers and sound facilities
  - easy development of a wide variety of learning applications targeted to fun, challenge, engagement and learnability

- Apple Hunt game
  - enhances skills in fundamental arithmetic operations
Interacting with Poetry

- Physical books augmented with interactive areas, which, when activated by users, trigger the display of related additional information
  - e.g., images, videos, text
- The first application displays poems of, and information about, the Greek poet Odysseus Elytis
Interacting with Poetry video
Next steps

- A real scale smart classroom,
  - will constitute one of the real life simulation spaces of FORTH-ICS’ AmI facility
- Long – term evaluation of AmI Classroom with actual students and teachers aiming to assess
  - the usability of the proposed system
  - its actual impact in the educational process as well