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Prologue

The Institute of Informatics and Applications (IIiA) is a research centre at the University of Girona conducting R&D&I in the field of Information and Communications Technologies (ICT). Since its establishment in 1996, it has brought together talent, effort and enthusiasm to achieve two major objectives: to expand the knowledge base on ICT and to develop ICT applications that improve the quality of life of people and the efficiency of companies and administrations.

Our work would not be possible without the on-going collaboration with researchers, research groups and research centres all over the world. That is why the IIIA pays special attention to international scientific collaborations, either by establishing new partnerships with strategic partners or by improving those that exist today.

The IIIA contributes to partnerships the talent and expertise of its staff, scientific knowledge, and the ability to develop, innovate and attract competitive funding. All this and much more is explained in this document. I wish after reading it a fruitful collaboration for both parties could begin.

Dra. Imma Boada
Director of the IIiA

Girona, 2012
Introduction

This document contains a description of the Institute of Informatics and Applications including its profile, key figures, research lines, application domains and partners. It also describes the profile of the partners the IIiA would like to collaborate with.
Institute of Informatics and Applications

[1] Profile
[2] The IIiA in figures
[3] Research lines and application domains
[4] Collaborator profile
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1. Profile
The Institute of Informatics and Applications, IIiA, is a research institute at the University of Girona (UdG). It conducts research, development and technological innovation (R&D&I) in the field of information and communication technologies (ICTs). The IIiA was established in 1996 and currently has 90 researchers, 40 of whom with a PhD, who carry out R&D&I at both national and international levels.

The IIiA's researchers are organized in 4 research groups:
- Communications and Distributed Systems (BCDS), bcds.udg.edu
- Control Engineering and Intelligent Systems (eXiT), exit.udg.edu
- Graphics and Imaging Laboratory (GILAB), gilab.udg.edu
- Modelling, Identification and Control Engineering (MICELAB), iiia.udg.edu/micelab

The academic staff belongs to three departments of the University of Girona:
- Department of Architecture and Computer Technology
- Department of Computer Science and Applied Mathematics
- Department of Electrical Engineering, Electronics and Automation

2. The IIiA in figures
The IIiA's activities result in the annual publication of 40 articles in journals indexed by Thomson ISI and the presentation of 6 doctoral theses per year. Moreover, the IIiA yearly earns competitive grants for R&D&I and technology transfer contracts worth € 3 million. The values shown are averages of the last five years.

3. Research lines and application domains
In accordance with its goals and strengths, the IIiA identifies and addresses scientific and technological challenges in the field of ICT. The IIiA's research agenda is not rigid but flexible to adapt to the continuous changes taking place in our field.

The IIiA's application domains are:
- Digital Media
- e-Tourism
- e-Learning
- e-Health
- ICT for Food
- Smart Cities / Smart Grids
- Computer Networks
DIGITAL MEDIA

The digital media sector is constantly evolving due to the increasing capacity of communication networks, the ability to manage networks with distributed intelligence, the emergence of the end-user as a content creator and the emergence of networked platforms for consuming and sharing digital media. Therefore R&D is needed to produce new models describing this new scenario and to develop the services required by creators, distributors and end users.

Users increasingly consuming personalized contents anywhere and at any time, the wide range of distribution platforms, and the vast amount of terminals available for consumers increase the complexity of the ICT systems to be designed to provide digital media services.

The IIIA faces this challenge by researching and developing new applications in the following areas:

- Management of high-speed networks needed to distribute multimedia services over the Internet including IP-TV.
- Content accommodation to different display terminals and to the availability of data transmission networks.
- Robust tools for content recommendation able to capture users' opinions on the content they are consuming, along with their context and preferences. These tools are also able to spot spam created by outsiders.
- Creation of virtual environments, Virtual Reality and Augmented Reality tools to deliver more immersive digital content to the end user.
- Analysis and processing of digital images and videos for automatically or semiautomatically categorizing and indexing large amounts of multimedia data.
- 2D and 3D visualization techniques that facilitate the interpretation of any kind of information.

The main projects in this field are:
4GAMES: Application of videogame technology and computer graphics to develop, manage and display of digital content and interaction techniques.

4GAMES deals with the automatic creation of virtual worlds, improved graphics realism and interaction techniques to develop serious games for education and training.

MIREIA: User modelling and recommendation of audiovisual content (Internet TV) for web 2.0 environments.

MIREIA will produce an audiovisual content recommendation engine geared towards both the marketing and the content markets. MIREIA will be delivered following the model of Software as a Service, and will smoothly integrate into the platforms used to produce contents and to deliver them to end-users.

MATMUSIC: Mathematical modelling of musical hits

The main objective of this project is to develop software that, given a song, indicates its chances to become a musical hit. The software is based on information theory tools and is transferable to the recording industry.
e-TOURISM
Both governments and private companies are trying to harness new technologies to promote economically sustainable, environmental friendly, all-year-long tourism. This new tourism favours quality over quantity.

As far as ICT are concerned, research and development of multimedia applications allows visitors to interact with and learn about the culture and history of specific places. The existing multimedia tourist guides are being improved with content tailored to the needs of the specific visitor and with new technologies like mobile videogames. All this has resulted in significant innovation in the tourist sector.

In the field of e-tourism, the IIiA carries out R&D on:

- The development of serious games used to inform players about historical events and cultural aspects of a city or region in a playful and attractive way.
- The application of game technology for re-enacting times and places of interest with a high degree of realism and providing interactivity to the user.
- The use of Augmented Reality and geolocalization to develop new tourist information applications. These applications run on different mobile devices and highlight tourist attractions and places with historical or cultural relevance for the user.
- The personalization of content for visitors to museums in different types of mobile devices.

The results of the IIiA’s projects are applied to historical tourism, virtual tourism, interactive tourism and educational tourism. Some of the most important projects in the field of e-tourism are:

**Legends of Girona**
Educational videogame which renders medieval Girona in 3D and allows for the re-enactment of several legends which took place in the town in that era.
e-flors
Tour around “Temps de Flors”, the flower exhibition held in Girona yearly, enriched by Augmented Reality.

Mercè Rodoreda
Mercè Rodoreda was a famous Catalan writer. The IliA has developed a virtual literary journey enhanced with Augmented Reality. The itinerary covers the writer’s most significant places and highlights.
e-LEARNING

ICT applied to education increase collaboration among students, help them focus on learning, improve their motivation and interest, foster their spirit of quest, promote integration and encourage the development of certain intellectual skills such as reasoning, problem solving, creativity and learning to learn. With regards to teachers, computer technologies have been used so far to facilitate the search for learning contents, improve collaboration with other teachers and to plan learning activities.

ICT benefits the development of learning forms such as distance education courses, education for adults and education at hospitals.

However, there are still several lines where research is needed to improve the quality of the education and training provided. Some of the areas the IIiA deals with are:

- Automatic correction and evaluation of all kinds of problems, both closed-response (tests, multiple choice, etc.) and open-response (software programming, electrical circuits, etc.).
- Customization of educational content according to the cognitive and learning characteristics of students and to the access technology they use (tablet, smartphone, PC, etc.).
- Improving existing Learning Management Systems (LMS) by incorporating instructional design techniques and the model of the students.
- Enriching e-learning platforms with social networks and Augmented Reality.
- Development of graphic-rich virtual environments for teaching any subject.
- Development of educational videogames for students with learning disabilities.
- Improvement of digital repositories with standardisation, reuse and retrieval techniques for educational contents.
- Educational robots: Educational platform based on the assembly of hardware.

The IIiA’s expertise in this area is endorsed by several projects. Among them, we highlight the following ones:
ARRELS: Augmented Reality in Adaptive Learning Management Systems for all.
The goal of ARRELS is to enhance users’ learning skills by means of several technologies such as Augmented Reality, mobile computing and open content. Thus, e-learning processes adapt to the students’ requirements and characteristics, which vary from student to student.

ACME: Avaluació Continuada i Millora de l’Ensenyament.
E-learning platform developed at the University of Girona. It incorporates a system of continuous evaluation which automatically corrects and evaluates of all kinds of problems. ACME is currently being used by more than 5,000 students. The platform can be used independently or integrated into Moodle.

ALTER-NATIVA
The main objective of this project is the application of ICT in education faculties in south America so that they can adapt their curriculums to students with disabilities and special needs.

Robotic Workshops
The IiiA runs robotics workshops for students at primary and high schools. Students learn about robotics by working with LEGO Mindstorms
**Lego League Organization**
LEGO League is an international competition of teams of robots designed by students of primary and high schools. The robots have to perform missions such as locating an object, moving objects, etc.

**LISSA: Life Support Simulation Applications**
Videogame which helps students of nursing and physiotherapy to learn patients’ care and rehabilitation processes.

![LISSA Image](image1)

**e-CECILIA**
Project which aims to develop an interactive video game that helps to learn how to play musical instruments. Given a score to interpret, e-Cecilia informs the student about his/her mistakes or deviations, and recommends a series of exercises. e-Cecilia includes the latest multimedia, 3D imaging, video and interaction technologies.

![e-CECILIA Image](image2)

**Edubody**
Videogame that allows navigation of a 3D representation of the human body. It is geared towards students of medicine, physiotherapy, nursing, etc.

![Edubody Image](image3)
e-HEALTH

Image-based diagnosis has become an essential tool in any hospital. Besides, modelling physiological processes enables in-depth analysis of certain diseases and the identification of new courses of treatment that have improved patients’ quality of life. Moreover, current computers and communication networks allow hospitals to go completely digital. Many more examples showing the benefits of applying ICT to health-care may be presented. However, there is still a long way to go and knowing how to process the information provided in this new environment has become essential. Therefore, new techniques are needed for the proper interpretation of the available information and for the proper knowledge extraction required.

Applying ICT to health-care is one of the most relevant challenges of the IIiA. That is why part of our research focuses on:

- New techniques for processing and viewing radiological images aimed at facilitating and automating image-based medical diagnosis. Our techniques allow automatic computation of injuries and fusion of different image modalities.
- Virtual environments for planning surgical operations and for training surgeons.
- Data Mining Tools and Decision Support Systems for medical applications.
- Tools for telemedicine, telerehabilitation, telecare and remote monitoring.
- Modelling biological systems and their application to medicine.
- Modelling, simulation and prediction of glucose metabolism.
- Artificial Pancreas: development of new effective and safe strategies for glucose control in patients with type 1 diabetes.

The IIiA’s most relevant projects related to this research area are:

CLOSEDLOOP4MEAL:

**New strategies for postprandial glycaemic control with insulin pump therapy in type 1 diabetes.**

The goal of the project is the automatic delivery of insulin for Type 1 diabetics, especially after food intakes. Closedloop4meal is part of a series of projects aimed at developing an artificial pancreas.
**Starviewer**

Image-based diagnosis platform that integrates the most advanced techniques for processing and visualization of radiological images in order to automate the diagnostic process as much as possible. The need for automation has led the IIIA to research and propose, among others, new methods for computing the volume of lesions, new ways to register images of different modalities and new ways to display in a unified way the different registered models of an image. StarViewer has been designed as a tool to be used in real environments, not just in research centres. That is why it has been implemented following all standards and regulations established by the IHE (Integrating the Healthcare Enterprise). The platform is being used in the main state-owned Catalan hospitals.

**MEDIATE: Patient Friendly Medical Intervention**

MEDIATE applies Case-based Reasoning (CBR) to develop a tool for decision support (DSS) used in aortic valve operations through a catheter.

**Vitality**

The objective of Vitality is to develop an intelligent broker which analyses a patient’s biophysical information collected by multiple sensors and selects the most appropriate e-health service for that patient.

**ViTAM**

Videoconference system providing patients and dependent people with healthcare and rehabilitation remotely.

**eXiT-CBR**

Tool for prototyping CBR (Case Based Reasoning) solutions. eXIT-CBR is currently being used in medical diagnostic applications.
ICT FOR FOOD

The food industry is striving to adopt Information and Communication Technologies to improve its productivity and competitiveness. More specifically, meat-processing companies want to improve product quality by controlling, monitoring and optimizing production processes.

The IiiA is conducting research on several lines, which will improve the way ICTs are applied to food companies:

- Application of image pickup devices in order to assess the quality of meat products in a non-invasive way. They are also used to monitor processes like meat salting.
- Modelling of biological systems and their application to the meat-processing industry. The IiiA is working on systematic methods and tools for inference, real-time monitoring, optimization and feedback control. Special emphasis is put on studying how to deal with uncertainty in production processes resulting from lack of data.
- Expert Supervision of processes in the meat-processing industry. Data collected from processes to produce stuffed meat products is analysed in order to improve their quality.

The most relevant projects in this area include applications for monitoring, and control. Some of them are:

**Visualpork**
Platform featuring visualization and image processing techniques to study CT and MRI images of the pork. The platform has been developed in collaboration with IRTA (Institute for research in food technology).

**Modelling biological systems**
Development of models based on the uncertainty of living organisms to analyse, estimate and predict their behaviour and develop these methods for monitoring, optimizing and controlling industrial bio-inspired processes.
SMART CITIES / SMART GRIDS

Applying ICT to the energy sector means significant savings in operating costs, improving energy efficiency and optimizing the timing of services (reducing tasks’ execution times and achieving better synchronization).

The dramatic development of the Internet of Things (sensor networks, RFIDs, etc.) and mobile data communications (M2M, Mobile Broadband, etc.) has improved the provision of many urban services with unprecedented performance, limited only by the financial capacity of the governments in charge. However, there is a lot left to do: applying ICT to cities and grids is a long-term challenge where cooperation and partnership between public and private sectors will play a big role. In any case the race for the urban intelligence has already begun.

Many research lines must be addressed to create smart cities. The IIiA has focused on the following topics:

- Smart Grid: AI-based new approaches to monitor the quality of electrical energy and new measures to improve energy efficiency; Monitoring and fault detection in electrical power networks and efficient restoration of the network.
- Control Systems: Control, monitoring and fault detection in mechatronic systems and smart structures.
- Route optimization for vehicle fleets.
- New methods of information visualization in order to support decision-making.

Results arising from research in this area have been transferred to both the public and private sectors. Therefore, some results are already being used by the industry. Some of the most relevant results and technology transfer activities in this field follow:

ENERGOS: automated and intelligent management of power distribution networks.

ENERGOS researches the key building blocks of the smart grid necessary to manage in real-time the multi-directional energy flows that will occur in the electrical distribution networks of the future. In this project the IIiA focuses on the efficient exploitation of field information by using data mining techniques, and on knowledge discovery to detect and diagnose network faults and to support network operations even in presence of faults.
i-PQM and IMPONET: Intelligent Monitoring of the electric power quality.

i-PQM and IMPONET are two complementary projects. The first one conducts basic research whereas the second one applied research. i-PQM aims at developing algorithms to improve the monitoring of the quality of the electric wave whereas IMPONET aims at the deployment of a Service-Oriented Architecture (SOA) software platform for managing SmartGrids with real-time and near real time performance.

ENERFICIENCY

The goal of the project is to develop a software platform that enables the actual deployment of ICT tools to manage energy efficiently. The project focuses on the consumer (smartmeter) but has access to network information. The project aims to be a facilitator for both the deployment of audit solutions (measurement and verification) and energy management in accordance with new standards (ISO 50001) incorporating specific computing services.

WinFloat

Development of control structures to mitigate the dynamic load on floating windmills installed at sea. Due to the varying conditions of wind and waves, the stability of the windmills is essential to ensure their proper operation.

Dynacar

The main objective of this project is to develop an ICT platform to monitor the state of civil engineering structures such as tunnels, bridges and roads. This project will develop a real-scale prototype capable of detecting failures in reinforced concrete at an early stage and of suggesting possible corrections including the redesign of some aspects.
COMPUTER NETWORKS

Services currently being provided by computer networks such as cloud computing and WSNs for smart cities, and the ones expected in the future put a lot of pressure on computer networks’ availability, reliability and resilience to communication faults. In this context, the IIiA carries out R&D in the following lines:

• Traffic engineering to improve computer networks’ performance and availability: transport networks based on commutation of labels (G/MPLS), optical systems and Ethernet (Metro Ethernet).

• Complex computer networks’ robustness analysis:
  • Optimization and graphs’ theories (topological analysis of networks).
  • New, scalable mechanisms for routing (greedy and compact models).
  • Multiple-fault evolution models: waterfall, epidemics, etc.

• Wireless Networks
  • Cognitive radio and dynamic resource allocation
  • Networks of sensors: use study, accuracy and reliability for specific applications such as preventing fires in the forests.

Research conducted at the IIiA has been applied by telecommunications companies and by Internet Service Providers. The most relevant projects in this area are the following:

EULER

EULER’s main goal is to design, develop and validate experimentally new routing schemes useful for the future Internet.
TRION
Every Internet Service Providers (ISP) guarantees quality of service and protection mechanisms only within its own domain. That is why when several domains are involved protection and recovery mechanisms are slow and expensive. TRION's goal is to develop a new reliable, transparent overlay network providing the best service among different domains regardless of the technologies used by the different ISPs.

TIGER2
TIGER2 aims at developing a new network architecture bringing together IP, GMPLS and Ethernet protocols in order to improve the way services are provided and to reduce operating costs.
4. Collaborator Profile

- Media companies interested in developing high-quality digital contents, serious games and immersive (Augmented Reality/Virtual Reality) applications.
- Educational institutions interested in innovating by integrating e-learning platforms and tools for content customization and recommendation.
- Hospitals that wish to improve health care by exploring and developing ICT applications. An example is the radiological application StarViewer.
- Museums and tourism businesses interested in IIiA's technologies (serious games, tools of perception, 3D reconstruction and Augmented Reality) to develop applications such as virtual tours and virtual catalogues.
- Universities and research centres interested in participating in international collaborative R & D projects.

5. Our Partners

- Institut Català de la Salut
- CLÍNIC BARCELONA
- IZASA PHILIPS
- dexcom
- UDIAT Centre Diagnòstic
- NOVARTIS
- Atos Origin
- SIEMENS
- RGB
- T-Systems
- Telefónica
- SPAMINA
- Lavinia
- D3
- Berto Jacobs
- vertice
- cms
- nspirit
- gmv
- MEDIAPRO
- IBERNEX
- Intercomgi
- creativ IT
- tecnalia
- Indra
- Fundación Investigación Clínico de Valencia