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# UPM technology marketplace *innovatech*

(version) September / 2013

Centre of Support for Technological Innovation CAIT-*innovatech*  
TECHNICAL UNIVERSITY OF MADRID

e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

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## Mycetum, advanced bioproduction generation

### Biotechnological solution for large-scale production of mycelium, a natural key component in pharmaceutical, biomedical and agricultural industries

*The mycelium natural product is a key component in many industrial applications of high economic value (pharmacological active principles, biomedical and biomaterials, agriculture or mycology and forest restoration). Obtaining one of their products (chitosan), with applications in agriculture and biomedical industry, is growing annually by 13%, an annual output of 2.000 tons and a global market estimated at 1,000 M \$.*

*A research team from the EUIT Agrícola at the Technical University of Madrid has developed a patented and internationally protected solution for mycelium production scale in a controlled manner and with a simplified process industrially from the multiplication of fungi in vitro culture. Mycetum business opportunity is checked as multi-application solution for a remarkable number of target markets, including the pharmaceutical one, world leader in R & D investment and technology.*

#### Technology solution supported by the Technical University of Madrid

#### Technology solution

This technological solution proposes an innovative method for obtaining global scale fungal mycelium in pure culture. The process develops inoculating the mycelium, for purification and then finally transfer for large-scale generation. This procedure can be implemented in industrial bioreactors for a rapid and controlled production.

The mycelium, a component of the fruit of the fungus, is a key component for the development of many applications of high economic value: extraction of active principles of pharmacological interest, obtaining chitosan (medicine, cosmetics, water treatment); obtaining principles food; biometariales generation and forest regeneration, among other applications.

*"Patented technological process for obtaining a large-scale natural product from fungi (mycelium) for several high value industrial applications"*



#### Areas of application

- **Health:** active ingredients used in pharma industry; biomedicine.
- **Biotechnology:** forestry practice and health.
- **Agri-food:** planting edible fungi.
- **Environment:** environmental regeneration.

## Market demands

- Complex and expensive procedures to produce mycelium before obtaining pharmacological active ingredients.
- Soil erosion in mycological areas and lack of guarantee of origin of the fungus species.
- Production recovery in mycological depleted areas: need for a more sustainable development of rural areas.
- Improved plant production of edible mushrooms, especially those of great commercial value, such as truffles.
- The global truffle demand (1,000 tons in 2010) is still far from the current production capacity, highly dependent on environmental factors. Even in 2020, this demand would not be covered even 25%.

*“Mycetum large-scale controlled production of mycelium improves key active ingredients generation for pharma industry”*



## Market potential

- Global pharmaceutical companies top rankings based on R&D investments (R&D expense at 17% of income), driven by Roche, Pfizer and Novartis [Global Innovation 1000, Booz & Co].
- Chitosan production market and derivatives (agricultural application or water purification component) has grown on average in recent years about 13%, with annual output of 2,000 tons. USA and Japan are the largest producers and consumers.
- USA companies producing chitin and chitosan generate a market equivalent to 335 M\$ per year, with an estimated global value higher than 1,000 M \$.
- World truffle plantation area grows at an annual rate of 9%, for an estimated production in 2020 of 270 tons [Micología Forestal Aplicada].

## Competitive advantages

- Simplicity in the production process capable of meeting several demands according to different business priorities.
- Production capacity of large amounts of mycelia in a fast and controlled manner: reducing production costs and boosting scalability.
- Multi-application solution with high added value:
  - pharmacological: generation of active ingredients;
  - biomedicine, agriculture (seeds, fertilizers...), water treatment: obtaining the chitosan component and derivatives;
  - biomaterials (fillers, degradation of materials, packaging ...);
  - customized inoculated planting and 'designation of origin'.
- 100% in vitro production, as a non-polluting process, no environmental impact without associated degradation of the natural environment.

## References

- Top worldwide research team in technological terms related to plant biotechnology and plant production.
- Mycetum spin-off creation for the marketing and business development.

## IPR

- Patent granted ES2332031 (OEPM-Spain) and international patent application in Europe, Chile and Mexico.
- Improved patent application P201231240 (OEPM-Spain).

## Development stage

- Concept
- R&D
- Lab Prototype
- Industrial Prototype
- Production

### Mycetum contact (Mycetum spin-off)

Consuelo Jiménez Aguilar, Francisco González Torres, M<sup>a</sup> Cruz Usano Martínez, César González García

EUIT Agrícola – UPM

e: consuelo.jimenez.aguilar@upm.es

### UPM contact

Innovation, Commercialization and Entrepreneurship Area

Centre of Support for Technological Innovation – UPM

e: innovacion.tecnologica@upm.es

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## BranchBiotech, increasing bioenergy production from plants

### Biotechnology solution for accelerating the development of branches in plants: higher biomass yield

*A research team from the Centre for Plant Biotechnology and Genomics (GBGP) at the Technical University of Madrid has developed a biotechnological application of a gene responsible of an accelerated and greater production of branches in ligneous species without showing changes either in their growth characteristics or in the composition and anatomy of their wood.*

*The challenge facing the global electricity market is managing the issue of carbon emissions with growing nations needing power. Obtaining bioenergy from plants could help to alleviate the effects of global warming and energy safety problems, provided that high yields can be sustained. The possibility of generating trees with a greater biomass by manipulating genes makes transgenic plants preferred candidates for bioenergy production. Biomass is simple and cost effective with some estimations predicting that by 2050, it could provide 50% of the world's primary energy needs. Biomass combustion technologies are fully mature with high commercial availability and a multitude of options for integration with existing infrastructure at both large and small-scale levels.*

Technology solution supported by the Technical University of Madrid

#### Technology solution

The lateral buds of most temperate woody species do not grow out during the season in which they form. These proleptic buds overwinter and grow out during the following spring. However, in poplar and a few other temperate species, as well as many tropical species, some lateral buds grow out sylleptically, that is, they grow out during the same season in which they form without an intervening rest period. Sylleptic branching may increase significantly branch number, leaf area and the general growth of the tree, particularly in its early years.

This solution consists of biotechnological application of the RAV1 gene (Related to ABI3 and Viviparous 1) in relation to their capacity for increasing the degree of development of sylleptic branching in ligneous species. Therefore, this tool can increase the biomass production of a forestry plantation genetically modified in this manner. This application is of great interest in various industrial sectors, such as energy industry or the chemical one.

#### Areas of application

- Energy: biomass production.
- Biotechnology: biotechnology and forestry practice.

*"Biotechnology applied in perennial plants: inducing branching as a profitable trait to increase biomass yield"*



## Market and social demands

- The sustainability potential of global biomass for energy is widely recognized. For example, the annual global primary production of biomass is equivalent to the 4,500 EJ (1 EJ=10<sup>18</sup>J) of solar energy captured each year.
- Obtaining bioenergy from plants could help to alleviate the effects of global warming and energy safety problems. In USA, the biomass power industry reduces carbon emissions by more than 30 million tons each year.
- The sustainable use of biomass as an energy source requires comprehensive management of natural resources such as land and water. Unsustainable biomass production would erode the climate-related environmental advantage of bioenergy.
- Currently, the amount of land devoted to growing energy crops for biomass fuels is only 0.19% of the world's total land area and only 0.5-1.7% of global agricultural land. According to estimations, a mere 10% increase in the efficiency of biomass production through irrigation, manufacturing, fertilizing or improved management through the cultivation of idle land, would create energy equivalent to the total current global energy demand [Swedish University of Agricultural Sciences].
- Biomass market lacks methods and standards for monitoring feedstock quality, which adds to the costs of collection, transportation, and storage of feedstock to the site of power plants.

## Market potential

- Global biomass power capacity will reach minimum 86 GW globally by 2021 from 58 GW in 2011, which represents a staggering growth of almost 50% [Pike Research].
- Total investment in the biomass sector between 2008 and 2021 would have reached a sum of \$104 billion [Pike Research].
- Biomass installations present a more attractive investment than other renewable energies. The major portion of interest is directed at biomass with 37% interested in investment of all renewable energies [KPMG].
- Estimations predict that by 2050, biomass could provide 50% of the world's primary energy needs. [Business Insight].
- Great growth in the trade of biomass commodities (biodiesel, fuel ethanol...): international trade volume increased by a factor of 10 between 2000 and 2010 [Bioenergytrade.org].
- Forest products global industry is recovering from the economic crisis, with the Asia-Pacific region and particularly China taking the lead. On average global production grew by 1-4% in 2011 compared to 2010. China is increasing its importance as producer of forest products, becoming the world's second largest producer of sawnwood after USA [FAO].

## Competitive advantages

- Accelerated development of sylleptic branching while the plants are young to increase biomass production of a forestry plantation: costs reduction in raw material production.
- Alternative application as timber logging, increasing both wood quality and forestry efficiency: reduction in the number of nodes in the trunk of high value limber ligneous species.
- Multi-application solution in industrial sectors of great economic impact: energy, chemical, silvicultural, paper industries.
- Potentially applicable to any genotype of a ligneous species: allow taking advantage of this genotype to a specific habitat.
- Required forestry plantations can be established in surplus marginal or agricultural lands: no competence with the food crop for fertile soils.

*“Power generation from biomass costs about €90 to €100 per MWh, more than the cost of power from cheap fossil fuels with low carbon prices. It is still necessary to make it cost competitive”*

## References

- Research group involved in the study of the molecular basis of cold acclimation and winter dormancy in woody plants.

## IPR

- Patent granted ES2371900 (OEPM-Spain).
- International patent application (PCT/ES2102/070471) - WO2013/007848.

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### BranchBiotech contact

Isabel Allona  
Centre for Plant Biotechnology and Genomics–  
UPM-INIA  
e: isabel.allona@upm.es

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: innovacion.tecnologica@upm.es

# ECO-SunLight: high-efficiency, ecological and natural lighting

50 % lower power consumption, longer life, 100% recyclable and high quality lamp

*This new lamp, as a research result achieved by the Group for Automation in Signals and Communications at Technical University of Madrid (UPM) in collaboration with other researchers at Rey Juan Carlos University, uses 50% less energy than current incandescent lamps and competes on efficiency with LED lighting, fluorescent and discharge lamps. It is able to faithfully reproduce more than 20 million colors, just like the sun, as, instead of concentrating light emission in narrow bands of the visible spectrum, it distributes its high power over the whole spectrum. In addition to this, lamp switch life is longer in terms of on/off cycle. It is 100% recyclable and it can be designed for any power rating.*

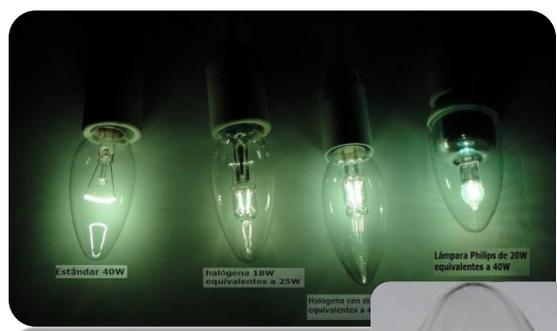
Technology solution supported by Universidad Politécnica de Madrid

## Technology solution

Eco-SunLight solution is a new kind of incandescent lamp with minor energy losses and high power based on a tungsten filament's special geometry that is immersed in a gaseous iodine atmosphere. It is controlled by a small solid-state device that achieves a higher energy efficiency, more than double previous lamps efficiency.

This lamp competes on efficiency with current LED lighting, fluorescent and discharge lamps, but the latter ones show the disadvantage of concentrating its power in certain wavelengths, giving a false sense of brightness. Alternative solutions achieve energy savings emitting all their power in wavelengths and in such a suitable proportion so that human retina is more sensitive, which could harm the eyes in the long term. Instead, Eco-Sun Light lamp is more natural and healthy as it distributes its light emission continuously throughout the visible spectrum, it doesn't have emission peaks and it is able to faithfully reproduce more than 20 million colors.

*"UPM and URJC researchers have developed an ecological and "solar" lighting: a long life and low energy consumption light bulb"*



## Areas of application

- **Energy:** energy efficient illumination.

## Market needs

- **Energy efficiency**
  - High efficiency lamps, based on thermal emission.
  - Quality lighting, with good color rendering, that doesn't damage eyesight.
  - Small device, low interference and noise emission, low heat dissipation.
  - Easy handling and replacement.
- **Sustainability**
  - Non-polluting and respectful environment low cost product.

*Eco-SunLight highlights are energy-efficient lighting (it duplicates incandescent lamps efficiency indeed), high quality, long-life and low cost production*



## Competitive advantages

- Ignition lamp that duplicates the efficiency of the rest of the lamps based on incandescence.
- Possible substitute product for applications that require low power consumption but higher quality, ease of handling and a small size.
- More natural and "healthy" lighting, compared to alternative solutions, by distributing its light emission throughout the whole spectrum.
- 100% recyclable.
- Possible design to any kind of power rating.
- Over 20 million colors faithful reproduction.
- Possible substitute product of current incandescent lamps according to new regulations.
- Safe for the circuit in which it is used, particularly for switches.

## Market potential

- Energy-efficient lighting industry is likely to sell 2.5 billion units by 2020 growing at a CAGR of 12.5% from 2012 [Energy-efficient Lighting Market in Europe to 2020].
- World demand for lighting is projected to grow 12.3% yearly through 2016 to \$78.3 billion. Gains will be boosted by an ongoing shift to higher value lighting technologies that are more efficient [RnRMarketResearch.com].
- Just in Spain, incandescent and substitutes lamps (like EcosunLight) sales overcome 50 million units per year.

## References

- Research team within Group for Automation in Signals and Communications (GASC-UPM), headed by Dr. Diego Andina, specialized in multidisciplinary applications of new technologies. Research lines include signal processing, circuits design and simulation of complex systems.
- Participation in more than 60 projects in collaboration with companies, co-funded by the European Union or national agencies, and regular provision of technological services to companies.
- 4 patented inventions; 2 spin-offs.

## IPR

- Patent pending P201132109 (OEPM-España).
- International patent application (PCT/ES2012/000280) - WO2013/098430.

## Development stage

- Concept
- R&D
- Lab-Prototype
- Industrial-Prototype
- Production

### Eco-SunLight contact

Juan Jiménez, Diego Andina  
e: [juan.jimenez@upm.es](mailto:juan.jimenez@upm.es), [d.andina@upm.es](mailto:d.andina@upm.es)  
ETS Telecommunications Engineering – UPM

### UPM contact

Innovation, Commercialization and Entrepreneurship Area  
Centre of Support for Technological Innovation – UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

## Technical protection for the historical - cultural heritage

**Portable electronic system capable of measuring the environmental acidity and facilitate preventive conservation of the historical - cultural heritage and its safety**

*Researchers from the Technical University of Madrid (UPM) have collaborated with the Spanish National Research Council (CSIC) for the development of an innovative electronic system able to measure and monitor environmental acidity (pH) in the air. The acidity is responsible, in specific circumstances, of chemical attacks against materials and living organisms. The main characteristics of the solution (tested in real environments) are the low cost of production, not-energy consumption and minimum installation requirements. Initially developed as a solution for conservation of the historical - cultural heritage, the system has potential applications in the chemical, food processing and environmental industry, among others.*

Technology solution supported by the Technical University of Madrid

### Technology solution

The solution is a portable electronic system for automatic determination of environmental acidity (pH) in any state of matter, liquid or solid damp and also gas (e.g. air).

The data capture component is based on the technology of sol-gel optical sensors capable of assessing environmental conditions of acidity. This optical response is measured by reading units, quantified and converted to an electrical signal that can be processed to monitor optimally and remotely, environmental acidity.

Compared to conventional systems, the proposed sensor system is a global pioneer in measuring the pH in the air in both open and closed environments.

### Areas of application

- ICT applied to the environment and energy efficiency
- Environment and health

*"The application of innovative technologies for cultural heritage preservation is key to ensuring cultural tourism, which in Spain attracts 7.5 million foreign visitors and generates more than 6,000 million euros in revenue"*



## Market demands

- Increasing greenhouse gas emissions (CO<sub>2</sub>, SO<sub>2</sub> ...) from engine combustion or industrial processes: Total emissions for 2010 were 30.6 Gigatonnes, 5% higher than the previous record year in 2008, according to an International Energy Agency
- In combination with the ambient humidity, the acidity generated can attack materials and living beings in the form of acid rain for example. In urban and industrial environments, environmental acidity (pH) is especially dangerous, with values distant from the neutral value 7.0.
- Environments generally not controlled due to installation complexity and lack of specific means.
- Much of the materials with historical and heritage interest (metals and alloys, glass, textiles, organic ...) are especially sensitive to polluted environments, as well as emissions of certain materials of the windows or exhibitors.
- In recent years, the deterioration of the properties of historical and cultural heritage has been accelerated by the increased pollution and the lack of preventive maintenance systems.
- In other industries, such as food processing, chemical, fish farming, water treatment or security, productivity and safety levels are in danger due to a lack of effective environmental control.

*“The Spanish heritage is one of the largest reserves of cultural capital of the world, comprises a stock of physical goods only comparable to that of Italy or France”*

## Market potential

- Public and private investment in the field of conservation and management of cultural and historical heritage amounts to 1,864 M € in 2004 (0.22% of GDP) [Fundación Caja Madrid]
- Tourism contributes 5% of the world's GDP and almost 12% in the Spanish GDP. [World Travel and Tourism Council]
- Spain is the 2nd country with the largest number of property declared as World Heritage Sites. [UNESCO]
- 89% of the motivations of the cultural tourism are based on heritage tourism (museums, historic areas ...). [European Association for Tourism and Leisure Education]
- Conservation & Restoration Subsector of artistic heritage in Spain consists of 44 specialized enterprises, with a turnover of 205 M € in 2008, and more than 600 enterprises indirectly. [ARESPA].

## Competitive advantages

- Innovative device capable of measuring the environmental pH in the air, both open and closed environments
- Low cost sensors (cost price € 0.1) mechanically simple and with minimal installation requirements
- No power supply required: ability to monitor for long periods of time or in remote environments.
- Small size: the base where the sensor base material is placed is 30x25 mm. It is possible to miniaturizing
- Chemical and thermal stability (-5/60 ° C)

## References

- Multidisciplinary successful collaboration between the CSIC and the UPM
- Solution validated in various buildings and heritage sites (eg. Wilanów Royal Palace in Warsaw, 3,200 m<sup>2</sup> of documentary of Tomás Navarro Tomás Library – CSIC; CSIC Headquarters; Church of the Holy Spirit in Madrid, etc..).

## IPR

- National patent granted (ES2373138 )

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Solution contact

Guillermo de Arcas, Eduardo Barrera, Juan Manuel López  
e: {g.dearcas, eduardo.barrera, juanmanuel.lopez}@upm.es

### UPM contact

Innovation, Commercialization and Entrepreneurship Area  
Centre of Support for Technological Innovation – UPM  
e: innovacion.tecnologica@upm.es

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# Glottex®: your voice treats you, your voice identifies you

## Innovative biometric application for the early detection of voice pathologies and security

Glottex Voice Analysis System® is an advanced voice analysis product for the biometrics identification, result of over 15 years of R&D of a team from the School of Computing of the Technical University of Madrid.

In its health version, is currently applied for the early detection of pathologies voice and laryngeal cancer, as well as medical treatment and rehabilitation, in different hospitals in Madrid. Another line of development with high-impact is based on the identification of initial symptoms of neurological diseases such as Alzheimer or Parkinson. Moreover, and as a security application, Glottex is used by one of the Spanish security forces for forensic identification by voice.

### Technology solution supported by the Technical University of Madrid

#### Technology solution

Glottex Voice Analysis System®, Glottex onwards, is a software application for advanced analysis of the voice and the determination of the sample closest to the biometric voiceprint.

This new solution identifies, with much more reliability, unique voice characteristics distinguishing those derived from the vocal tract (pharynx, oral cavity, nasal cavity) from those of the excitation source of the voice. Glottex is able to assess and extract unique physiological parameters from the glottal source - part of the larynx that is limited by the vocal cords and whose vibration generates the voice - .

This represents a unique technological solution able to identify early detection for voice pathology, its treatment or even identify a person biometrically

#### Areas of application

- **Health:** support for the early detection of voice pathologies, including larynx cancer symptoms or neurological disorders.
- **Security:** forensics, biometrics for user identification and verification.

*"Glottex is able to determine the closest voice print from the glottal waveform"*



## Market and social demands

### ▪ Health

- Voice disorders affect 5% of the world population, with a higher incidence among young people and professional groups dependent on the use of voice. Early detection is a key factor for treatment.
- Laryngeal cancer affected 150.000 persons in 2008, with a very out-standing degree of mortality and incidence increasing (Spain, at the top European level). The hoarseness of voice is one of the main symptoms of this cancer.
- According to the World Health Organization, an estimated population of 6.8 million people worldwide dies each year as a result of neurological disorders.

### ▪ Security

- Global interest increasing for trustworthy biometric solutions and of difficult impostation (new and sophisticated threats for the safety).
- The safe management of digital identity is critical in numerous niche markets, with sales volumes rising (e.g. mobile banking).
- The security and intelligence departments analyze conversations related to crimes with increasing frequency. Nowadays, it is more difficult to identify suspects with traditional methods.

*“It is well known the growing demand for biometric technologies to ensure reliability and low cost of implementation. Remote voice identification is getting maximum attention”*

## Market potential

### ▪Health

- Demand for new innovative and low-cost methods for diagnosis diseases.
- European medical technology industry (2007): € 72.6 billion sales revenues; 15% annual growth rate [Eucomed].

### ▪ Security

- The turnover associated with voice biometrics is doubled in the period 2011-2014. This year, it is expected a volume of \$ 260 million market with a market share growth of 16% [Opus Research].
- Innovative technological advances have relaunched the evolution of forensic research sector through a better cost.
- The market for forensic products and services in the U.S. represent \$ 10.3 thousand million [BCC Research].

## Competitive advantages

- Support for reliable and early detection of voice pathology through a pioneer analysis based on scientific and technological advances.
- R&D ongoing that could allow identify early symptoms of neurological diseases prematurely.
- Low cost of implementation in health systems: software customizable, no specific hardware requirements. 50% savings cost per patient (estimations made by medical professionals that already use Glottex).
- Non-invasive diagnostic technique, fast and without side-effects for the patient. 50% savings in time per patient (estimations made by medical professionals that already use Glottex).
- Maximum reliability in biometric identification of people.
- Very simple and low cost incorporation to the already existing voice equipment.
- Biometric technology enabling remote authentication.
- Positive market research regarding the acceptance of biometric technology users.

## References

- Hospital Universitario Gregorio Marañón de Madrid.
- Guardia Civil – España.

## IPR

- Patent granted ES2364401 (OEPM-Spain) and international patent application (PCT/ES2012/000137)
- Registered software M-006038/2008 by the Technical University of Madrid.

## Development stage

- Concept
- R & D
- Lab-Prototype
- Industrial Prototype
- Production

### Glottex contact (spin-off BiometroSoft )

Pedro Gómez Vilda, Victoria Rodellar Biarge  
e: pedro@pino.datsi.fi.upm.es

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation –  
UPM  
e: innovacion.tecnologica@upm.es

# Ophthalmologic Kit: reducing risks in the retinal detachment treatment

Patented ocular device that optimizes the accuracy of retinal detachment surgical operations, reducing risks and improving patient well-being

*A research group of the Center of Biomedical Technology (CTB) at the Technical University of Madrid (UPM) has developed an innovative solution to improve the efficiency of the retinal detachment surgery, both potential medical costs resulting from the treatment and patients welfare, in collaboration with researchers and doctors of University Hospital Ramón y Cajal, Universidad Autónoma de Madrid and the Biomedical Research Networking center in Bioengineering, Biomaterials and Nanomedicine. Applying nanotechnology in the field of biomedicine, this patented device has already been successfully tested in animals with a success rate over 80%, proving the expected benefits in terms of reducing the likelihood of new surgical operations, side effects and post-surgical recovery time. The global market for ophthalmologic surgical equipment is expected to increase to 7.300 M€ in 2014, an average compound annual growth rate of 6% during the last few years.*

Technology solution supported by Universidad Politécnica of Madrid

## Technology solution

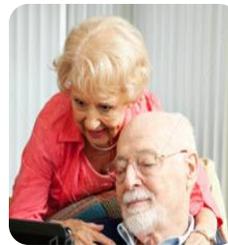
This solution provides a magnetic ocular implant, a ferrofluid and a methodology for using in the retinal detachment treatment and other eye disorders. Magnetic nanoparticles, which remain in suspension in this ferrofluid, are used as a tamponade agent after their intraocular injection and location in the outer layer of the eye through magnetic field.

The appropriate dosage and introduction of ferrofluid, which interacts magnetically with the implant, allows a more reliable and adequate arrangement of the retina after its detachment, reducing risk of side effects and additional operations and shortening the post-surgical recovery time.

## Areas of application

▪**Health:** ophthalmology; surgery; biomedicine and bioinstrumentation; veterinary medicine.

*A new worldwide ocular device applying nanotechnologies to improve both retinal detachment surgery performance and patient welfare*



## Market demands

- The rapidly population aging leads to a fast population growth over 65 years, the sector with the highest incidence of eye diseases and disorders [BBC Research].
- High incidence of retinal detachment (epidemiological approaches indicate one case per 10.000 population per year): this surgical operation is one of the most common ophthalmological procedures.
- Around 50% of these cases need to have a second surgical procedure.
- Need for specific and uncomfortable patient positionings during the most common surgery: eye incisions for the retina reattachment and later injection of substance for sealing off the hole after detachment.
- Alternative solutions (gas or silicone retinal tamponade agents after surgery) have significant side effects and could lead to medical complications: risk factors for retinal re-detachment because of a very specific rehabilitation protocol in terms of patient positionings.

*“Ophthalmologic procedures require millimeter precision and are needed for real advances in the surgical equipment... a healthcare industry that would reach 7.300 M€ in 2014”*

*“Innovation Award in 12th EURETINA International Congress (Milan, Italy)”*

## Market potential

- Changing trends in diets, lifestyle, and increased longevity are growing the global market for ophthalmic devices and treatments: it is expected to reach 28.000 M\$ in 2016, with a compound annual growth rate (CAGR) of 2.5% until 2016. Surgical procedures currently represents a leading division for this industry [GBI Research].
- By 2014, ophthalmic surgical equipment industry would be valued at 7.300 M€, a CAGR of 5,9% [BCC Research].
- 3 priority healthcare areas impacted by this solution: electromedical and medical technology; medical and surgical materials; and prostheses and implants.
- In Europe, medical technology market size is estimated at 100 B€, employing 575.000 people and being driven by 25.000 medtech companies, the majority of which, around 95%, are small and micro-sized companies [Eucomed and EuroStat].

## Competitive advantages

- Increase retinal detachment surgery and other eye disorders treatment success rate: medical and surgical equipment cost savings.
- Increase patient comfort and safety after the operation: higher tamponade agent placement accuracy in the retinal detachment area and lower risk of side effects such as cataracts or inflammation.
- Device already tested in animals with a success rate over 80%.
- Additional use as a surgical aid auxiliary (subretinal fluid drainage).
- Ability to place other substances into the device (drugs, proteins ...) in order to shorten the patient recovery time or protect him from infections.

## References

- Top level multidisciplinary collaboration in the field of medical engineering: Center of Biomedical Technology (CTB)– UPM, University Hospital Ramón y Cajal, Universidad Autónoma de Madrid and the Biomedical Research Networking center in Bioengineering, Biomaterials and Nanomedicine.
- Innovation Award EURETINA 2012 (12th EURETINA International Congress, Milan, Italy).

## IPR

- Patent granted ES2370014 (OEPM-Spain), 2012.
- International patent application (PCT/ES2012/070474).
- Patent application at USA patent office 13/534,583.

## Development stage

- Concept
- R & D
- Lab-Prototype
- Industrial Prototype
- Production

### Ophthalmologic Kit UPM contact

José Javier Serrano Olmedo  
Center of Biomedical Technology (CTB)– UPM  
e: josejavier.serrano@upm.es  
w: <http://www.ctb.upm.es>

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation –  
UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

## Tracheo4Life, highest reliability for emergency tracheotomies

Device for tracheotomies assisted performance, both emergency and elective ones: life-saving surgical operations and patient safety

*Complications and mortality associated with tracheotomy are mostly avoidable if the procedure is carefully performed. Post-tracheostomy complication rates are found to be significantly higher in emergency tracheotomy than in elective one (2 or 5 times higher). In these situations, patient's condition could be a critical difficulty for surgical operation because of patient's anxiety and sudden movements.*

*Tracheo4Life combines in a single device imaging systems for a medical diagnosis and mechanical means for patient's immobilization and the subsequent precise incision in the trachea, according to the anatomical characteristics of the case. This innovative device has been the result of multidisciplinary cooperation between a research team from the Technical University of Madrid and health-care professionals from Universidad Autónoma de Madrid.*

Technology solution supported by the Technical University of Madrid

### Technology solution

This solution provides a new device for performing tracheotomies, both emergency and elective ones, which enhances the effectiveness of the surgery and patient's safety, particularly in those situations requiring a faster medical operation.

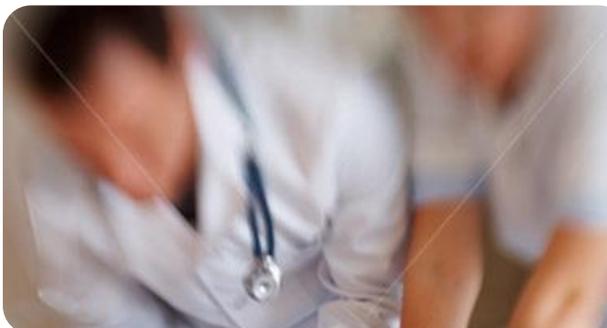
To this end, the device includes:

- an image processing system for medical diagnosis and most suitable placement of tracheal incision;
- mechanical devices to prevent patient's neck area from moving;
- mechanisms for an effective tracheal incision in order to maintain an effective airway, and;
- a control unit for information processing for the purpose of adapting medical procedure to patient's anatomical characteristics.

### Areas of application

- **Health:** medical devices for assisted surgical procedures (tracheotomies).

*“Tracheo4Life combines medical imaging systems, an effective stabilization method of the patient, a precise mechanism for the tracheal incision and a control unit in a single device”*



## Market and social demands

- Around 10% of mechanically ventilated critically ill patients receive a tracheotomy to facilitate prolonged airway and ventilatory support.
- Complication rates associated with tracheotomy have been reported to range from 15-40%; the mortality rate related to tracheotomy is reported to be less than 2%. Mortality is caused, among other factors, by the blockage of the tube to be inserted or its displacement.
- Complications and mortality associated with tracheotomy are mostly avoidable if the procedure is carefully performed. Post-tracheotomy complication rates are found to be significantly higher in emergency tracheotomy than in elective one (2 or 5 times higher).
- Urgent tracheotomies:
  - Urgent tracheotomies can not be usually performed in controlled environments, with the patient under local anesthesia. The awake patient could contribute to this topic negatively, as the patient's anxiety and movements challenge the whole surgeon.
  - The risk of pneumothorax is highly increased in patients with abnormal work of breathing.
  - Urgent awake tracheotomies imply the necessity of fast and simple techniques, that may be easily learned and performed with minimal assistance.



***“Tracheo4Life represents an essential advance to improve the reliability of emergency tracheotomies, such a critical***

***surgery in terms of complications and patient safety”***

## Market potential

- Global respiratory care equipment and supplies market is estimated to reach \$11 billion by 2017, growing at a CAGR of 8.8% from 2010-2015. The therapeutics devices market dominates the global respiratory care market, followed by monitoring devices and disposables, including tracheotomy devices [Global Industry Analysts Inc.]
- USA, Western Europe and Japan dominate the world's consumption of medical devices (USA, 41%) [Frost].
- Many emerging markets are witnessing annual medical device consumption growth rates of 15-20% (China, India, Brazil, Mexico), while most established markets are stuck at growth rates between 5-7% [Frost].

## Competitive advantages

- The combined application of medical imaging tools with medical procedures set to the patient's characteristics, provides a solution that minimizes the risks associated with emergency tracheotomies, a feature not offered by commercial devices being marketed nowadays.
- Compact, easy to use, accurate and safe:
  - tools for providing a previous diagnosis that fits the path of the cannula and the incision to the patient's anatomy;
  - elements for securing the placement of the device on the patient's neck, clavicles and upper chest, enabling patient immobilization;
  - a portable medical imaging camera that contributes to the diagnosis and the execution of the diagnosis: a medical probe should be held to the patient's neck to define the location of the tracheal air column and the tracheal rings, as well as arteries, veins and other anatomical structures of the neck;
  - a control unit to manage the information provided by the camera in order to analyze patient anatomy and set properly some factors related to the incision procedure through control signals.

## References

- Multidisciplinary cooperation between top researchers and health-care professionals.
- UPM research team, co-inventor of other 7 patents, including results in the health sector.

## IPR

- Patent pending ES2387667 (OEPM-Spain).

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Tracheo4Life UPM contact

Andrés Díaz Lantada, Pilar Lafont Morgado, José Alberto Jaén Gallego

ETS Ingenieros Industriales – UPM  
e: [adiaz@etsii.upm.es](mailto:adiaz@etsii.upm.es) (Andrés Díaz contact)

### UPM contact

Innovation, Commercialization and Entrepreneurship Area  
Centre of Support for Technological Innovation – UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

# D-HOUSE: the co-management of diabetic patients

Technologies and process-centred approach are facilitators to enable better diagnosis, treatment and management for Patients Across the Continuum of Care

The Life Supporting Technologies group of the Technical University of Madrid (UPM) has developed an innovative solution that supports the integrated management of diabetes, in collaboration with the Technical University of Valencia and Medtronic Iberica. The solution was tested in a clinical exploratory study, in 4 clinical centres with 51 patients and 24 care professionals. It focuses on the improvement of diabetes disease management by providing patients and medical doctors with a technological platform to help them handle and analyze all information related to diabetes treatment, integrating it with patients' lifestyle data. The platform is arranged for interoperability and data transfer among different monitoring devices, based on shared semantics. Applications are running in Smartphone, Tablet and Home PC and are personalized to different profiles, supporting monitoring, education and HC communication functionalities. The added value and effectiveness of the integrated system as a whole is more performing than its beyond the use of its components separately, in terms of detection, delivery of care and adopted strategy.

Technology solution supported by the Technical University of Madrid

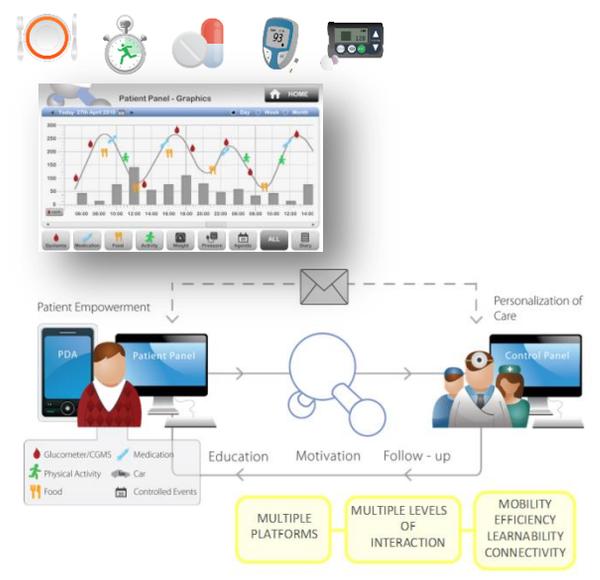
## Technology solution

The solution provides a framework for diabetes disease management implemented in a technological platform. Treating professionals and patients are provided with applications running in multiple platforms and with multiple levels of interaction, depending on their profile. Population triage and stratification are implemented. American Diabetes Association guidelines have been transformed in a structured Professional Control Panel for patient monitoring, education, treatment prescription and follow-up activities. T1D and T2D patients are provided with tools to enable self-management, disease and healthy habits awareness. Few solutions are as much as comprehensive as the proposed one and the healthcare sector (the private, especially) is now demanding these tools.

## Areas of application

- ICT applied to Health care and personalized care

*D-House addresses the need of health practitioners to implement more effective care provision, and empower patients in being co-producers of their own care.*



## Market demands

### Healthcare Sector (HC sector)

- Diabetes is one of the most important disease. By 2030, 550M people will suffer diabetes [WHO]
- The HC sector is evolving to new models were private-public collaborations, patient-centric care, prevention of onset and complication and health education are needed.
- Investments in HC technologies and consumer electronics including HC-like services have been exponentially growing
- Mobile health monitoring is one of the ten top applications in 2012 [Gartner]

*“Health is a process not just an outcome: Diabetic patients must be followed along all the whole process and must recognize their role and that of the healthcare system in each stage”*

## Market potential

### HC Sector

- 2.834€ is the average cost of T2D in Europe, representing 55% of HC cost [Code 2 study].
- 67M\$ overall cost in NHS Europe (IDF Atlas 2007) and 23M years of life lost per annum to disability and reduced QoL.
- Hospitalization is a major determinant for costs (T2ARDIS study) and usually is linked to complications
- Cost profile high at diagnosis and at complications onset.
- Loss of productivity may cost more than NHS direct costs [WHO, 2002].
- Mobile Health monitoring is one of the ten top applications in 2012 [Gartner].

### Target

- 20-59yy (active population, technology friendly): 46% of diabetic people [Internet World Stats].
- 286M in EU (46%) mobile broadband subscribers, growing at a 7%-9% ratio each year [Distimo Report January 2011]

### Diabetes Care devices market

- \$10.9 billion in 2009 with a Compounded Annual Growth Rate (CAGR) of 10% in period 2009–2016
- Forecast for year 2016: \$18 billion [GBI Research, January 2010].

## Competitive advantages

- Completeness and at the same time the adaptability of the solutions
- Clear and assessed scientific background
- Independence from proprietary solutions in favor of interoperable developments
- Low costs SW application
- Validated in a exploratory study with 51 patients and 24 care professionals. Usability, User Acceptance and Satisfaction, Technical Feasibility have been assessed (more than satisfactory results). Clinical trends have been detected at a preliminary stage.
- Depending on the user and on level of the disease, we offer specific tools and solutions, encompassing education, monitoring and follow-up in “light” and “deep” modalities.
- Positive feedback was received when the paradigm and its application have been presented to potential clients and stakeholders.

## References

- The project was evaluated with the maximum note (“Excellent”) by the expert panel nominated by the European Commission.
- Top level multidisciplinary collaboration in healthcare and technology: Medtronic, Healthcare Agency of Modena, Univeristy Hospital of Parma, Hospital Clínico de Madrid and Charles University Hospital of Prague.
- Solution will be further tested with other centres, among them Associação Protectora dos Diabéticos de Portugal.

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Contact D-House

Giuseppe Fico  
e: [gfico@lst.tfo.upm.es](mailto:gfico@lst.tfo.upm.es)  
María Teresa Arredondo  
e: [mta@lst.tfo.upm.es](mailto:mta@lst.tfo.upm.es)  
Life Supporting Technologies (UPM)  
w: [www.lst.tfo.upm.es](http://www.lst.tfo.upm.es)

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

# Mood Monitor: telemonitoring platform to assess mood disorders

## Mobile app and wearable sensor to remotely assess mood status and empower patients with mood disorders

*Life Supporting Technologies designed and developed a solution for the assessment and prediction of the mood status of persons with unipolar (e.g. major depression) and bipolar disorder. The system gathers subjective and objective data to estimate the evolution of the mood status; the patient is empowered by a set of tools that improve the therapeutic alliance with the health professional.*

Technology solution supported by the Technical University of Madrid

### Technology solution

The solution provides a tools to improve the therapy and the follow up of patients with unipolar and bipolar disorder. The end users use a Smartphone application (Android based) to record voice information (speech ratio, harmonies of the voice), report the mood status (questionnaires, mood scales), the medication intake and the daily habits (diary). The phone is connected with a wearable sensor that during the day monitors the level of energy and during the night the sleep quality. The concept provides support to the patient by providing a set of useful tools to communicate with the therapists, check the medication, mood charts and reminders. The Smartphone app also provides psycho education support (via personalized messages, educational content and goal settings support). A Web cloud service provides the access to this information to the health professionals and they remotely assess the mood status and prevent relapses or mood swings. The powerful visualization tools, the prediction tools and the alert systems enrich the user experience of the professionals to have a more clear understanding of patient situations. The solution is fully flexible and adaptable for several typologies of subjects: every module (e.g. medication tools, sleep monitoring, questionnaire) could be customized according to patient's condition.

*"State of the art solution to assess mood disorder; a cost benefit solution to improve the therapy alliance, the disease management and the patient empowerment"*



### Areas of application

- Health: personalized health system for affective disorders; tele psychiatry; eHealth, mHealth

## Market demands

- The major mood disorders, unipolar (UP) depression and the bipolar (BP) disorders (both BP I and II expressions) have high lifetime prevalences and impact on individuals' ability to function. In 2012, the World Health Organization (WHO) ranked depression as the leading cause of mental health disability world-wide, affecting some 121 million people.
- Much of the economic burden of mental illness is not the cost of care, but the loss of income due to unemployment, expenses for social supports, and a range of indirect costs due to a chronic disability that begins early in life.
- Approximately 20.9 million American adults, or about 9.5 percent of the U.S. population age 18 and older in a given year, have a mood disorder [Archives of General Psychiatry, 2005].
- E-health services provide treatment and support to people with mental health disorders through telephone, mobile phone, computer and online applications, and can range from the provision of information, peer support services, virtual applications and games, through to real time interaction with trained clinicians. The treatment of mental health disorders through traditional techniques such as cognitive behavioral therapy has been shown to be effective in an online environment for high prevalence conditions.

*"There is medical evidence of benefits of tele psychiatry and monitoring programs to promote and support mental wellbeing"*

## Market potential

### Spanish health care

- Public funding of mental costs in this area are 3% less than the EU trends respect to the public cost of healthcare system. The innovation investments has been cut of the 8% in the 2013, but still there are opportunity of innovation in the hospitals where psychiatry department has active research and innovation programs for tele psychiatry services. The private healthcare system and the pharmaceutical industry could be another market to exploit.

### Mobile application (mental wellness app)

- The exponential grow of the Smartphone technologies opens new opportunity to build a new sustainable model of health care. GSMA predicts that in future mobile solutions of health can have a market of 6.9TR \$ and save globally 400BN \$ in the OECD countries [GSMA Mobile economy 2013].
- During the last 2 years the application market offers a plenty of solutions (Mood tracker, Mood Panda etc) but none offers a solution that enrich the patient's information by using a wearable sensor.

## Competitive advantages

- The system has been designed and tested involving real users.
- Small clinical trial (n=30) to measure the benefits of tele monitoring and remote mood assessment.
- Approval of ethical comité of Italy, Swiss and France
- High level of personalization of the telemonitoring routine.
- Personalization of the notifications / alarms for patient.
- Full data visualization on both side (patients and professionals).
- 8 years of experience in the design, development and validation of tele monitoring systems.

## References

This research was partially founded by the EU founded project PSYCHE (IST 247777). The key partners that contribute to the research:

- Università di Pisa and Milano (Italia).
- Smartex (company that produces the wearable sensor).

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Mood Monitor contact

Manuel Ottaviano  
e: mottaviano@lst.tfo.upm.es  
María Teresa Arredondo  
e: mta@lst.tfo.upm.es  
Life Supporting Technologies (UPM)  
w: www.lst.tfo.upm.es

### UPM Contact

Innovation and Entrepreneurship Area  
Centre of Support for Technological Innovation – UPM  
e: innovacion.tecnologica@upm.es

## TELMA: a new technology enhanced learning environment for Minimally Invasive Surgery (MIS)

Exploitation, enrichment and efficient management of surgical video allows the development of Telm@, a new MIS (minimally invasive surgery) learning environment based on web technologies

*The solution presents a training and on-line learning environment based on laparoscopic video edition, knowledge management and collaborative work to improve the effectiveness and efficiency of surgeon's training process (both initial and ongoing). Telm@ supports the optimization of the trainee's learning curve, while providing surgeons ubiquitous access to didactic contents and methodologies and allowing them being more active and developing greater interactivity, a greater acquisition of knowledge and skills as well as a better use of the information sources available. The solution will reduce direct training costs and indirect health care costs associated with hospital stays and postoperative complications..*

Technology solution supported by the Technical University of Madrid

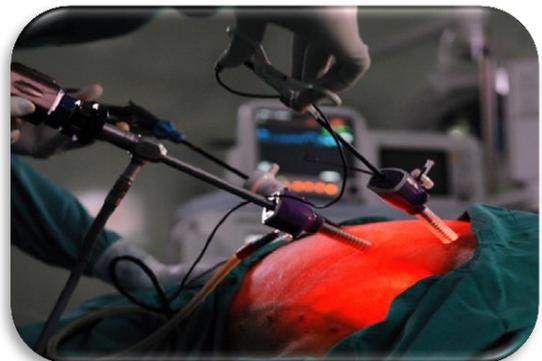
### Technology solution

The paradigm shift that is assuming the introduction of the MIS in clinical routine requires a change in the patterns of training new professionals.

Telm@ has created a new training strategy based on knowledge management, cooperative work and information and communication technologies in order to improve the effectiveness of the training process (initial and ongoing) of surgeons.

A new learning environment based on web technologies has been developed, providing a custom learning service to users and allowing them to create, share and reuse didactics contents in compliance with specific learning needs. For the above reasons, the use of the laparoscopic video is at the core of the didactic contents, adding them educational value by using an authoring tool tailored to the needs of surgeons.

*The environment enhances the didactic value of surgical videos by editing them, giving the user a more interactive role in their initial or ongoing training and fostering collaboration between users with different surgical experience.*



### Areas of application

- **ICT applied to health:** cognitive skills training in MIS.

## Market and social demands

### Initial training

- Society demands greater investment in training and raising awareness of doctors and patients about the MIS benefits, which will increase its safety use.
- It is critical the development of training methodologies and the effective transfer of skills from the training environment to the doctors, in order to standardize the training and accreditation in MIS..
- Society demands effective training programs, which take into account the complex stages in the training of surgeons. Currently, such training processes for new surgeons are very demanding, extensive and costly.
- During the early stages of training, teaching should focus on the acquisition of knowledge outside the operating room, so that patient safety is not compromised due to medical errors resulting from a lack of preparation.
- Training programs with objective assessment that provide feedback to students on their progress in the learning curve are needed.
- Nowadays there is a video repository of surgeries that are not used for doctors training but have great educational potential.

### Ongoing training

- Informal training for professionals who require little or no supervision.
- Fostering the exchange of knowledge among professionals for dissemination and training in new techniques of MIS.

## Market potential

- In western countries, 50% of revenues are due to possible complications and postoperative convalescence. The arrival of MIS techniques, with any or short hospital stay reduces the social and economic costs. In USA, a 10% of the 15 million annual surgical procedures are performed with these techniques. In Europe it is estimated that in five years a 25% of all operations will be carried out by MIS.
- Outpatients' facilities and university hospitals: only in Spain, more than 150 university hospitals is a unique niche market for the proposed solution.
- Specialized training centers: large training centers (CCMIJU, IAVANTE), with hundreds of students a year, which offer in classroom and long distance learning
- Medical & Surgical Associations: could be interested in offer to its members the training programs.
- Surgeons

## Competitive advantages

- Customized training: personalized learning content recommendation focused on training pathways linked to specific learning processes.
- Efficient management of knowledge: the solution monitors processes and interactions in the training environment, allowing the creation, capture, storage and distribution of information, turning it into reusable knowledge.
- Content management: content ingestion, automatic transcoding of new content to different qualities. Content retrieval based on medical thesaurus.
- Objective assessment of skills: the solution provides valid and reliable data about student performance automatically, instantly and objectively.
- Enrichment of surgical videos: the solution provides an authoring tool that allows the creation of educational content based on the editing and processing of surgical videos.

## References

- Pilot experience carried out in a training center for surgeons and a hospital in the Spanish National Health Service. Other hospitals interested in the solution.
- The Bioengineering and Telemedicine research team of the Technical University of Madrid has an extensive collaborative experience with industry in R&D projects.
- Innovation commitment: The Bioengineering and Telemedicine research team has been involved in technology transfer through patents and the startup of new technology based companies.

## Development stage

- Concept
- R&D
- Lab-Prototype
- Industrial Prototype
- Production

### TELMA contact

Patricia Sánchez, Enrique J. Gómez  
e: {psanchez, egomez}@gbt.tfo.upm.es

### Contacto UPM

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation –  
UPM  
e: innovacion.tecnologica@upm.es

## OAD (Objective Audiometric Diagnostic): the ultimate method to diagnose hearing loss in children

With only one test, get the real audiogram without the need of patient collaboration, easily, fast and precise, no matter the age.

*The electrical cochlear response to acoustic stimuli for both ears is registered by means of a couple of wet conventional electrodes on the neck and one more on the forehead. Several sound frequencies are tested ranging all the hearing frequency band so that the hearing loss is precisely noted. No need of patient collaboration is required for what it is very useful for children, even just born, cognitive unpaired people and even for forensics needs and for animals. The system offers a fully reliable data on the hearing in very few minutes and can be operated by low skilled users, without the need of a special echoless chamber, therefore dramatically reducing the test costs. It can offer more information than normal audiometry systems (recruitments, microseconds cochlear response delays, high frequencies for animals etc.) what makes it very useful for applied research on hearing. This solution has been developed by the Centre for Biomedical Technology of the Technical University of Madrid*

Technology solution supported by the Technical University of Madrid

### Technology solution

The cochlea produces some responses to the acoustic stimuli including acoustic emissions, electric potentials called microphonic signals, and evoked potentials in the brain cortex.

Otoacoustic emissions and brainstem auditory evoked responses are conventionally used as objective screening methods, and have well known limitations in hearing loss detection. The newest technique, semi-automated multiple auditory steady-state responses, needs further technological improvements.

Our solution, based on microphonic signals method, is the unique way to both perform a precise and objective *diagnosis*. Also, it allows to diagnose the loss of cochlea sensitivity to each sound frequency in between the edges of normal human hearing band.

### Areas of application

- Health and ICT applied to health and personal care, specifically :
  - Unresponsive patients: newborn and older children, cognitive unpaired people, even animals or patients for which the subjective method is not useful.
  - Forensics: objective determination of hearing loss at work or caused by accidents or diseases.

*"Our solution, unlike other, is capable to diagnose the loss of cochlea sensitivity to each sound frequency, which for children and unresponsive patients is not possible nowadays"*



## Market demands

### ▪ Children

- Even a mild or partial loss of hearing can affect a child's ability to speak and understand language. Hence, early diagnosis of hearing loss is crucial for the development of language, cognitive and psychosocial skills. However, until three or four years old, only objective screening methods are available with which it is not possible to obtain the required audiogram.

### ▪ Cognitive impaired & older people

- Studies suggest that elderly people with compromised hearing are at risk of developing cognitive deficits — problems with memory and thinking — sooner than those whose hearing is intact.

### ▪ Assurance Companies

- Sometimes doctors are under the obligation to emit reports about hearing damages due to illness or accidents, that generally will determine economic lendings or recongnition of discapacity. Objective test is needed independent of the opinion of employees, chiefs or governments.

*“Our solution offers audiometric objective diagnosis in cases in which only screening is possible nowadays, in very few minutes and in a cost-effective way”*

## Market potential

- More than 360 million people in the world have disabling hearing loss, according to the World Health Organization (WHO). One in three people over the age of 65 years (a total of 165 million people worldwide) have hearing loss.
- Hearing loss is strongly associated with aging, rapid growth in older population groups will cause the number of persons with hearing and balance impairments to increase markedly.
- In Spain, there are about one million people affected by hearing impairment (INE , 2000). Five out of every thousand newborn children have varying degrees of hearing loss (CODEPEH, 2000), and three of them will need prosthesis that should be prescribed as soon as possible.
- Without programs for early detection of congenital hearing loss, the average age of diagnosis is around three years old in the EU and USA, so these programs are needed to prevent future disturbances in language acquisition.
- The trend is to perform hearing screenings on all newborns allowing detection of infant hearing loss within the first month of life and diagnosis at 3 months to begin treatment as sooner as possible.

## Competitive advantages

- The diagnosis is possible in cases for which now only screening are possible. So, therapeutic strategies like the use of audiphones are early possible, enlarging the market.
- The method is objective so minimizing the possibility or errors and the need of bothering the patients with a second diagnosis.
- It is robust and easy to use, avoiding the need of very skilled operators and echoless chambers, what reduces the overall costs.
- Even more, the path from the diagnosis to the audiphone calibration for a patient can be almost automatic, reducing time and costs to adapt the prosthesis, bettering the experience of patients.
- Objective diagnosis will simplify the trials because no doubt is possible about the hearing loss, making easier and cheaper certain insurance policies and overall insurance costs.

## References

- The Centre for Biomedical Technology brings together researchers from different disciplines on biomedical technologies in order address major challenges in Biomedicine and Health R&D
- Commitment to the development of biomedical technology and its transfer to the industry

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### OAD UPM contact

José Javier Serrano Olmedo  
Center for Biomedical Technology  
e: josejavier.serrano@ctb.upm.es

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: innovacion.tecnologica@upm.es

# Artificial Pancreas: advanced control of blood glucose

## Automatic control of blood glucose levels in diabetes patient

The Technical University of Madrid, in collaboration with the Sabadell Hospital, has developed an algorithm that automatically calculates the insulin dose that should be administered to a continuous subcutaneous insulin infusion or 'insulin pump', in order to maintain healthy blood glucose levels. The control algorithm has been evaluated with a group of patients during the night and has managed to increase by 340% the time in normal glucose levels (80-110 mg/dl), therefore avoiding hypoglycemia during the night. The insulin pump manufacturers are potential customers of this algorithm which could be integrated easily into these devices.

Technology solution supported by the Technical University of Madrid

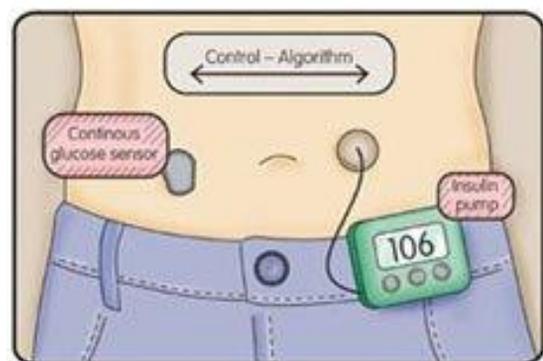
### Technology solution

The control algorithm could be included directly into a continuous subcutaneous insulin infusion or to an external device capable of communicating in real time with the insulin pump and a continuous glucose sensor.

The algorithm is based on rules and forecasting techniques. Its operation is customized for each patient allowing maintain blood glucose levels within normal limits.

Its use will prevent low blood sugar (hypoglycemia) and high blood sugar (hyperglycemia), especially during night, which is when patients have more difficulty recognizing the symptoms.

*"Automatic algorithm to maintain glucose levels within normal limits and minimize the risk of hypo-and hyperglycemia"*



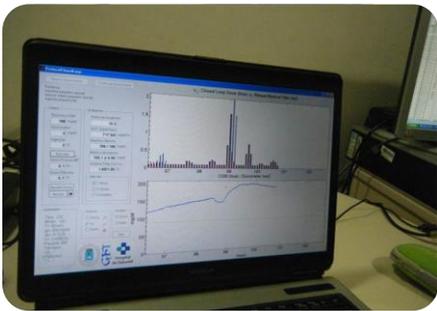
### Areas of application

- **Health:** technology manufacturers for diabetes care (insulin pump manufacturers).

## Market and social demands

- People with diabetes who use continuous insulin pumps generally have great freedom to adjust insulin to their routines and unexpected events, such as changes in mealtimes, food intake and quantities, physical exercise, disease states, stress, etc. all of which affect glucose levels.
- This fine adjustment of insulin requires knowing the blood glucose levels almost continuously but in a minimal invasive way. Nowadays, it is possible because there are commercial solutions which measure glucose every few minutes with a sensor implanted in the subcutaneous tissue.
- However, it is not easy for a patient to have a normal and quality life, if he must continually interpret his blood glucose profiles and make decisions about programming the insulin pump.
- The solution is the use of algorithms that can automatically control the insulin pump and to prevent hypoglycemic events, which is the greater risk in insulin treatment.
- Also it is important to avoid a continuous hyperglycemia over the years which could produce the loss of quality of life due to renal diseases, blindness, or amputations.

*“The artificial pancreas can prevent and avoid hypoglycaemia and the occurrence of complications in the future due to poor metabolic control”*



## Market potential

- The global market for insulin pumps:
  - 1,600 million € per year, and
  - 9% annual growth.
- In the U.S.A., there are approximately 500,000 patients with insulin pump, which implies:
  - an initial outlay of about 4.000€,
  - replacing in a period of five years,
  - 6€ daily costs in consumables.
- In Spain there are currently about 6,250 pump users, which represents 4% of patients candidates to use compared to 37% of patients with pump reached in U.S.A.

## Competitive advantages

- The control algorithm has been evaluated at the Sabadell Hospital with a group of patients during the night and has managed to increase by 340% the time in normal glucose levels (80-110 mg/dl), therefore avoiding hypoglycemia during the night.

## References

- The research group GBT-Bioengineering and Telemedicine of the Technical University of Madrid has been working in the technologies diabetes field for 25 years, specifically in monitoring in consult and through mobile devices, decision support and control algorithms.
- In the artificial pancreas research line, the research group has collaborated with Sabadell Hospital and Sant Pau Hospital in Barcelona. The team has published several papers and has participated in a European Union project and two other projects funded by Fondo de Investigación Sanitaria:
  - INCA: Intelligent Control Assistant for Diabetes (IST2011-37632). 2003-2005
  - PARIS: Intelligent artificial pancreas (FIS PI042466). 2005-2008
  - A PRIORI: Predictive Analytics for insulin adjustment and optimization of systems in closed loop control using intelligent algorithms (FIS PS09/01318) 2010-2012.
- The research conclusions were presented at the Annual Congress of the Spanish Society of Diabetes and are under clinical journal publication.

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Artificial Pancreas contact

M<sup>a</sup> Elena Hernando  
e: [mariaelena.hernando@upm.es](mailto:mariaelena.hernando@upm.es)  
w: <http://www.gbt.tfo.upm.es>

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

## GameCare: lose weight the healthy way

Customized solution for obesity treatment designed to help you lose weight in a healthy way through ICT in such a simple way that it will even seem like a game

*Life Supporting Technologies (LST) of the Polytechnic University of Madrid (UPM) together with healthcare professionals, has developed Gamecare, a virtual clinic based on intelligent systems that are able to monitor and control biological parameters and the user's diet information, with the aim of treating obesity. By applying innovative technologies, LST has achieved a low cost system that engages users. It also controls and supervises their activity steadily. Training modules and voice guidance have been validated with more than 30 users in a medical environment. The global market related to obesity in Spain is around 8% of the annual public health expenditure, therefore it is estimated that in 2013 the potential target market of Gamecare could grow up to 4,600 M €.*

Technology solution supported by the Technical University of Madrid

### Technological solution

The solution developed is an online clinic where the patient through virtual visits has the opportunity to follow the right method to treat obesity without having to commute.

This clinic is based on intelligent systems able to monitor and control both biological parameters and the patient's nutrition with the goal of losing weight.

By using different technologies the system can monitor the health of the patients and it is also able to engage them through games and achievements, as well as by means of social networks between doctors and patients. During physical training session, the doctor can control the patient in real time and he also has the opportunity to send supportive and motivational messages.

### Areas of application

- **ICT for health and wellness:** obesity; sport; healthy lifestyle; active aging.
- **Biotechnology:** smart textiles.

*A new solution that helps to lose weight in a fun way while playing games, with continuous monitoring of the patient by professionals in a full immersion of social network with experts*



## Market demands

- Obesity is considered the responsible for more than 3 million deaths per year worldwide. Obesity and overweight pose a major risk for developing chronic diseases, including type 2 diabetes, cardiovascular disease, hypertension and stroke, and certain forms of cancer. A total of 502 million people worldwide are obese and in the last 30 years the numbers have doubled; nowadays, more than 10% people are obese people. The World Health Organization (WHO) rates obesity as the pandemic of the 21st century.
- These 3 million obesity related deaths in 2010 is 3 times as much as the number of people who died due to malnutrition. The trend has been reversed, according to data collected over the past 20 years in the prestigious journal The Lancet report "Global Burden of Disease Study 2010".

***"This is a global public health problem. Obesity is one of the four risk factors responsible for a high number of global premature deaths: 3 million deaths related to obesity have been recorded in 2010."***

## Market potential

- In the International Congress of Nutrition Programs and Physical Activity for the Treatment of Obesity (PRONAF) it has been affirmed that the treatment of obesity reaches a total 8% of health expenditure in Spain, this is the main result of a pioneering study on obesity held in Spain for the past five years. The causes of the high spending are: the low physical activity and the poor nutrition that affects Spanish citizens.
- According to the Ministry of Finance, public health expenditure expected in Spain for 2013 is 57.042 M €, this is a budget that exceeds the GDP of countries like Bolivia, Iraq, Uruguay and Luxembourg.
- In accordance to these sources the potential market of Gamecare is 4,600 M € per year only in the Spain public sector.
- Potential clients are: healthcare centers, both public and private clinics specializing in nutrition and weight loss, as well as sports and nutrition organizations or professionals of the healthy food industry.

## Competitive advantages

- Pioneered development of the use of non-invasive textile sensors based on Continua Standards compliance interoperability with low-power technology Bluetooth 4.0: devices cost savings (50 € compared to 200 €).
- Training system and voice guidance validated with more than 30 users, getting an acceptance degree more than 95%.
- The use of games, personalised exercise with voice guidance and gamification in training sessions to support health care: users engagement.
- Realtime monitoring, management system of patients, creating custom rules (alerts, notifications...), feedback between doctors and users: continuous control and supervision.
- The use of social networks between doctors and users.

## References

- Life Supporting Technologies has been working for over 10 years in the areas of health and wellness. It has also been partner in several European projects on nutrition and wellness such as: WeightInfo, PIPS, HeartCycle.
- AmIRTEM: a functional model for training of aerobic endurance for health improvement. IEEE transactions on bio-medical engineering, August 2012 DOI: 10.1109/TBME.2012.2207953
- Aml System for Functional Assessment of Aerobic Endurance EMBC'11: 1st IEEE Unconference on Wearable & Ubiquitous Technology for Health & Wellness, Boston, August 30, 2011

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### GameCare contact

MT Arredondo, Eugenio Gaeta, Gloria Cea  
Life Supporting Technologies (LST) - UPM  
e: {mta, eugenio.gaeta, gcea}@lst.tfo.upm.es

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation –  
UPM  
e: innovacion.tecnologica@upm.es

## LST-Box: a box full of services for better living

LST-Box helps the older people to control home automation devices, monitor their health and stay in touch with family, caregivers and friends through social networks, in a customized and intuitive way

*Facilitating daily living of the older people through self care of health and diet, control of household devices and frequent communication with family members, caregivers and friends through social networks are the main functions of the LST-Box. This "service box", developed by Life Supporting Technologies group, is an ICT tool that connects various sensors and actuators to provide its functionality, and it can be accessed through television, mobile phone or computer both from within and outside the home. All this in a personalized way for the user according to his needs and preferences.*

Technology solution supported by the Technical University of Madrid

### Technology solution

The LST-Box solution offers a system composed of hardware with internet connection and Bluetooth which integrates three services specifically designed to facilitate daily life of the older people:

- KNX domotic control (includes security alerts),
- management of social networks (Facebook and Twitter) and self monitoring of health care, to track daily blood pressure, weight, medication and diet via Bluetooth connection to a blood pressure cuff and a scale.

These data can be shared with the primary care physician via email. LST-Box can be accessed through the television, computer or smartphone both within and outside the home. Services are offered in a personalized way, adapted to the needs and preferences of the user, in terms of its contents presentation and the way he interacts with them.

### Commercial application sectors

- **Health:** ICT applied to health and personal care; ICT applied to independent living and e-inclusion.

*"LST Box offers an independent living support system, integrating home automation devices with health sensors and social networks"*



(example of commercial set-top box)



## Market demands

- Need for improved technology approach to older people [Seniorwatch, 2008]. ICT solutions can prolong independent living for the older people and extend the time they remain active and safe in their everyday environment.
- The process of aging is leading to an increasing number of older people (aged 65 years or over) with various health problems such as hypertension, obesity, dementia, etc.. It is necessary that health and welfare systems are adapted to be more friendly to older people, through active promotion of health and self-care.
- The main fears of getting older are living with physical limitations (worldwide, more than 46% of people over 60 have a disability), having to depend on other people (the dependence increases with age) and feeling alone [INE].
- Loneliness is a common problem among the older people, and the fact of living alone is not always an indicator of loneliness. For senior citizens, social support is very important, especially when something bad happens.

*“The main fears of getting older are: living with physical limitations, depending on others and feeling of loneliness”*

*“...the solution is being tested on a pilot with 7.000 users in several European regions...”*

## Market potential

- At global scale, every second 2 people turn 60, which means that the annual total is almost 58 million people that turn 60. In 2012, 810 million people were 60 or older. It is estimated that the proportion will be 1 over 5 people in 2050. [Aging in the XXI Century, HelpAge Internacional].
- In Spain, 85% of older people have access to ICT solutions, 86,6% of people between 55 and 64 years old and almost 80% of people over 65 use mobile devices. This is a great market potential for assistive technologies[CENTAC].
- Regarding expenditure, people with disabilities invest, on average, 25% more in ICT solutions than the rest of the population, which is equivalent to more than 2.800 annual Euros– 9% of average expenditure per family unit. [EDAD].

## Competitive advantages

- Multiplatform: access to services through various devices (TV, mobile, tablet), vs. dedicated devices.
- Modularity: additional services and sensors can be installed, vs. closed, not modular systems.
- Configurable and personalizable solution, according to the user’s needs and preferences, providing high usability levels. Especially focused on older people (contents, user interface).
- Reduction of health and welfare services expenditure, thanks to the support on self-care and health status self-management (the system improves the accessibility at home and increases the older’s people autonomy): 80% of public health resources are assigned to chronic diseases management and it is estimated that managing these conditions through ICT solutions could help reduce around 15-30% of the expenditure. [CENTAC].
- The solution is being tested on a pilot with 7.000 users in several European regions.

## References

- Multidisciplinary research team (Life Supporting Technologies), with more than 10 years experience on solutions for health and wellbeing, and partner in cutting-edge projects in the area.
- Integrated with the Smart House Living Lab infrastructure, member of ENoLL (European network of Living Labs).

## Development stage

- Concept
- R&D
- Lab-prototype
- Industrial prototype
- Production

### LST-Box contact

Juan Bta. Montalvá, Viveca Jiménez, María Teresa Arredondo, María Fernanda Cabrera  
e: {jmontalva, vjimenez, mta, chiqui}@lst.tfo.upm.es  
Life Supporting Technologies  
w: www.lst.tfo.upm.es

### UPM contact

Innovation, Commercialization and Entrepreneurship Area  
Centre of Support for Technological Innovation - UPM  
e: innovacion.tecnologica@upm.es

# Biolasersports. Improved sports performance at the highest level

## System for biomechanical analysis of the athlete: real-time information to optimize competitive performance

Researchers from the Faculty of Sciences for Physical Activity and Sport of the Technical University of Madrid, in collaboration with the University Pablo Olavide of Seville, develops Biolasersports, a complete system of recording, analysis and interpretation of biomechanical data of the athlete in motion. Provides real-time critical information to the coach, able to optimize the performance in sports where technical efficiency depends on the velocity, such as football and athletics. Another important characteristic is its reliability in data collection, because the system is capable to integrate the movement of the athlete through a mobile laser system. In sports environments increasingly competitive, Biolasersports is an innovative breakthrough in the application of the latest technologies to the sport.

Technology solution supported by the Technical University of Madrid

### Technology solution

Biolasersports is a kinematic analysis system of competitions and sports training in real time.

Based on laser technology, a mobile platform on mechanical rails measures the instantaneous speed of an athlete along their displacement.

The biomechanical data captured are processed by a software, which record, analyze and perform an assessment of motor skills and sports technique (applied to distance traveled, speed and acceleration).

This accurate information, offered in real time, is very valuable to the coach, who will be able to use biomechanics science as a tool to improve sport performance.

### Areas of application

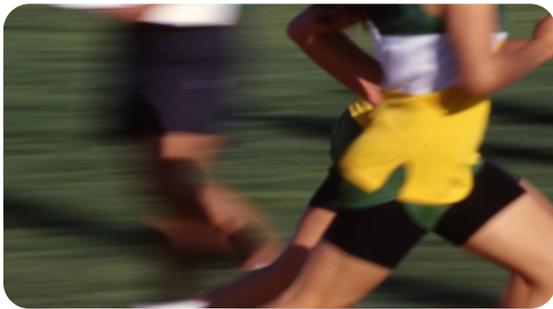
- ICT applied to health, physical and sports science, sports biomechanics.

*"Biolasersports provides key biomechanic data about the athletes and their movement during the race, for improving their performance"*



## Market demands

- The Sports Biomechanics is recognized as a key for improving athlete performance. Specifically, the study of the motion of bodies with respect to the speed of movement is critical for a big number of competitions.
- It is needed techniques of sports performance analysis in real time: immediate feedback to the trainer and athlete for effective decision making.
- Nowadays, laser systems are generally adapted and used for measuring the speed of movement, compared to classical techniques such as photoelectric cells or the use of video.
- Current solutions using laser technology to track the athlete require specific conditions to obtain reliable data which are not met in practice: rectilinear movements or without interposition of other elements during the measurement (interpositions probability occurs up to 40% of the measurements real).
- It is needed mobile measurement systems, adapted to the natural motion of athletes without interfering it.



## Market potential

- In Spain, sports industry is about 2% to GDP (9,000 million € a year of income), with a growth rate similar to the most dynamic sectors, such as new technologies. [Sports Council - Spain]
- In Europe, in 2010, this industry generated revenues of 63 billion € compared to € 213 billion worldwide, a decline of 2% from the previous year. [NPD Group]
- The main European markets in the sports industry are Germany (11%) and France (9%). Spain is the fifth (4.7%). [NPD Group]
- Potential customers for Biolaserports are the sports federations. Only in Spain there are 64 registered, among which those of athletics, basketball, handball and gymnastics have an annual budget over 5 million €. The football federation has a budget of € 86 million.

## Competitive advantages

- Industrial prototype done, optimization is needed.
- Technological support to the coach for improving effectively the performance of athletes.
- On time biomechanical results: without the data digitization needed in classic techniques of photogrammetry which are time-consuming.
- Application to any sport in which the race is critical to the performance (football, basketball, athletics, cycling, handball, gymnastics ...), both in competition and training.
- No affect the natural motion of athletes thanks to laser technology
- Software tools included for the interpretation of biomechanical data collected and its assessment: reference variables, historical ...
- Portable, lightweight and easy to assemble: adaptation to any terrain or sports court.

## IPR

- Patent granted in Spain (P200900134)

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Biolasersports Contact

Amalia Ferro Sánchez  
e: amelia.ferro@upm.es

### UPM Contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: innovacion.tecnologica@upm.es

# CardioRehab. A personalized system for cardiac rehabilitation at home

## Custom system for home cardiac rehabilitation for coronary heart disease patients

Life Supporting Technologies Group of the Technical University of Madrid (UPM), in collaboration with European partners, has developed a customized solution for home cardiac rehabilitation for patients with coronary heart disease who have suffered an acute cardiac event. The solution includes an application developed on a mobile device, a wearable sensor and a t-shirt, which monitors patients in real time while performing exercises previously prescribed by their doctor. Furthermore, the system also includes an application on a tablet that the patient can use from home to check their results and progress, receive information about his rehabilitation status, and access a full program of education and motivation. CardioRehab is complemented with an application for the medical professionals, in which data are collected during the exercise sessions of patients for analysis and monitoring. The solution has been validated by patients and healthcare professionals in a randomized trial, and has been used for 60 patients in three different European countries.

Technology solution supported by the Technical University of Madrid

### Technology solution

CardioRehab offers a technological solution for cardiac rehabilitation of patients with coronary heart disease who have suffered an acute cardiac event (e.g., myocardial infarction or coronary surgery). It includes a rehabilitation program that addresses not only physical exercise but also other aspects such as education and patient's motivation.

The solution consists of an application on a mobile device together with a wearable sensor and a t-shirt, which monitors patients in real time while performing physical exercise according to a plan of care prescribed by the doctor. A second application on a tablet offers patients continuous feedback on progress and evolution, as well as an innovative educational and motivational strategy focused on formal aspects of their disease, helping them deal with risk factors, and motivate them to follow a healthy style life.

CardioRehab also includes an application for medical professionals, in which data are collected from different patients for analysis and monitoring.

### Areas of application

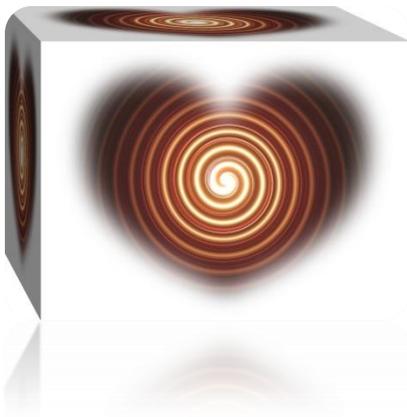
- Health: e-health (cardiology, cardiac rehabilitation, management of coronary heart disease).

*"Personalized system for cardiac rehabilitation at home based on ICT which includes a complete physical exercise program along with an innovative education and motivation strategy"*



## Market demands

- Coronary diseases is estimated to cost the EU economy almost €60.000 million a year, 31% is due to cardiovascular disease (CVD) [European Cardiovascular Disease Statistics 2012].
- Of the total cost of CVD in the EU, around 33% is due to health care costs, 29% due to productivity losses and 38% due to the informal care of people with CVD informales [European Cardiovascular Disease Statistics 2012].
- Several studies have shown that cardiac rehabilitation is beneficial for patients who have suffered a cardiac event.
- Cardiac rehabilitation reduces the likelihood of early death by 20% -25% and the risk of heart attack by 28%.



## Market potential

- In Europe:
  - Fewer than half of eligible cardiovascular patients benefit from Cardiac Rehabilitation in most European countries [European Cardiac Rehabilitation Inventory Survey].
  - Deficits include absent or inadequate legislation, funding, professional guidelines and information systems in many countries [European Cardiac Rehabilitation Inventory Survey].
- In Spain:
  - Every year, there is an average of 55.582 acute myocardial infarction and each of them has a unit cost of 14,069 Euros [Spanish Journal of Cardiology, 2012].
  - Cardiac Rehabilitation units have capacity to serve only 3% of the infarcted [SEC 2012].
  - Cardiac rehabilitation programs are recommended only 0.6% of high-risk patients who need care. Only receive rehabilitation 0.2% [SEC 2012].

## Competitive advantages

- CardioRehab is the first cardiac rehabilitation program based on ICT which combines aspects such as physical rehabilitation, and education and motivation strategies based on internationally recognized programs (such as the Heart Manual, NHS Lothian, United Kingdom).
- It has been validated with patients and healthcare professionals in a randomized trial with 120 patients in three European countries (Spain, Germany and the UK).

## References

- Multidisciplinary researcher group specialized on technologies for the health and well-being. More than 10 years collaborating with European partners of reference.

*“The system has been tested and its functionality has been validated by 120 patients and healthcare professionals in Spain, Germany and the UK”*

*“CardioRehab provides a low cost solution for personalized cardiac rehabilitation at home”*

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### CardioRehab contact

Cecilia Vera Muñoz; María Teresa Arredondo  
e: {cvera, mta} @lst.tfo.upm.es  
Life Supporting Technologies (UPM)  
w: www.lst.tfo.upm.es

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation –  
UPM  
e: innovacion.tecnologica@upm.es

commercial sheets  
UPM *innovatech*  
@ IT, Internet & Mobile

## DicComb: an application to write well

Web software application for the creation, management and support of combinatorial dictionaries from sets of documents chosen and managed by the user

*Writing reports of all kinds, court rulings, a translation, a diagnosis or medical report in a clear and unambiguous way, a language teacher choosing examples and best texts, a lexicographer building a dictionary and looking for representative examples, a journalist looking his best style... have on the bottom the same need. DicComb provides the ability to review material processed from existing documents to enable these people to choose the best way to write something between several proposals. DicComb stands for Combinatorial Dictionary, as this application is based on this kind of dictionary in which the user can manage and process own documents as often as the user likes and then build a customized dictionary and style guide.*

Technology solution supported by the Technical University of Madrid

### Technology solution

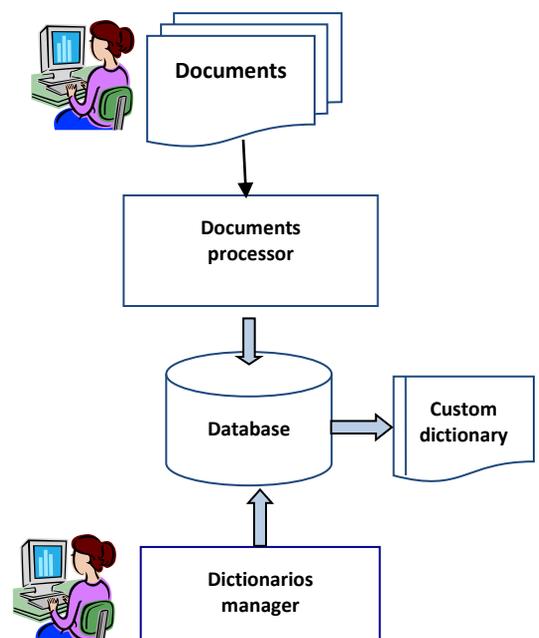
The product is available as a web application for using by subscription or installed in intranets, which includes the ability to upload amounts of documents in different formats (pdf, doc, docx and txt at least) to be processed (debugging, counting terminological term extraction, stemming) at rates exceeding 1.000 words/sec. The result will select either the combinations of words as the representative examples that a user would choose to build a corporate or thematic dictionary that supports copy-editing.

- **why is it different:** there is not a similar application in Spanish language (also in Portuguese and Russian, which are being analyzed to penetrate the market of these languages).
- **why is it innovative:** these tools, which do not exist at the moment, allow the standardization of production methods texts in any field.

### Areas of application

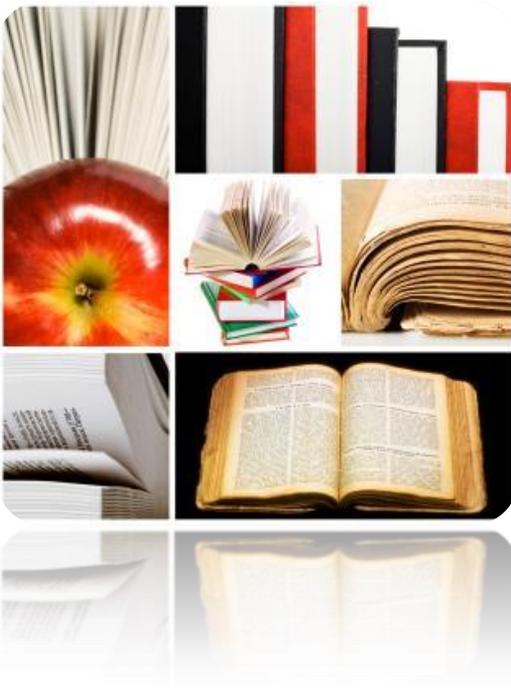
- **ICT for social sciences and digital content processing:** network and infrastructure services and digital content.

*"Let's combine the words accurately, rigorously and easily"*



## Market demands

- Processing of written texts properly, accurately and in less time, aimed to the following groups:
  - Judges and Lawyers (judgments, orders)
  - Medical / clinical (diagnostic reports)
  - Researchers (description of the language)
  - Language teachers (preparation of teaching materials)
  - Translators (finding the best expression)
  - Lexicographers (construction of dictionaries)
  - Editorials (definition of a style)
  - Journalists (normalization style)
  - Content providers
  - Writers



## Competitive advantages

- Reduce time and costs dictionary definition process.
- Increased accuracy and productivity in the drafting of reports and similar ones.
- Developing intuitive and user interfaces for users with less experience in combinatorial lexicography and dictionaries.
- Improvements in knowledge management processes in companies and institutions.
- Low implementation costs as web application.

## References

- Supported by UPM Validation and Business Applications Group: more than 20 years experience in this field and international contacts.
- DAIL spin-off creation for the market development (3rd prize in actúaupm competition 2011).
- Group elected in 1996 to represent the Spanish Language in the multilingual Internet project of the United Nations.
- Key group of UNESCO Chair in language technologies (in process of final acceptance).

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

## Market potential

- Some figures on the potential would be (pending better evaluation):
  - Lawyers: more than 1,600 law firms over 3 lawyers in Spain.
  - Teachers of Spanish (first language and as a foreign language): more than 18 million students of Spanish in the world.
  - Health care facility
  - Translators
  - lexicographers
  - Journalists
  - Editorials
  - Market analysis done to exploit the solution in Brazil.

### DicComb contact

Jesús Cardeñosa

e: [carde@fi.upm.es](mailto:carde@fi.upm.es)

Carolina Gallardo

e: [cgallardo@eui.upm.es](mailto:cgallardo@eui.upm.es)

w: <http://www.vai.dia.fi.upm.es>

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area

Centre of Support for Technological Innovation  
– UPM

e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

## GreenCPD: saving energy beyond the limits

### Application-aware and resource-aware holistic method and tools to decrease energy consumption in data centers beyond the state of the art

*GreenCPD provides methods and tools to reduce the total energy consumption pretty much below the available technologies in the state of the art. Unlike previous approaches, we use knowledge about the cooling and computing resources, as well as the applications, and the previous execution history to deliver non-intrusive proactive strategies for minimizing the energy requirements and, at the same time, to increase the reliability of the resources by avoiding thermal hotspots or thermal stress.*

*The green data center market is rapidly growing. By 2010 data centers consumed 1.3% of worldwide electricity use and produced 2% of total CO<sub>2</sub> emissions. Power density frequently exceeds 60 kW/m<sup>2</sup>. Many data centers already have a lack of power and cooling capacity to meet the needs of such high-density equipment. The flexible GreenCPD architecture will ensure continuous adaptation to present and future requirements, coordinating actions at different abstraction levels and multiple scopes to decrease the total energy consumption beyond the state of the art.*

Technology solution supported by the Technical University of Madrid

### Technology

Global strategy and tools to use multiple information sources and to coordinate decisions at different levels in the data center aimed at a common objective: reducing the total energy consumption.

Innovative components of the GreenCPD architecture include:

- Automatic energy characterization and classification of the workload.
- Optimal resource selection taking into account cooling resources, computing resources and the applications.
- Leveraging the heterogeneity of the data center to reduce energy consumption.
- Automatic application-aware management of resources, low-power modes, just-in-time compilation, etc.
- Enhanced reliability by avoiding failures due to high temperatures or thermal stress.

### Areas of applications

- **Energy:** energy efficiency
  - **Urban data centers:** non-intrusive energy optimization of existing data centers, optimal selection of new acquisitions, power outage avoidance, reliability enhancement.
  - **New state-of-the-art data centers:** energy optimization compatible and beyond the state of the art.

*"By taking advantage of the heterogeneity of the resources in the data center, the IT energy consumption can be reduced up to 30%."*



## Market needs

- By 2000 data centers used 0.53% of the world's total electricity consumption. By 2010 data centers consumed approximately 235.5 BkWh, representing 1.3% of worldwide electricity use.
- Due to the rapid growth of the data centers capacity, the power densities handled by their infrastructure and energy consumption have grown dramatically. The electricity bill, including computation and cooling costs, is over \$7 billion only in the US and the power density exceeds 60 kW/m<sup>2</sup>.
- According to Gartner, 50% of current data centers already have a lack of power and cooling capacity to meet the needs of high-density equipment. A survey of 369 IT professionals performed by OnStor reported that 63% of survey respondents have run out of power or cooling without warning.

Current data centers need:

- to take into account many different aspects at the same time in order to minimize the total energy consumption, as cooling is not dominant any more;
- to significantly decrease their energy consumption and their peak power needs to avoid power outages, specially in urban data centers during the summer;
- to apply reactive and proactive techniques to adapt the energy consumption to internal and external changes of requirements (peak load or outage avoidance systems of smart grids).

*“US data centers consume 1.5 times the electricity consumed by New York City.”*

*“Worldwide data centers produce 2% of global CO<sub>2</sub> emissions.”*

## Market potential

- Pike Research forecasts that the green data center will offer an overall market opportunity that exceeds \$40 billion worldwide by 2015. While North America and Europe will lead the way over the next two years, the Asian market will catch up quickly due to the continued rapid expansion of its data center capacity and eventually a growing commitment to the principals of the green data center.
- Microsoft predicts that capital expenditures in new data centers will likely flatten over the next few years as a result of innovations in new designs that bring down cost. However, once these innovations become prolific and further improvement opportunities diminish, the growth will continue at historic rates.
- In 2000, the annual construction market size globally was three times that in the US. By 2020, it will likely be four times as large. This should be no surprise that the growth will be higher globally, than in the US. By 2020, we can expect the construction market size for datacenters to be about \$18 billion in the US and \$78 billion globally.

## Competitive advantages

- **Holistic approach.** We optimize energy consumption by taking into account the thermal state of the datacenter, workload energy requirements, thermal and energy characteristics of the cooling and computing resources, and recent execution history.
- **Proactive strategies** besides reactive ones. We use knowledge about workload and resources to anticipate the energy requirements and to plan in advance.
- **Application-aware.** We have proven that, by taking advantage of heterogeneity in IT resources, resource allocation algorithms can be improved to decrease the total IT energy consumption by 30%.
- **Non-intrusive.** Our approach does not require radical changes in the infrastructure nor the management software. Data gathering, data analysis, and automatic control modules can be added gradually with no impact in performance or service discontinuation.
- **Adaptable.** The flexible architecture of our dynamic optimization system can be easily customized to specific needs. The decision support system is continuously learning what works and what doesn't.

## References

- CeSViMa-UPM supercomputing center. Reached in June 2011 TOP500 top 1 of Spain, 44 of Europe and 136 of the world, providing a peak performance of 103.4 Tflops and 72.03 of capable TFlops. Also reached position 18 in Green500 (June 2011). Currently installing a prototype.

## Development stage

- Concept
- Industrial prototype
- Research
- Production
- Lab prototype

### GreenCPD contact

José Manuel Moya  
Integrated Systems Lab  
ETSI Telecomunicación - UPM  
e: [jm.moya@upm.es](mailto:jm.moya@upm.es)

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

## Handroid: hand biometrics on android

### Biometric system verification based on hand geometry oriented to mobile devices

The Group of Biometrics, Biosignals and Security (GB2S) within Centro de Domótica Integral (CeDIInt) from Technical University of Madrid has developed a fast and reliable biometric verification system oriented to mobile devices. The system is able to verify an individual based on a hand picture taken by a mobile phone. Main advantages rely on not requiring any contact flat surface, few constraints when carrying out the hand acquisition and a certain resistance against biometric attacks, such as tamper biometrics or spoofing attacks. The proposed system is able to perform a verification within less than 2 seconds in a standard mobile device (smartphone) with an accuracy of 98%, being also able to achieve false acceptance rates close to 0%, which means a great acceptance by the final user.

Technology solution supported by the Technical University of Madrid

#### Technology solution

This solution is based on a verification software by means of hand geometry, without requiring much collaboration from the final user.

The system is able to verify the identity of a person allowing different degrees of hand rotation and distance to camera, on condition that hand is within a plain parallel to the camera.

The proposed method provides with a unique template for each individual, based on which the system carries out a comparison involving a very low computational cost.

Furthermore, the implementation of this system in Android allows its embedment in any mobile devices based on this former technology.

*The proposed biometric system is able to verify the identity of an individual with false acceptance rates close to 0% in a mobile devices in less than 2 seconds.*



#### Areas of application

- **Security:** suitable system for carrying out payments on mobile devices, and access protection.
- **Transport:** creation of an electronic ticket associated to the mobile device based on micro-payments.

## Market needs

### ▪ Security

- Secure systems based on authentication (verification) in mobile devices in order to avoid spoofing attacks.
- Fraud on payments on mobile devices arises to losses close to 1.13% for each transaction.
- Security in payment on mobile devices is currently under development and it must be solved in order to ensure user acceptance.

### ▪ Transport

- There is a certain need to speed the acquisition of transport tickets in different platforms: underground, train, bus, plane. Save in paper and dedicated devices.

### ▪ Identity verification on mobile devices.

- Blocking mobile.
- Limited access to certain applications in the mobile (mail, agenda).
- Temping agency to "hire" by mobile phone.
- Security, alarm management from the mobile device.
- Bounded to a buying ticket (access to a specific event associated to the service the user has acquired).
- Adequate age confirmation for visualization in mobile devices.

*"The use of biometrics on mobile devices could increase the confidence on mobile devices payment, making biometrics being present on each transaction from a mobile device"*

## Market potential

### ▪ Security:

- Product and services market oriented to biometric security in mobile devices will arise from 30 million dollars in 2011 (concerning 4 million users) to 161 million in 2015 (39 million users).
- Fraud in payment mobile nets is around 1.13% which implies a market potential of 4,800 million dollars.
- Biometric market will increase a 22% from 2009 to 2014.
- Next 5 years, it is expected an annual increase of 54% in pay per mobile (426 billion dollars).

### ▪ Transport:

- In 2015, around 500 million persons will use their mobile phones to pay tickets on public transport. [Juniper 2011].

## Solution competitive advantages

- No additional hardware is required as only an embedded camera is needed, and nowadays are included within each mobile.
- No flat platform is required to acquired hand picture.
- Low computational cost, being the whole process carried out within the mobile device.
- Advanced prototypes embedded on an Android platform.
- Possible to be used with other devices with cameras (interoperability) and with other programming languages (iOS, Symbian).
- Non-invasive technique and with high user acceptance.

## References

- Wide experience on research and development.
- High research interest on this technology solution at national and international level.

## IPR

- Software register M-1274-2013

## Development stage

- Concept
- R&D
- Lab-Prototype
- Industrial-Prototype
- Production

### Handroid contact

Alberto de Santos Sierra, Carmen Sánchez Ávila  
e: {alberto,csa}@cedint.upm.es  
w: <http://www.gb2s.es>

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation-  
UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

## LILIAC: the utmost reliability

Security and authentication device for products and brands based on a unique and disruptive technology protected by international patent

Nowadays, 10% of annually worldwide sold products are forgeries. This represents a 600 billion dollars a year loss for brands and manufacturers.

Security and authentication measures used today, such as holograms, are forged easily as exact replicas. LILIAC technology developed by Alise Devices engineers is a new generation of innovative and totally unfalsifiable security device. This technology has been developed in recent years on the facilities of CEMDATIC at ETSI Telecomunicación (Technical University of Madrid).

Due to their performance and features, LILIAC devices are applicable to products of almost all sectors of market. Through inserting them into their products, manufacturers get protection against forgery and a considerable reinforcement of its reputation and brand image.

Technology solution supported by the Technical University of Madrid

### Technology solution

Alise Devices offers its customers a unique product whose technology is totally innovative. LILIAC is a plastic and flexible device, which is transparent when it's checked daylight, and with multi-image latent on both sides. These images are individually visible when polarized light or partially polarized light affects the device. This light is emitted by consumption common devices such as mobile phones, a computer screen or an LCD TV, for example.

The three LILIAC product lines (duo, quad and 256) are totally adaptable to the needs of the client. LILIAC can be inserted in any kind product, material or surface. Hidden latent images can be designed according to the client preferences.

*"LILIAC technology developed by Alise Devices gives to its holder a unique and innovative authentication system that revalued its brand image and prevent from forgery"*



Brand protection

Prevent from forgery

### Areas of application

#### Security:

- **Security and authentication of products and brands:** applied on their products, manufacturers reduce their losses from the sale of counterfeit products.
- **Document security:** application in currency of legal tender, official documents, identification documents and other stamped products.



Current security measures

LILIAC



## Market demands

### ▪ Security and authentication of products and brands

- It is estimated that counterfeit goods market represents 10% of the entire volume of world trade. The annual cost of losses in the global economy due to the trade in all kinds of forgeries is higher than 600 billion dollars.

Some of the most affected market sectors are:

- Medicines&Drugs: with an annual volume of 200 billion dollars. LILIAC is inserted in the packaging or the blister, as a proof of authenticity for users and reducing the losses of the manufacturer.
- Electronic equipment: 100 billion dollars annually. The device is inserted in the packaging.
- Clothing&Accessories: 20 billion dollars annually, inserted in the fabric or on the label, such as distinction system, and as aesthetic and brand image reinforcement.
- Cosmetics&Hygiene: 3 billion dollars annually, as a part of the packaging or the main structure of the product.

### ▪ Document security

- The main application is in banknotes sector. The European Central Bank found 751.000 forged banknotes during the year 2010. This amount of banknotes accounted for a fraud of more than 40 million euros.
- Authentication system in official identification documents (identity cards, passports, visa, etc).
- Certification of valuable documents.

*"It is estimated that counterfeit goods market represents 10% of the entire volume of world trade, amounting to 600 billion dollars annual in losses for manufacturers and brands"*

## Market potential

### ▪ Security and authentication of products and brands

- Total market potential for protection and authentication technologies applied in products and brands is estimated at 4.633 million dollar [Reconnaissance International].
- The main substitutes for LILIAC products are holograms and RFID (1.064 and 2.2 million dollars).
- It is a growth sector as demonstrated by the figures of two of its main actors. Bilcare Research net sales increased in a 27% in 2010. OpSec Security Group PLC, as an example of a smaller agent, increased profits in a 15% to 40 million pounds.

### ▪ Document security

- In 2009, market potential of printing money services was measured in 500 million euros [Pira International].

## Competitive advantages

- The unique technological benefits of LILIAC are far exceeding current substitute products.
- Due to its versatility, the device developed by Alise Devices can be inserted in any kind of product.
- Wide range of potential customers in various sectors of the market.
- Integration of the device in the final product as aesthetic reinforcement and upgrading of the brand image.
- Total adaptability of design and features of LILIAC to the client needs.

## References

- First prize for the best business plan in the 8th competition of entrepreneurship actúaUPM.
- Award for the best business idea in the 8th competition of entrepreneurship actúaUPM.
- Founding team with more than 50 years of combined experience in the field of technology.

## IPR

- Patent: "Procedimiento y dispositivo de seguridad documental por generación de imágenes múltiples".
  - Patent number: ES2337010 B2/ Date: 21/01/2011
  - Patent Cooperation Treaty: PCT/ES2010/000461 / Date: 22/02/2011
  - Patent applied in the USA (US13/513,517) and Europe (EP10845616.1).

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Alise Devices Provider's contact

Carlos Carrasco, Beatriz Cerrolaza, Morten Geday, Xabier Quintana, José M. Otón  
e: carlos.carrasco@alise-devices.com  
beatriz.cerrolaza@alise-devices.com  
w: <http://www.alise-devices.com>

### UPM contact

Innovation, Commercialization and Entrepreneurship Area  
Centre of Support for Technological Innovation – UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

# Automatic Translation into Spanish Sign Language (LSE)

## Spanish into Spanish Sign Language (LSE) translation system

*The system is made up of a speech recognizer (for decoding the spoken utterance into a word sequence), a natural language translator (for converting a word sequence into a sequence of signs belonging to the sign language), and a 3D avatar animation module (for playing back the signs). Based on preliminary experiments in restricted domains, the translation system performance is close to 100%, operating in real-time. The system allows an easy adaptation to a specific application domain. This technology has been developed by the Speech Technology Group at UPM in collaboration with FCNSE (the Spanish Deaf Association). This technology has been included in several industrial prototypes already developed for different scenarios.*

Technology solution supported by the Technical University of Madrid

### Technology solution

The system is made up of a speech recognizer (for decoding the spoken utterance into a word sequence), a natural language translator (for converting a word sequence into a sequence of signs belonging to the sign language), and a 3D avatar animation module (for playing back the signs).

The speech recognizer is speaker independent and it is able to recognize continuous speech.

For the natural language translator, three technological approaches have been implemented and evaluated: an example-based strategy, a rule-based translation method and a statistical translator.

Combining these three strategies, it is possible to take advantage from their advantages.

### Areas of application

▪ **ICT for Health, Ageing Well, Inclusion and Governance:** information and interaction systems with deaf people (information kiosk, cash machines, web pages,...).

*Based on preliminary experiments in restricted domains, the translation system performance is close to 100%.*



## Market demands

- Deaf people have a lot of communication barriers that generates a significant number of educational, social and cultural problems.
- **Educational needs of the deaf.** 47% of the deaf population have no education or are illiterate. Furthermore, only between 1% and 3% of the deaf population has completed college, compared to 21% of the entire Spanish population (INE MECED 1999 and 2000/2001).
- **Social integration needs.** Deaf students ends in social guarantee programs 10 times more than the entire student body (INE 1999). Another fact is enlightening that between 45% and 50% of deaf children have psychological disorders compared to the maximum of 25% for the rest of the population (European Society for Mental Health and Deafness 2000). Finally, unemployment is much higher among deaf people, especially among the group of deaf women (INE 2003). These general needs can be specified in the followings points.
- **Subtitled audiovisual content** in sign language. The relevance of this aspect is increasing given the Law about Audiovisual Communication 2010, which imposes very high subtitling needs, requiring automated tools.
- Translation of **web pages** into sign language to facilitate deaf people accessing them.
- Generation of information in sign language to be provided through **information points or cash machines**.
- Content translation into sign language for **education and training** of deaf people.

*Deafness gives rise to significant communications problems. With this technology it is possible to develop content and services accessible for deaf people.*

## Market potential

- According to the Survey of Disability, Personal Autonomy and Dependency Situations INE (EDAD, 2008), the number of people with disabilities are: 3,847,900 people, more than 8.5% of the population. The number of hearing impaired is 1,064,100, ie 25.20 per thousand population.
- From the recognition of LSE (Spanish Sign Language) as an official language in 2007, the number of LSE users is growing significantly.

## Competitive advantages

- Translation rate is close to 100% for restricted domains (<1000 words).
- Real-time operation for on-line interaction services.
- Speaker independence when translation from speech.
- Easy adaptation to a specific application domain.
- Flexible to be adapted to other languages or sign languages.
- Available a sign vocabulary with more than 1000 signs. This vocabulary includes a description of every sign in both SEA (Sistema de Escritura Alfabética) and HamNoSys.
- These signs are already generated. They can be used in different contexts: it does not require re-design them.
- There is a user-friendly visual tool for designing new signs in both HamNoSys or SEA.

## References

- Research group with wide experience in this subject and collaboration with companies.
- This technology has been developed in collaboration with FCNSE (the Spanish Deaf Association).
- There are several industrial prototypes already developed for different scenarios: Identity Card renewing, Driving License renewing, Hotel reception and Information Point of the EMT.

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Contact LSE

Rubén San Segundo Hernández  
e: [lapiz@die.upm.es](mailto:lapiz@die.upm.es)  
José Manuel Pardo Muñoz  
e: [pardo@die.upm.es](mailto:pardo@die.upm.es)  
w: <http://gth.die.upm.es/>

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)

## Maximum microelectronic efficiency

### Compact and ultra low power smart temperature sensor for on-chip thermal management: high performance and reliability of electronic devices

*A research team of the Higher Technical School of Telecommunications Engineering at the Technical University of Madrid (UPM) has developed an advanced sensor for the dynamic thermal management in electronic circuits. This temperature sensing is key factor to integrated circuits (chips) performance, and therefore, to all kind of electronic devices or components. The demand for reliability and best performance in microprocessors applied to computation is rising, focused on computer multi-core architectures, graphic processing units or smartphones. The sensor improves previous results in terms of area and power consumption (first class circuits design constraints) by more than 85% .*

Technology solution supported by the Technical University of Madrid

#### Technology solution

This solution is based on a tiny ultra low-power smart sensor, specially suitable for Dynamic Thermal Management (DTM) techniques and the detection of possible on-chip hot spots.

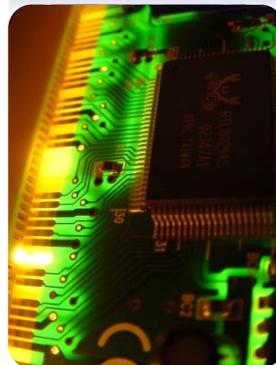
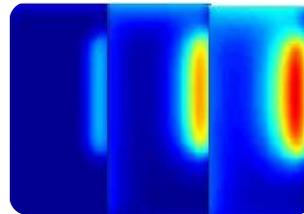
It stands out for a robust design against chip self-heating effects, for a fully compatibility with standard CMOS processes and for an easy integration of these sensors in VLSI (*Very Large Scale Integration*) layout, as well.

Furthermore, a specific interface that can be integrated into the sensor has been implemented to digitalize the temperature sensing. This advantage implies a significant cost savings comparing it to previous works, which usually consider this A/D conversion in their design.

#### Areas of application

▪ **ICT applied to embedded systems:** microelectronics supporting advanced electronic devices performance (PC, *smartphones*, graphic processors, automotion...).

*Sensor characterization work outperforms previous solutions by more than 85% as far as area and power consumption are concerned*



## Market demands

- Integrated circuits (chips) production and optimal design: key constraint in advanced electronic devices performance evolution, from mobile handsets to server systems, through all kinds of electronic devices.
- High integration densities in digital circuits, that implies an important rise in heat density (on-chip hotspots).
- Temperature management and sensing is a chip critical design constraint and, therefore, it impacts on a large number of applications: circuit reliability and performance degradation risks.
- Chips design and manufacturers firms must face new challenges by providing thermal-efficient systems that support electronic performance evolution.
- Traditional on-chip cooling solutions, that affect the whole chip instead of targeted regions, imply an inefficiently overcooling (rising both costs and required area).
- Industry's interest focused on circuits designs that take power and thermal management functionalities into account: higher performance, higher efficiency and lower size requirements.
- The increasing demand for longer mobile devices battery life and its rapid adoption (16% increase in smartphone usage year over year; global sales expected to top 500 million units in 2014) require an improved circuit design with a more efficient power performance and temperature management.

*“A dynamic and efficient chip temperature management is a success factor to support the rising demands for high performance and reliability of consumer electronics devices (e.g. smartphones)”*

## Market potential

- Semiconductor global market grew by 29.3% to reach a value of 400.000 M\$ in 2010. Integrated circuits is the largest segment of this market, accounting for 80% of the market's total value. [Datamonitor]
- Forecasted increase of 33% during 2010-2015; market boosted by consumer electronics devices demand. Asia-Pacific region accounts for 66% of the semiconductor market value. [Datamonitor]
- China, the second largest producer of semiconductors in the world, is poised to grow even larger over the next years due to government's decision to invest 50.000 M\$ in semiconductor related projects. [GBI Research]

## Competitive advantages

- DTM (*Dynamic Thermal Management*) techniques implementation: energy and thermal-efficient solutions.
- 85% reduction in power consumption comparing with previous solutions (1.05–65.5 nW at the conversion rate of 5 samples/s).
- 85% reduction in area of the sensing part comparing with previous results (very reduced area: 10.250 nm<sup>2</sup>).
- Specific interface designed to digitalize the temperature sensing, compatible with the sensor, that allows a lower cost implementation comparing with previous results.
- Fully compatibility with standard CMOS processes, technology widely used in microprocessors, semiconductor memories or signal processors designs.
- Easy implementation: possibly be included in any standard-cell library for designing integrated circuits.
- Flexible enough for leaving the interface up to the designer's necessities.

## References

- Wide research background and collaboration with industry.
- Worldwide research interest in this technology solution (relevant scientific citations).
- Innovation background: university spin-off creation and involved in 3 patents.

## IPR

- Granted patent P200702109 (OEPM-Spain).
- International patent application (WO2009/022038) through PCT procedure.

## Development stage

- Concept
- R&D
- Industrial Prototype
- Production
- Lab-Prototype

### Technology solution providers contact

Pablo Ituero Herrero, Marisa López Vallejo  
e: {pituero, marisa}@die.upm.es

### UPM contact

Innovation, Commercialization &  
Entrepreneurship Area  
Centre of Support for Technological Innovation –  
UPM  
e: innovacion.tecnologica@upm.es

# Verify: bringing tranquility to an online world

## Efficient and targeted management of online reputation, privacy and trust.

*In an ocean of personal and corporate information, how can we assure the contents we find are truthful? And when that information refers to ourselves or our companies, how can we ensure our online appearance?*

*A research group of the Telematics Systems Engineering Department (DIT) at UPM (Universidad Politécnica de Madrid) has developed a technical solution that funnels all this information, bridging the gap between referred users and information consumers. We offer tailored value propositions targeting different industries where reputation and trust provide an added value. Our technology allows consumers to verify the information they find online and check it with the referred users, who may in turn acknowledge or deny that and defend their position.*

*We increase the quality of personal information retrieved by consumers at a reduced cost, as well as we ensure their perception matches the intents of the referred users. We offer tailored value propositions targeting different industries where reputation and trust provide an added value, with several demonstration prototypes available.*

Technology solution supported by Universidad Politécnica of Madrid

### Technology solution

Verify provides a set of software modules allowing that:

- Users referred by online contents can acknowledge or deny that information, reaching those who consume it.
- Users consuming online contents may directly check it with the people or companies it refers to.

They stand out for letting referred users modulate the perception others get about them, as content consumers directly obtain the view of those that might be concerned.

Moreover, it includes specific components for information consumers, information producers and referred users, deployed as add-ons that integrate within different systems (application servers, user browsers, search engines, etc.), and communicate through novel protocols.

### Areas of application

- **ICT applied to digital contents:** information service providers aiming to serve quality contents that include personal information (e.g. social networking services, etc.)
- **ICT applied to service and network infrastructures:** network and service providers mediating between people who consume information and people referred by it.

*"Verify may allow information service providers to boost user engagement and expand their premium services, as it improves the quality and credibility of the contents they deliver"*



## Market demands

- **ICT applied to digital contents:**
  - Online reputation management: 80% of users in continental Europe take steps to manage their online reputation. [Microsoft]
  - Personal branding: a good quality of a user's online presence may be a guarantee to succeed in finding a new job, meeting people, etc.
  - Conversely, bad online reputation may ruin personal growth opportunities. 70% of recruiters dump candidates based on their online records; same as 43% of online dating services do with potential dates.
  - Human resources: 90% of recruiters spend the equivalent to €7 to verify each candidate's reputation.
  - Social relations: 45% of users believe their reputation can get or prevent them to meet people.
  - Mass media: scandals arise when they provide low-quality, unverified information.
- **ICT applied to service and network infrastructures:**
  - Social Networking Services are taking on decentralized, federated and interoperable models. Now, the social network provider does not control the contents it serves any more. Allowing users to take back the helm of their personal information is a key factor to succeed in this new scenario.
  - Loss of online privacy: top concern in 2020 for 45% of European Internet users.
  - Do-Not-Track regulations in US and EU to ensure users privacy: estimations on similar initiatives show 10% of registered users would pay \$5 a month for privacy protection

*"I cannot control who may seek or come across online information about myself. But ensuring they ultimately encounter a good reputation about me is key to succeed in finding a job"*

## Market potential

- Online Reputation Market amounts to the equivalent of \$3.75 Bn worldwide, with a 30% annual growth [e-Consultancy].
- Identity and reputation as an economic asset: successful identity certification services exist that charge \$50 to verify user attributes.
- Online privacy: products usually charge individuals with \$7 – \$18 monthly installments for preventing access to their personal data.

## Competitive advantages

- Previous reputation management solutions used to be based on recurrent screening and information flooding, which have proved to be quite inefficient and require to spend a lot of resources. Verify provides a much more **cost-effective** way to ensure our appearance reaches the consumers as we intend, since it directly channels information from the referred users to the content consumers.
- Verify solutions are inherently **dynamic**, so they allow easily managing new information as soon as it appears.
- Verify solutions work **robustly** even on massively distributed environments where no previous trustworthy relationships exist between the domains of the consumers and the referred users.

## References

- Verify: infrastructure prototype and user tools for OneSocialWeb (Vodafone).
- Finalists at entrepreneurship competitions: Wayra, ActuaUPM
- 4-year Cenit Segur@ project on security, privacy and trust management, contracted by Ericsson, resulting into 5 patent applications.
- Combined 40+ year experience in R&D on digital content solutions (customized search engines, usability and user experience, etc).

## IPR

- International patent application (PCT/ES2011/070098) "Method and System for Obtaining a Level of User Recognition of a Statement" through the Euro-PCT procedure.

## Development stage

- Concept
- R & D
- Lab Prototype
- Industrial Prototype
- Production

### Verify contact

Yod Samuel Martín, José M. del Álamo,  
Juan Carlos Yelmo  
e: {samuelm, jmdela, jcyelmo}@dit.upm.es

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation –  
UPM  
e: innovacion.tecnologica@upm.es

commercial sheets  
UPM *innovatech*  
@ Transport, Security & Space

# DynaWheel: innovative technology for improving vehicle safety

## Improved safety of vehicles using the innovative worldwide instrumented tire DynaWheel

A research group of the University Institute of Automobile Research (INSIA) at UPM (Universidad Politécnica de Madrid) has developed an instrumented tire that improves the current electronic systems of vehicle dynamic control (ESP, ABS, ASR). It provides real-time information to this kind of systems at a cost well below competitors, so it would make a product more affordable to a wider range of companies and research centres related to this sector.

Technology solution supported by Universidad Politécnica of Madrid

### Technology solution

Active safety systems, like Electronic Stability Program (ESP) and Anti-locking Braking System (ABS), are based on measuring the rotation of the vehicle wheels. On the other hand, all forces acting on a vehicle, except for the aerodynamical and gravitational ones, are generated by the contact of the tire with the road. Instrumented tires can determine these contact forces experimentally. Current commercial instrumented tires usually have different properties than the original ones, so altering the vehicle dynamic behaviour.

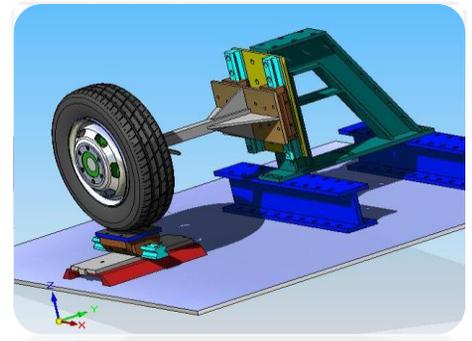
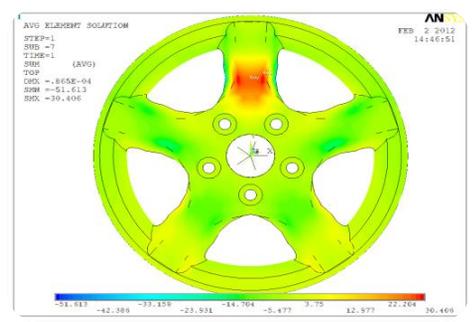
In the proposed solution, these efforts are determined from the deformations signals that are measured in different positions of the tire.

Deformations are measured by strain gauges attached to the tire, which are grouped into angular and radial measuring positions.

### Areas of application

•**Transport:** suppliers of automotive components (wheels, Advanced Driver Assistance Systems...) and automotive research centres.

*"Efforts are determined from the deformations signals that are measured by strain gauges attached to the tire"*



## Market demands

- There is a social need to design and build safer cars. Hence, it is essential to keep on improving safety systems, above all both active and passive safety systems.
- Current commercial instrumented tires are used for the development of active safety systems, but modifying the vehicle behaviour.
- High prices (around 61.000 € and 172.000 €) make these tires unaffordable to most companies and research centres.



## Market potential

- Automotive sector is of great importance in the Spanish economy [investinSpain]:
  - Trade: 6,1% GDP.
  - 8,7% of the Spanish labor force works in the automotive sector.
  - This industry accounts for nearly 17,6% of national exports of goods and services.
- There are 20 research centres supporting R&D activities and 11 universities with specialized structures in this area, just in Spain [investinSpain].
- Most of the main vehicle manufacturers in the world are present in Spain supporting 17 plants [investinSpain].
- Automotive equipments and components sector has increased its turnover by 9% as compared to last year.
- Components and equipments sector invested 29.530 M€ in 2011, a 9% increase from previous year. 63% of this amount corresponded to export trading, which also experienced a rise of 15% over 2010.
- 11 tire manufacturers are producing in Spain, with a turnover of more than 3.9 M€ [infoCap] .

## Competitive advantages

- It delivers real-time information to vehicles dynamic control systems, improving their performance.
- Much lower production cost than competitors, which makes increasing profit margins possible and affordable to a greater number of potential customers.
- Better adaptability to a wider range of tires.

*“Improving vehicle safety, available to everyone: better control systems at a lower cost thanks to this innovative solution*

## References

Research team at INSIA-UPM (University Institute of Automobile Research )

- Javier G. de Jalón: UPM Full Professor. Recently awarded D’Alembert and IFToMMAward of Merit prizes in Washington (2011).
- M<sup>a</sup> Dolores Gutiérrez: UPM PhD student in mechanical engineering. Industrial engineer and degree in business administration. National graduation award.

## IPR

- Patent granted P201130287 (OEPM-Spain).
- International patent application (PCT/ES2012/000044) “Method and system for estimating the effort generated by the contact of a tire with the road in an instrumented tire” through the PCT procedure.

## Development stage

- Concept
- R & D
- Lab-Prototype
- Industrial Prototype
- Production

### DynaWheel contact

Javier G. de Jalón y M<sup>a</sup> Dolores Gutiérrez  
INSIA - UPM  
e: javier.garciadejalon@upm.es

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: innovacion.tecnologica@upm.es

# BIO-stress: real-time stress detection system

## Low computational cost software for detecting the stress level of an individual in real time

*The Group of Biometrics, Biosignals and Security (GB2S) within Centro de Domótica Integral (CeDInt) from Technical University of Madrid (UPM) has developed a stress-detection system to provide information on the state of mind of an individual for real-time applications and designing a low computational cost implementation. This detection is of great interest for applications requiring a good preparation in high stress demand situations (such as training special forces) or a complement to existing security (as in the case of biometrics, road safety or automation). The method requires only two physiological signals (heart rate and galvanic skin response) and just easily integrated and noninvasive sensors, resulting in wide acceptance and usability by the individual. The stress-detection accuracy obtained is 99%.*

Technology solution supported by the Technical University of Madrid

### Technology solution

The software provides a solution for stress detection based on two physiological signals (heart rate and skin conductance), especially geared for real-time environments, which requires knowing the individual's mood instantly.

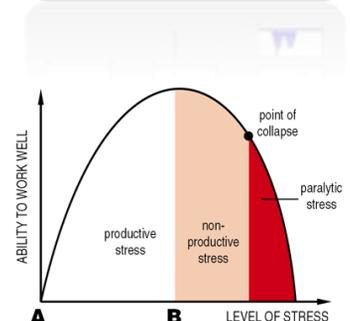
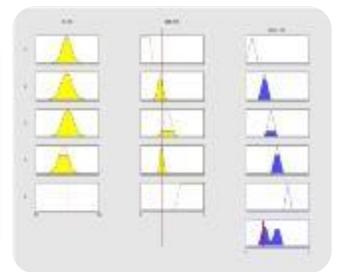
It must be noted that the main difference is based on modeling the behavior of both physiological signals in different degrees of stress by employing fuzzy logic, which allows a maximum adaptation to each subject.

Moreover, its low computational cost and the ability to integrate the required sensors represent a low invasiveness, resulting in increased acceptance and usability.

### Areas of application

- **Security:** training special forces (police, fire, military) to improve its performance in stressful environments.
- **Transport:** drowsiness detector driving.
- **Health:** monitoring elderly (falls, accidents).

*The method achieves stress-detection accuracy rates close to 99%, representing a 10% improvement compared to previous solutions and using just 2 human physiological parameters*



## Market demands

### ▪ Security

- Training special forces (police, fire, military) to act properly under stressful situations.
- Soldier monitoring to quantify resilience and maximize the effective action in combat.

### ▪ Transport

- In Spain, 16% of road accidents are caused by falling asleep while driving.
- Monitoring the attention of a driver in a non invasive way is one of the main goals in research related to road safety.
- Also, excessive stress while driving leads to traffic accidents.

### ▪ Health

- Falls and other common accidents are a major cause of death in elderly people.
- The social phenomenon called Silver Tsunami provides current governments' inability to deal with proactive monitoring of elders.

*"An accurate and instant stress detection could detect when a person falls asleep while driving (no stress), when an older person falls (nervousness) or if a soldier needs reinforcements for being unable to face combat missions (high stress) "*

## Market potential

### ▪ Security

- Post-traumatic stress disorder treatment could cost USA Army up to \$1.5 million over the lifetime of a soldier. [Los Angeles Times]

### ▪ Transport

- Accidents caused by over-fatigued drivers in the U.S. represent a total of 12. 500 \$ millions annually. [Drowsy Driving]
- In 2011, 238 people died from falling asleep while driving in Spain. [Dirección General de Tráfico]

### ▪ Health

- In 2020, direct and indirect costs related to falls and accidents of elderly will account almost 55 billion dollars a year. [CVIDA]
- In 2020, there will be a total of 10.1 million disabled elderly, which will require a total of 2.5 million dedicated nursing [Elder Parent Help].

## Competitive advantages

- Low invasiveness in acquiring physiological signals, resulting in higher integrability of sensors and user acceptability.
- Continuous monitoring by quantifying the stress level of the individual.
- High accuracy in the stress detection (99.5%).
- Customized and adaptative stress detection according to individual's mood over time.
- Stress detection method based on fuzzy logic with low computational cost and processing times in milliseconds.

## References

- Wide research background and business collaboration.
- High research interest for this technology solution both nationally and internationally.
- Clear focus on innovation and commercialization of research by the group.

## IPR

- Patent granted P200930993 (OEPM-Spain), 2011.
- Patent applied USA P6752EP00.
- Software register M-003315/2012 (Madrid, Spain).

## Development stage

- Concept
- R&D
- Industrial prototype
- Production
- Lab Prototype

### Bio-stress contact

Alberto de Santos Sierra, Carmen Sánchez Ávila  
e: {alberto,csa}@cedint.upm.es  
w: <http://www.gb2s.es>

### UPM contact

Innovation, Commercialization and  
Entrepreneurship Area  
Centre of Support for Technological Innovation  
– UPM  
e: [innovacion.tecnologica@upm.es](mailto:innovacion.tecnologica@upm.es)



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