Designing Smart Home Environments for Unobtrusive monitoring for healthier lives: the use cases of USEFIL and REAAL

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National Center For Scientific Research “Demokritos” is a multi-disciplinary Research Centre, with research activities in the field of physical sciences and significant laboratory infrastructure.

- Total number of staff: 700 (Scientific personnel and full time high qualified Researchers)
- Graduate students and post-doc researchers: 180

NCSR consists of five institutes and the Division of Applied Technologies:

- Institute of Informatics and Telecommunications
- Institute of Biosciences and Applications
- Institute of Nuclear & Radiological Sciences & Technology, Energy & Safety
- Institute of Nanoscience and Nanotechnology
- Institute for Nuclear and Particle Physics
- Division of Applied Technologies
Mission of the Institute of Informatics and Telecommunications and the Division of Applied Technologies:

*Connect society, business-innovation and research*

- **Transform research results** into tangible commercial innovation opportunities.

- **Generate new products and services** responding both to public demand and to the needs of the knowledge economy.

- **Enhance new research** perspectives stressing interdisciplinary approaches in areas with strong societal and economic importance.

- **Commercialize (spin of)** the most up-to-date and relevant research findings, potentially giving advantage in the latest technological fields.
Who we are – Spin Off Company

SYNDEESIS
Intelligence in Health and Wellness

B2C: Web2.0 for health and wellness
- Electronic health and wellness services (eHealth) to end users-customer in collaboration with affiliated diagnostic centers and private practitioners.
- Care Services (assisted living) distance to end-users using online systems and television

R&D
Develop non-invasive diagnostic tools using bio-monitoring tools and eHealth services to detect CVD diseases such as Coronary Artery disease.
We are using a 3 tier solution by daily monitoring: nutrition, health vital signs and activity.
Our long term objective is to provide health tests that can help find health problems early, when the chances for treatment and cure are better.

B2B: Hosting and maintenance of "Virtual eHealth Operators"
Potential target customers among the others are:
- Insurance companies for the creation and support of their insurance products
- Maritime and Transportation companies
- Fitness companies and gyms
- Large Hotels,
- Hospitals and clinics

Knowledge Management:
- Professional eLearning services to end users such as businesses and organizations in the health and care as medical, nursing and care staff
- Use of online games, serious games and game mechanics to enhance eLearning services

www.syndesis.eu
Through E.U. funded projects an integrated network supporting advanced applications in the field of telemedicine ensuring the interoperability between wireless and terrestrial segments of the network has been developed.

This medical network interconnects hospitals using advanced terrestrial and wireless technologies.

The network is being developed and expanded more utilising advanced technologies.

Telemedicine via Integrated Networks
(indicative projects)

1. The Intermed Network
2. The GALENOS Network
3. The Grundvig project
4. The Tillelpokratis Network
We have developed an integrated satellite and terrestrial network and cloud based hosting infrastructure supporting advanced applications in the field of telemedicine and eHealth ensuring the provision of advanced eHealth services.
Telemedicine and Home care: We have implemented the pilot sites within the Island of Samos, Hios and Cyprus (Hospital of Nicosia).

Medical center in Karlovasi

We have developed and tested the services within: Intermed and Tile-Ippokratis projects

Rural medical center in Marathokampos
We have experimented with state of the art monitoring devices (wireless - ease of use) and we have developed web interface open to many devices / vital signs.

The above services have already been successfully applied in rural areas. These test cases have provided to us useful data concerning the technical operational status of the whole system.

ECG  Wireless Weight  Alarm Button-HR
Multi-monitoring  Home care scenario

First Simple Web Presence
Telemedicine and eHealth in Homecare

Consultation service

Basic Telemedicine service

Transfer of Data
Telemedicine and eHealth in Homecare – Target Groups

Who actually needs this service?

Chronic Patients

Rural Areas

Elderly People
Telemedicine and eHealth in Homecare – Ageing: A promising Target Group

All of us….in a few years time

“Ageing” costs in healthcare system

Rapidly growing elderly population in key markets

Our time: Less Money

Facts and comparisons
Telemedicine and eHealth in Homecare – ICT ecosystem is booming

Sensing technology: Smart Activity Trackers

Biosensors technology

Wearables: smart watch

Ecosystems for monitoring and managing personal data

Apps Apps Apps Apps Apps

Social Media

Lifestyle
Food & Drink
Games
Health & Fitness

Data
Running projects

Data: Personal Record
Running projects - USEFIL

What we are trying to do?

We are not inventing new fancy systems.

We are just trying to exploit the ICT Ecosystem for the benefit of the Elderly people.
The most commonly quoted definition of health: “a complete state of **physical**, **mental** and **social well-being**, and not merely the absence of disease or infirmity.”

http://www.who.int/bulletin/bulletin_board/83/ustun11051/en/

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**Ease of use Services**
- Automated monitoring
- Unobtrusive monitoring
- Easy Access to technology
- Personalized services

**Useful Services**
- Support Social activities
- Support mobility
- Use Low cost systems

**Determinants of our services**

- **Physical:** Vital signs
- **Mental:** Cognitive Games
- **Social Well-Being:** Social Communication
Running projects- USEFIL

• Interfaces
  o a Slate-tablet PC
  o a Web-TV (TP-Vision) in the living room

• Sensors
  o a wrist watch
  o a Depth camera (living room)
  o mic and camera on the Slate-tablet PC
  o mic and camera behind a mirror

• Processing Power for homePC
  o a nettop pc / laptop

We exploit low cost systems
Running projects- USEFIL

• Web-TV:
  o To deliver content from other computers or storage devices on the network.
  o To provide access to internet-based services including traditional broadcast TV channels, catch-up services, video on-demand, interactive advertising, personalisation, voting, games, social networking.

• Low-cost / Low power consumption hardware:
  o Nettops (e.g. Zbox ID80), USB-sized (FXI Cotton Candy)
  o Kinect / Asus Xtion
  o Cameras

• Unobtrusiveness:
  o No wires
  o blending with common furniture
  o cameras behind mirrors
Running projects- USEFIL

• Slate Tablet:
  o Tablets running open-source OS that allow for peripheral connection
  o Smartphone apps make easier the connection to a social net by elderly users
  o bigger screens make use of apps much easier

• Wrist watch:
  wearable multi-sensor data logging device recording activity, accelerometer, galvanic skin response, skin temperature and ambient temperature
Three Directions of monitoring

1. **Functional** Status: How well can the elderly perform activities of daily living independently?

2. **Emotional** Status: How does the elderly feel when living alone:
   - certain emotions can indicate health problems
   - some emotions can even be mental health problems

3. **Physiological** Status: What are his/her health signs?
   - Heart Rate
   - Breathing Rate
   - Pupil size
   - Face Color
   ... + (Ideally) **Blood Pressure**

   • *We use common hardware with minimum effort from the user*
   • *everyday, long-term monitoring*
Running projects- USEFIL

We tried to embed Intelligence

We use Machine learning techniques to diagnose, predict and monitor
Running projects- USEFIL

We keep people connected:
Running projects - USEFIL

Web Portal

Family Access

Elderly profile

Doctors access
Running projects - USEFIL

Architecture Design: Web based
Running projects- USEFIL

The target population in Israel is:
- Patients who had **stroke event** (first) and are independent and living in their home alone or with the assistance of daily operations only.

The target population in Greece is:
- Elderly participants aged 60 or older (ideally older than 65).
- Healthy individuals, patients with **mild cognitive impairment**, individuals with a propensity for sporadic bouts of mild depression.

The target population in UK is:
- Elderly (>65) with **chronic conditions (co-morbidities included)** with the exclusion of any form of dementia.

www.usefil.eu
Running projects- USEFIL

We provide: APIs and guidelines, platform to create and test your own apps
Running projects - REAAL

Smart Home

We monitor: Humidity, smoke, light, Temp, CO2 and others

Web Server

Provided Services:
- Speaker notification
- Switch Controller (e.g. turn on/off home devices)

UniversAALisation

We monitor: Humidity, smoke, light, Temp, CO2 and others

Medical Data:
- Blood Pressure
- Heart Rate
- Blood Oxygen Saturation
- Body Weight
- Blood Glucose

http://www.cip-reaal.eu/home/
Running projects - REAAL

Innovative IoT and WoT platform to create advanced apps
Advantages Perceived

• New sensors, perhaps more advanced or suitable, can be easily integrated without much effort.

• New applications can be easily integrated in the system and extend its functionalities.

• There is the ability to trigger events e.g. an unexpected vital sign measurement will trigger the relay to act accordingly based on the specified rules.

• Ability to create lightweight applications acting as agents, responsible for small dedicated tasks.
Running projects- Profound

Identification of the Need for an App for Professionals

- 30-40% community dwelling >65yrs fall in year
  - 40-60% no injury
  - 30-50% minor injury
  - 5-6% major injury (excluding fracture)
  - 5% fractures
  - 1% hip fractures

- Falls - most serious frequent home accident
- 50% hospital admissions for injury due to fall
- History of falls a major predictor of future fall
- Assessment of the suitable treatment is a key point for prevention of further event

Falls can be prevented!

Masud, Morris Age & Ageing 2001; 30-S4 3-7
Rubenstein. Age & Ageing; 2006; 35-S2; ii37-41
Running projects- Profound

Resources Webpage

Resource Usefulness Rating System

Video Resources Webpage (Most Recent/Most Popular)

Profound site www.profound.eu.com
Running projects - Profound

Expert Knowledge: Profound Application

Falls Prevention App

Enhance with Machine Learning Algorithms
Four scenarios were identified according to the evidence

The App leads to different recommendations and to a personalized but reasonable prevention plan.

The healthcare professionals defined the assessment and treatment plan that should be followed in each of the scenarios, thus leading to the production of the App’s wireframes.
Innovative approaches for Telemedicine and eHealth – The Whole loop

IoT – WoT - IoE

Generate Data

Smart Cities – Smart Homes

BIG ?

Use Intelligence

Decrease the entropy of the unstructured/chaotic data
Innovative approaches for Telemedicine and eHealth - Web Architecture

Social media

ML algorithms for Prognosis

Data mining

Health status, daily routines, behaviour and events

Information Data

Monitoring Data / events / other data

Notification

Professionals / doctors / health system

End Users / elderly

Social Network / unofficial carers

Web based Portal

Feedback

Health status report

Personal health Record and information Logic

Feedback messages

Personal health Record and information Repository

Sensor data pipeline

Sensor backend information service

Sensors/ Monitoring Devices

Main web based Portal / App

@ Elderly User

Web Based Architecture to cope with the Big Data
Intelligence will be embedded in ConCorde

Intelligence has been embedded in USEFIL for data fusion

Pilot PCC with Evangelismos Hospital
- Vital signs (BP)
- Adherence behaviour
- Demographics

ReAAL pilot (60 end users)
- Vital signs
- Environmental data
- Demographics
- Adherence behaviour

We create data sets
We create algorithms to support prediction/diagnosis

The proposed conceptual knowledge modelling framework

Semantic technology:
- Open Linked Data
- RDF/SPARQL
- OWL/DAML
- ElasticSearch (LO- JASON)
- RES/ISON

The Depression scenario
1. Detect low level audiovisual/accelerometer cues
   Location-change, Pose , Qiet, Heart beat, Times to get up, Sleep area, Skin color, Voice Cadence, Lights on/off, To on/off, Phone discuss, Yell/Shout, Tearful, Rot eyes

2. Fuse cues into events
   depression symptoms, momma
   
   гал-лой, location_change, motion_slow, heart_rate_change, Working Memory

3. Combine events to infer depression
   
   Psychomotor agitation
   Insomnia
   Depression Mood
   Reduced Interest
   Depression

Innovative approaches for Telemedicine and eHealth - Intelligence
Innovative approaches for Telemedicine and eHealth – The domains

Services

- Health tracker App
- Innovative approaches for Telemedicine and eHealth
- The domains

- Ehealth
- Well-Being
- Professional Training/Support
- Assistive Living
- Emergency
Innovative approaches for Telemedicine and eHealth – Intelligent wellness Platform

www.iWelli.com
Innovative approaches for Telemedicine and eHealth – Intelligent wellness Platform
Thank You

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