

## Project PLAYMANCER

Serious Game and Multi-Modal Interface applications for Mental health and Physical Rehabilitation



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www.playmancer.com : www.playmancer.eu



- Serious games offer alternative gameplots and tools via the same technological base as used by Computer Games in order to attract children to more serious problems and topics.
- Serious games can be compelling, educative, provocative, disruptive and inspirational.
- 3D Games for entertainment more and more tend to reproduce reality (in 3D, physics, etc.). They even tend to embrace violence
- 3D Games can be more than that : Imagination, Fantasy, Poetry, Illusion

#### Serious game for mental health



- Personal Investigator → 3D Internet therapeutic detective game, targeted at engaging adolescents suffering from mental health problems such as depression.
  - Earthquake in Zipland → Assists children 9-12 years old to overcome a parental divorce or separation Re-Mission → video game for kids who are cancer patients, helps them to understand and manage their disease better

EyeSpy- The Matrix → A self-esteem game against social phobia





Sign.com Page:



- NEAT-o-Race → rewards the user when she walks by daily scoring points against real or virtual opponents.
- Nike+ Sports Kit → Smart sport shoes that communicate running statistics to Apple iPod/iPhone.
- IREX → assists in muscle motor rehabilitation using 2D optical recognition of player's motions with a low-cost camera
- Nintendo Wii Fit + balance board → Helps with balance rehabilitation and provides exercises for certain muscle groups.



**Palm Treo** 

Database



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#### Table 1: Worldwide video game market, by geographical area

Source : IDATE, September 2009

(million EUR)	2009	2010	2011	2012	2013
Asia/Pacific	12137.2	13178.5	14 433.4	15 739.7	17 746.8
EMEA	19 732.2	19 446.5	19 158.7	19 108.8	22 341.8
Latin America	2 062.5	2 162.8	2 277.1	2 354.6	2 691.1
North America	17 058.5	15 823.0	14 933.2	15 669.6	18 525.2
Total	50 990.4	50 610.8	50 802.4	52 872.7	61 304.9

• Serious games are nothing more than video games with a utilitarian purpose

## Innovation in using serious games: the project PlayMancer

- PlayMancer is a Games for Health research project aiming at implementing an environment for serious games by augmenting existing 3D gaming technology
- Two Playmancer games have been developed:
  - one for physical rehabilitation, and
  - one for therapeutic support / lifestyle management programs for behavioral and addictive disorders

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• each with a different set of input devices.



- to construct a next generation networked gaming environment :
  - augmenting the gaming experience with innovative ICT modes of interaction between the player and the game world,
- 3D game-like world
- Distributed playgrounds
- Multi-modal interaction:
  - Speech
  - Motion tracking
  - Bio-feedback
  - Immersion

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- Systema Technologies S.A. (Coordinator) Athens - Greece
- Netunion s.a.r.l.
  Lausanne Switzerland
- University of Patras, The Wire Communications Laboratory
  Patras Greece
- Technische Universitaet Wien
  Vienna Austria
- Fundacio privada institut d'investigacio biomedica de bellvitge Barcelona - Spain
- Universite de Geneve
  Geneve Switzerland
- Serious Games Interactive (SGI)
  - Copenhagen- Denmark
- Roessingh Research Development BV (RRD)
  - Enschede- Nederlands



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#### Meet the users : Project use cases



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# Usercase 1: John, the gambling addict

- John is a pathological gamble addict. He receives psychiatric treatment by Dr.Tom. Dr. Tom, apart from the traditional therapy, puts John into an experimental treatment program of 17 sessions, including a pro- and a post- session.
- Except of the questionnaires and other assessment tests, John is presented each time with a computer game, titled PlayMancer island. Dr. Tom escorts John in a room where there exist 2 PCs. Dr. Tom is sitting on one, John on the other. On Dr. Tom's command, John starts playing the game.

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- John's avatar explores a deserted island, and learns to relax and control himself. He may use the keyboard or mouse or even speech for more complex commanding of his environment.
- John is wired to a bio-feedback device, while all his in-game actions are monitored. Dr. Tom is controlling the game session, and gathers all data for post-processing.
- At the end of all sessions, Dr. Tom is assessing John's progress, judging from John's behavioral variations during the therapy.
- Dr.Tom is happy to conclude about the medical value of PlayMancer when used properly in therapeutical programs with patients suffering from mental or behavioral disorders.

# Use case 2: Mary, the stroke accident patient

- Mary suffers from cerebral hemorrhage in the right brain hemisphere after a serious stroke. She is treated in a hospital by Dr. Gus.
- Dr. Gus, after having being informed of a new rehabilitation method through games, is adding PlayMancer "Around the world" game in his therapeutical program for Mary.
- Mary is guided once per rehabilitation session in a room where there are 2 PCs. On one sits Dr. Gus, while the other is sitting on the other end of the room. Mary is instructed by Dr. Gus to stand in a marked area ontop of a balance board. On the four corners of this area four infrared cameras are attached on the ceiling.

# Use case 2: Mary, the stroke accident patient



- By the time the game starts, Mary moves her body or her arms swaying on the balance board while she controls an avatar that flies on a magic carpet on the big screen in front of her. She moreover squeezes a small ball-like device in order to get objects that are getting in her avatar's way, and uses speech for complex commands.
- The wireless motion tracker system captures her movements, and Dr. Gus is controlling all the game variables while gathering the game session data for later assessment.



- The game environment recognises in run-time the player's emotional state using the following modalities:
  - Optical recognition of her face expressions (through a camera)
  - Voice-processing of the player's utterances
  - Bio-feedback from player's physiological measurements (Heart rate and variability, GSR, ECG, ...)
- The recognised emotional state of the player regulates some game parameters. The aim of the Cognitive-Based Therapy that the game is supporting is the player to improve certain characteristics less susceptible to change through regular therapy, such as:
  - temperament and personality traits,
  - deficits in concrete skills [build and keep schedules],
  - emotion recognition, emotion management
  - self-control

## Mental Health game: screenshots of project PlayMancer



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- The physical functioning of patients with chronic pain is often due to the deconditioning and/or disuse syndrome of the painful muscle(s). According to cognitive-behavioural models, patients with chronic pain often develop a vicious circle of maladaptive pain-related cognitions (i.e. fear of movement) and coping strategies (i.e. avoiding physical activities) and physical disuse.
- The player is standing or running on a stepper machine, wearing a special suit that facilitates the motion capture system, away from the computer
- Player motions are recognised in real-time by an optical-based motion tracking system
- EMG from aching muscles and the player's speech commands are used to steer the game play
- The aim of gaming is to improve the physical condition of the patients on a motivating and attractive manner. A set of mini-games that demand from the player to correctly perform given exercises serves this aim.

#### Rehabilitation game: Screenshots of project PlayMancer







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#### **Behavioral and Addictive disorders**

- Where the information for the therapist comes from:
  - Oral information from the patient
  - Body language
    - Expressions of the face
    - Body movement (hands, head, ..)
    - Behavior of the patient
    - Voice intonation
- Other sources of information that are more difficult to detect
  - Heart rate and heart rate variations
  - Transpiration
  - Overall body muscle activity



From therapist to electronic system for routine consultations

- Minimally intrusive system ideally non-intrusive
- Very short installation time (for the patient) ideally zero
- Simple set-up for the consultation

Shortcomings of the HUMAINE project results:

- Low success rate (66%)
- Intrusive system (EMG, ECG and respiration require a rather long installation procedure)
- No face expression recongition



The Playmancer set-up for addictive disorders will be based on:

- Voice and intonation identification (non-intrusive)
- Heart rate and heart rate variation (minimally intrusive)
- Skin conductivity (minimally intrusive)
- Face expression (non-intrusive)

# Overview of the ICT platform



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- Speech emotion signal processing
- Galvanic skin (monitoring) signal processing, Oxygen saturation and Heart rate and heart rate variation (monitoring) signal processing
- Facial expression (recognizer) signal processing
- Multimodal Emotion Fusion
- EMG (monitoring) signal processing
- Optical motion tracking (iotracker) signal processing
- Body State Fusion
- ASR signal processing
- PlayMancer game platform
- Visualization and analysis client
- Calibration and Tuning Component



- Bio-Sensor physiological vital signal based emotions' recognition
- Video based facial emotion recognition
- Speech based emotion recognition

Fusion of the multimodal emotion recognition results

### **Body Area bio sensor network**

- Body Area Network
  - sensors
    - psychophysiology, e.g., ECG, temp, resp
    - context, e.g., location, time, activity
  - actuators
    - feedback via, e.g., audio, visual, tactile, light
- Application Domains
  - wellness, clinical, performance, safety, ...
  - research: medical, psychology, social sciences, ...





- Which systems are available off-the-shelf
  - different technologies and objectives
- Which requirements are put on BANs? – different application domains





ActiveTwo by <u>віо</u> бемі

g.MobiLab+by GUGER TECHNOLOGIES

LifeShirt by VivoMetrics







Zephyr

BioHarness by













TeleCliniq by

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NeXus-4 by

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- psychophysiological, bio-kinetic and context measures: raw/derived
  - ECG, temp, resp, SpO2, ..., acc, location/time
  - sample frequency/resolution, sensitivity/accuracy, drift
- intra-BAN connectivity: wired, IMS, Bluetooth, ...
- extra-BAN connectivity: wired, WiFi, 2.5G/3G, ...
- support for mobility and mode of data transmission
  - local vs remote, offline vs (near) real-time
- usability
  - wearability, size/weight vs battery lifetime
- security and privacy e.g., encryption
- programmability by the end-user, possibility of exporting raw data
- compliance with standards e.g., HL7
- clinical validation
- market availability and price

#### How the emotions are recognised

# Bio-Signal based Emotion recognition

- Specialized interface for emotion annotation during training
- Rule based system
- Multiple iterations for the improvement of the rules



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- Anger
- Joy
- Frustration
- Sadness
- Surprise
- Neutral Boredom



HeartRateVar > 3.5) and (PulseRate <= 67.5) and (ECGI <= -514257.5) => ViewerMark = 3 (58.0/0.0) [32.0/0.0] Except (AuxResp > 1926657.5) => ViewerMark = 9 (9.0/0.0) [40/0.0] Except (ECGI <= -966130.5) => ViewerMark = 9 (9.0/0.0) [40/0.0]



TP (true positive) and FP(false positive) per class variable [that is per emotion category], and overall Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE).

Algorithm	weighted avg TP	weighted avg FP	MAE	RMSE	
Decision Table	0.992	0.002	0.0766	0.1421	
Decision Table Naïve Bayes hybrid	0.996	0.001	0.0082	0.0372	
Jrip	0.969	0.01	0.0054	0.0714	
One Rule	0.984	0.005	0.0027	0.0518	
PART	0.993	0.002	0.0012	0.034	
Rlpple DOwn Rule Learner (Ridor)	0.994	0.002	0.0009	0.0306	

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#### **Facial emotion recognition**

#### **Presentation by Maher ben Moussa**



#### **Speech based emotion recognition**

Emotion modelling is performed via training diagonal covariance matrix Gaussian Mixture Models .



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#### **Completed first non-patient trials**

First level calibration of tools

#### Trials with real patients are starting this week.

- Will last 4 months
- Expecting recalibration at the end of the trials



- Elderly monitoring (AAL Trainutri)
  - activity and nutrition
- Emotional state (FP7 Playmancer)
  - <u>6 emotions</u>





- Serious Games is an attractive medium for:
  - Education
  - Training
  - Health
    - Psychological treatment
    - Rehabilitation
  - Defense
  - Data collection and knowledge discovery
  - Communication and social networking
  - E-Governance
  - Activism
  - Marketing
  - Other...
- PlayMancer is just a small atoll in an ocean of possibilities