Pervasive Interaction
New research Group – Formerly PRIMA

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Situated Interaction with Smart Objects

Research Objective:
Develop theories and models for natural, unobtrusive interaction with systems and services that are dynamically composed from collections of interconnected smart objects

Approach: Draw on theories from cognitive systems, ergonomics, machine perception and human-computer interaction.
The Pervasive Interaction Team

James L. Crowley (Computer Vision, Robotics, Multi-modal interaction, Context aware computing)
Patrick Reignier (Robotics, Context Aware Computing)
Sabine Coquillart (Augmented Reality, 3D interaction)
Emmanuel Mazer (Bayesian Reasoning)
Dominique Vaufreydaz (Speech Recognition, Affective Computing, Service Robotics)
Thierry Fraichard (dynamic motion planning, social robotics)
Research Program

RA 1 Situation models for context-aware systems
   1.1 Techniques for learning and adapting situation models
   1.2 Reasoning about actions and behaviors
   1.3 Algorithms and data structures for situation models

RA 2 Perception of people, places and things
   2.1 Perception of people, actions, activities and emotions
   2.2 Recognition of activity from environmental sensors and electrical usage
   2.3 End User Development of Context Aware Services
   2.4 Perception of location, activity and context from embedded sensors on Mobile Devices

RA 3 Sociable Interaction with Smart Objects
   3.1 Moving with people
   3.2 Understanding and communicating intentions from motion
   3.3 Socially aware interaction
   3.4 Stimulating Affection and Persuasion

RA 4 Interaction with Pervasive Smart Objects
   4.1 Wearable, tangible and ambient interaction
   4.2 Pervasive interaction with ecologies of smart objects in the home
   4.3 Ubiquitous augmented reality
P.I. - Research Program

RA 1 Situation models for context-aware systems

RA 2 Perception of people, places and things

RA 3 Sociable Interaction with Smart Objects

RA 4 Interaction with Pervasive Smart Objects
RA 1 Situation models for context-aware systems

Objective
• Theories and models for Interaction with Context Aware Systems

Approaches:
• Situation Models (Johnson-Laird 83) for organizing systems.
• Developmental learning for acquisition and adaptation. (Weng 2004)
• Tools for programming of situated systems and services.

Research Axes
RA 1.1 Techniques for learning and adapting situation models
RA 1.2 Reasoning about actions and behaviors
RA 1.3 Algorithms and data structures for situation models

Situation Models are widely used in Cognitive Psychology to describe human abilities for

1) Providing context for story understanding
2) Interpreting ambiguous or misleading perceptions.
3) Reasoning with default information
4) Focusing attention for problem solving

Proposal: Use situation models as a software framework for systems and services that interact with humans
Situation Models: as a theory for context aware services

Situation Graph: A network of situations with transition conditions
- Each situation specifies: Entities to observe, actions to take,
- Behaviors for sensing, action, interaction, changes to state and context.

Context Model:
A specific set of entities, relations, behaviors, situations and transitions.
A Theory for Situated Perception and Action

Situation Models drive Perception and Action

Situation model enables:
- **Assimilation**: interpretation for entities, relations and events
- **Projection**: Transition probabilities for possible next situations
- **Implication**: Possible outcomes of actions
- **Decision**: Appropriateness or inappropriateness of actions.
- **Attention**: Relevant entities and properties to perceive
Early Examples of Situation Modeling

Examples of situation aware systems constructed by the PRIMA group
- Privacy filter for MediaSpace
- Lecture recording system (IST FAME)
- Activity monitoring for assisted living (ANR CASPER)
- Polite, social interaction with robots (Barraquand 08)

Examples constructed in IST CHIL (multi-modal services)
- Memory Jog (non-obtrusive memory prosthesis)
- Context aware Mobile Phone manager
- Meeting minute recording system
Recent Examples of Applications

1) Event Recording (Startup MeanInFull - 2014)
2) Video Surveillance (Startup BlueEye Video – 2003)
3) Customer monitoring (Start up: HiLabs - 2008)
4) Actimetry and monitoring for Elderly and Handicapped
5) Socially-Aware Human-Computer Interaction
6) Context aware mobile applications (Start up: Situ8ed 2015)
7) Sociable Systems (Startup planned for 2017)
RA 2 Perception of people, places and things

Objective
• Provide perceptual components for interaction with Pervasive Services

Approach:
• Build on recent progress in Visual, Acoustic and Environmental Sensing
• Emotions as trajectories in physiological parameters (Pleasure-Arousal-Dominance)
• Directed perception organized as a process of assimilation, projection and implication (Endsley 95)

Research areas:
RA 2.1 Perception of people, actions, activities and emotions
RA 2.2 Recognition of activity from environmental sensors and electrical usage
RA 2.3 Perception of location, activity and context from embedded sensors on Mobile Devices
MinImage: Integrated Vision System for Mobile Devices

Applications include:
- Face Detection and tracking
- Face Stabilisation
- Age Estimation
- Face Orientation
- People Counting
- Face expression recognition
- People tracking
- Logo detection and recognition
- Text detection
- Localisation and Mapping
Multi-scale Target Detection and Tracking
On mobile platforms
Face Orientation Estimation

- Face Detection
- Face Tracking
- Normalised Imagette
- Multiscale Gaussians Derivative
- Multiscale Derivatives
  - 1st, 2nd order, 2 scales, all pixels
- Principal Component Analysis
  - Support Vector Regression
    - Pitch Angle
  - Support Vector Regression
    - Roll Angle
Smile Detection Example
RA 3 Sociable Interaction with Smart Objects

Objective
• Theories and models for polite, socially aware interactive systems

Approaches:
• Explicit models of social roles, relations and situations
• Developmental learning for acquisition and adaptation

Research Axes
  3.1 Moving with people
  3.2 Understanding and communicating intentions from motion
  3.3 Socially aware interaction
  3.4 Stimulating Affection and Persuasion
Sociable Interactive Agents

- Virtual or mechanical agents
- Coupled with Perception, Action, Cognition and Communication
- Using speech, vision, gesture, illumination and other modes for interaction
- Situated social interaction

AIBO

NAO

Jibo
Sociable Interactive Agents
Sociable Interactive Agents

Systems that interact with people and with each other in a socially situated (appropriate, polite) manner.

Scientific And Technological Challenges
1. Robust perception and action
2. Natural multimodal interaction (including spoken language)
3. Affective Computing (Perception and stimulation of emotions)
4. Developmental learning
5. Situation Awareness

Sociable systems and services will appear to people as intelligent.
Human Robot Interaction

1. Situation understanding
   - Persons/objects detection
   - Activity recognition

2. HRM concepts identification
   - Personal/Activity spaces
   - Attention

3. Navigation schemes design

Projects proposed by Thierry Fraichard
RA 4 Interaction with Pervasive Smart Objects

Objective
• Theories and models for immersive, non-obtrusive interaction with pervasive media

Approaches:
• Ecological sensing and interaction
• Explicitly model and minimize barriers to immersion.
• Sensory substitution

Research Axes
4.1 Wearable, tangible and ambient interaction
4.2 Pervasive interaction with ecologies of smart objects in the home
4.3 Ubiquitous augmented reality
M2R Project 1: 
Observation of Human Emotions

Directed by James Crowley and Dominique Vaufreydaz

ANR research CEEGE (Chess Expertise from Eye Gaze and Emotion) 
Joint project with Center for Neurocognition University of Bielefeld

Challenge: evaluate the effectiveness of visual techniques for measuring these physiological manifestations of emotion during chess play

Data recording from a color camera, Kinect2 3D camera, and Tobi Eye Tracker.
M2R Project 1: Observation of Human Emotions

Objective: Use vision and eye-tracking to estimate attention and measure emotions (PAD space) in chess players.

The PAD (Pleasure, Arousal, Dominance) emotional state model is used to study nonverbal communication such as body language in psychology.
Project #2 Mobile Robots among People

Two challenges: robot motion must be SAFE and APPROPRIATE
Interested? Check PCARRE or get in touch with thierry.fraichard@inria.fr