RESPONSIVE FLEXIBLE COLLABORATING AMBIENT

Smart Chairs
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La révolution des objets communicants & Intelligents pour la Sante et le handicap
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Overview

- Motivation
- Reflective Approach
- Reflective Framework
- A Smart Chair
- Medical Applications
Motivation (HMI vs. MMC)

Nowadays, when computers have become an integral part of our everyday surroundings, HMI is obsolete!

It is necessary to re-thing and re-design ways in which we cooperate with computers.

- The ideal man-machine confluence (MMC) is the one that minimises explicit interaction and maximises the functionality of the system.
- The goal is to avoid giving commands to a control system, but rather enabling the system to understand what is needed in given circumstances.
- Individually customized, not for a generic ‘everyman’ user, but tailored to the specific needs of an individual in a defined place at a precise time.
The aim of the cognitive loop is to monitor the level of mental effort exerted by the user during task activity in order to prevent:

- **information overload**
  - too much to process in given time
  - safety-critical performance
- **task disengagement**

- Biocybernetic loop
- Reflective computing
- Reflective ontology
- Reflective architecture
- REFLECT framework
  - Transparent distribution
  - Component-based support
  - Dynamic and Flexible Architecture
- Theoretically sound and safe

### Software

- Emotional loop carrier
- Cognitive loop carrier
- Closed loop
- Tangible layer
- Reflective layer
- Application layer

### Physical loop carrier

- Demonstrator Ferrari
- Numerous experiments

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Detecting uncomfortable positions

- Sitting is one of our major "motor activities" ...
- Considered a “motor milestone”, it is studied also from one’s earliest childhood, for example to detect development pathologies such as cerebral palsy (Hedberg et al., 2005; Gesell, 2007; Deffeyes et al., 2009).
- Localized contact stresses are identified as one of the main responsible of sitting discomfort:
  - prolonged pressures → blood flow reduction at the buttock/seat interface → discomfort
Detecting uncomfortable positions

- The terms “Fidgeting” or “In-Chair Movement (ICM)” are used to describe the constant slight posture changes that people do while sitting.

- Increase of these movements is directly linked to increase of perceived discomfort (Hermann, 2005).
Detecting uncomfortable positions

- While sitting in a car during driving, the pilot and the passengers are also subjected to vibrations generated by the vehicle and the different types of road surfaces.
- To compensate for these vibrations, the human body reacts with micromuscle adjustments.
- This behaviour, combined with the above-mentioned seated-position issues lead to a faster degradation of perceived comfort.
Detecting uncomfortable positions

- The main efforts of researchers dealing with car sitting comfort seem to aim at helping car manufacturers in designing more comfortable seats.
- But, since sitting comfort appears not to be a static issue, a new concept called “adaptive seat” deploys adaptive loop control to perform dynamic modification:
  - sensors are used to continuously measure the driver’s seating posture - according to a proper “seat adaptation strategy”
  - actuators integrated in the seat are activated in order to modify the seat’s shape (and therefore driver’s posture).
Proposed solution

Components:
- USB camera
- Q1 Ultra mobile PC (Samsung)
- REFLECT middleware
- Drowsiness detection
- Speakers, Seat
The REFLECTive Seat Adaptation prototype

- **The Seat adaptation prototype** is a system for identifying and possibly enhancing the physical state (comfort) of end users (drivers).

  - It monitors the postural behaviour of a car driver, (and the state of the road) detecting whether he/she feels uncomfortable
  - It acts on the car seat in order to help the driver in finding a more comfortable position.

- This prototype is based on the **REFLECTive middleware** proposed and developed within the REFLECT project.
The REFLECTive Seat Adaptation prototype

- A dedicated electronic control unit is responsible for controlling all the motors and other actuators the seat is equipped with.
- The driver, before starting the engine, can easily tune the seat position according to his/her preferences, just by pressing the buttons and joysticks available at one side of the seat itself.
The REFLECTive Seat Adaptation prototype

- A seat is provided with a wide range of adjustments (seat and backseat positions, heating, ventilation…), in particular
  - four couples of air inflating cushions:
    - **seat cushions**
    - **backseat cushions**
    - **lumbar cushions (high)**
    - **lumbar cushions (low)**

- The Seat adaptation system acts on these cushions in order to modify the shape of the seat.
The REFLECTive Seat Adaptation prototype

- The pressure map at the driver-seat interface is used as an indicator of sitting behaviour.
- As vibrations have shown to have a role in drivers’ sitting comfort, also vertical accelerations are taken into account.
- The raw data, collected by means of a matrix of pressure sensors, an accelerometer, and a proper acquisition device, are processed to calculate:
  - COP coordinates, then COP speed.
  - number of bumps per minute
- The system decides whether to act on the seat (inflating/deflating cushions) to improve sitting comfort.
Seat Adaptation: System design
Detecting uncomfortable positions

- Fluctuation of the centre of pressure and pressure distributions of a subject sitting on two different chairs: In-Chair-Movements are more evident when the subject is sitting on an “uncomfortable” chair
Preliminary tests

Aim

- to get a very first feedback on the effects of inflating air cushions and sitting behaviour in different conditions (both simulated and real).
Possible further use in medical application

- The REFLECTive Seat Adaptation could be very helpful in medical applications, e.g.:
  - Adaptive wheelchair cushions
  - Adaptive hospital beds
- Some patients are not capable to do the normal in-chair-movements (and "in-bed-movements") that healthy people can do while sitting (or lying on a bed).

- Prolonged pressures $\rightarrow$ blood flow reduction at the buttock/seat (body/bed) interface $\rightarrow$ discomfort $\rightarrow$ pressure ulcers (decubitus ulcers)
Smart Seat

- Systems for decubitus ulcers prevention are currently available, but they use mainly alternative inflating/deflating strategies.

- In the “REFLECTive seat adaptation” sensors are used to detect the posture and to act on actuators in order to adapt the seat accordingly.

Smart Bed

- ANTIDECUBITUS BUBBLE MATTRESS alternating air exchange, made of medical PVC and Polyurethane (by COMETE, Italy; [http://www.cometemedicali.it](http://www.cometemedicali.it))

- Reflective bed could use sensors to detect discomfort and reshape the bed.
- It could also act to improve muscle tension and blood circulation.
REFLECT Project: “What you feel is what you get”

Under the motto “The best assistant is the one that you do not notice!” the REFLECT project investigates ways of realizing pervasive-adaptive environments. A software framework with a set of practical tools has been developed which can be used for building pervasive, adaptable, self-organized systems that seamlessly collaborate with users (based on the emotional, cognitive, physical and behavioural awareness) and control their environments.

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