Biomimetic Decision Making in a Multisensor Assisted Living Environment

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Aim and Novelty

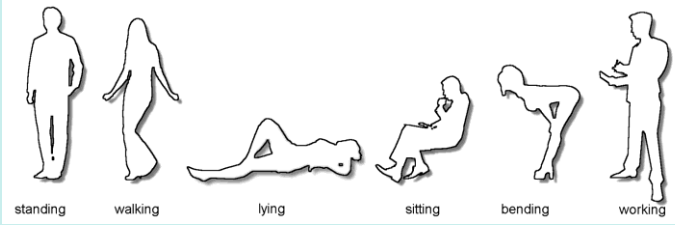
The proposed **surveillance system** consists of several complementary sensors based on different physical principles. Considering an optimal performance of the system in wide range of possible human actions, we propose a **dynamic modulation of sensors' contribution**, which is the main novelty of this paper.

Studying the rules of information propagation in living neural systems, we focused on two different types of chemical synapses:

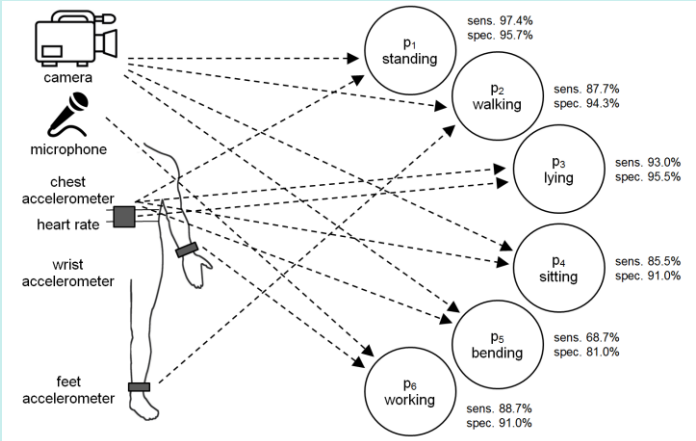
- ionotropic, with quick and short synaptic response, specialized in fast sensory or executory, excitatory or inhibitory pulse messaging,
- metabotropic, with delayed and long standing response, which role is modulation of the pulse conduction.

Multisensory surveillance system for elderly

1. what are elementary poses?



2. how are they detected?



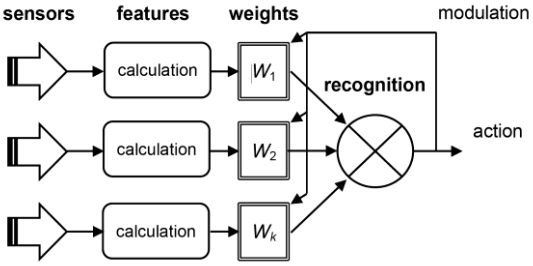
How good perform individual sensors?

activity	best	good	moderate	worst
standing(up)	ACC	EMG	Video	Pressure
standing(down)	EMG	ACC	Video	Pressure
walking(right)	Video	EMG	Pressure	ACC
walking(left)	EMG	Pressure	Video	ACC
lying(getting down)	ACC	EMG	Video	Pressure
lying(getting up)	EMG	ACC	Video	Pressure
sitting(getting down)	EMG	Pressure	ACC	Video
sitting(getting up)	EMG	Pressure	ACC	Video
bending(forward)	ACC	EMG	Video	Pressure
bending(return)	ACC	Video	EMG	Pressure
working(right)	EMG	Video	ACC	Pressure
working(left)	EMG	Video	Pressure	ACC

- we performed a detailed quantitative analysis of recognition rate
- the variability of performance reveals the need fo modulation of sensors contribution depending on subject's state

Architecture of multisensor environment for assisted living

The proposed innovation replaces the selector by a modulator using weight coefficients W_k

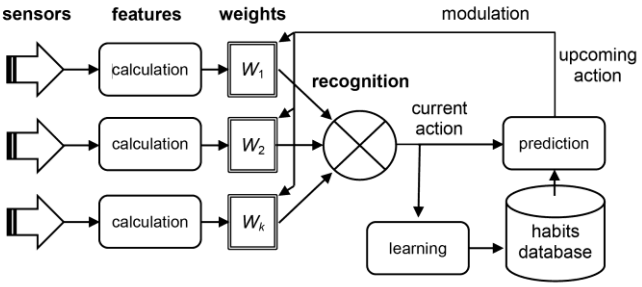


Let f be a function $t = f(S_k;W_k)$ assigning a unique subject's action t to specific sensor outputs S_k modulated by W_k. Let m be a function $W_k = m(t)$ modulating the contributions from sensors S_k to maximize the reliability of the recognition of t Therefore, the modulator is stable if:

$$\forall f : f(S_k, W_k) = f(S_k, m(t))$$

Predictive modulation of sensors' contribution

We propose to use the information from the habits database to predict the subject's upcoming action and adjust the sensor's contribution accordingly.

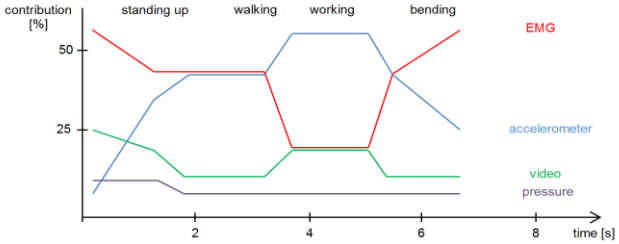


Introducing the habits database in the feedback path has two benefits:

- prediction of upcoming action takes into account multimodal time series instead of single points, what stabilizes the prediction in case of singular recognition error,
- focusing on optimal recognition for current action makes the system conservative, whereas optimizing for future action makes it progressive (i.e. awaiting changes of the status).

Case Study

We used previously recorded data from 20 volunteers (8w/12m, age 20-61), acting accordingly to predefined realistic scenarios.



The tachogram presents sensor contribution to recognition of an example compound action of searching a book on a wall-mounted shelf, consisting of: standing up, walking, working and bending.