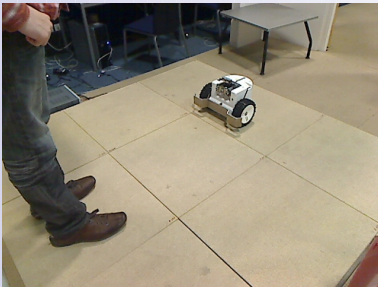# Intelligent Tiles :

Spatial Computing for Actimetry

Olivier Simonin

MAIA team - INRIA Nancy Grand Est – LORIA Lab.
PAL Project

I. Context : intelligent environments

Maia Team : studying *bio-inspired intelligence*

New experimental device

- ➢ Interactive table : active environment for mobile robots

- ➢ Exploring swarm robotics mechanisms

Patrolling with the EVAP Model [Simonin, Charpillet 2010]

PAL project : connexion to the intelligent home

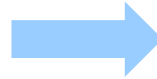where objectives are **Actimetry, People assistance, Medical alarm,** etc.

Smart Appartment at INRIA Nancy
(CPER InfoSitu INRIA/Lorraine & AEN PAL projects)

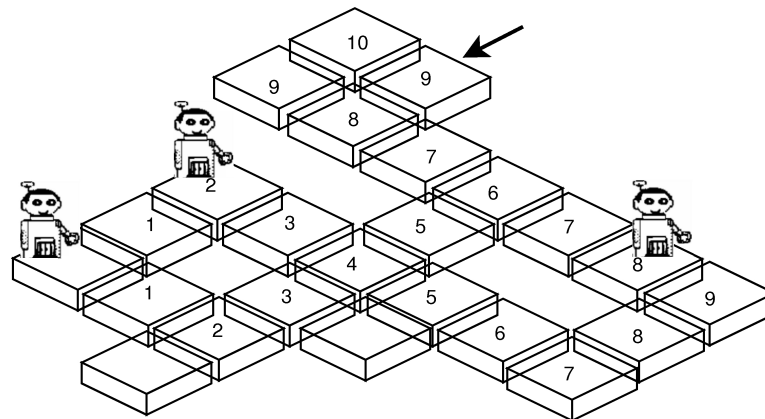# From requirements to intelligent tiles

Intelligent environment ?

- Sensitive
- able to Communicate
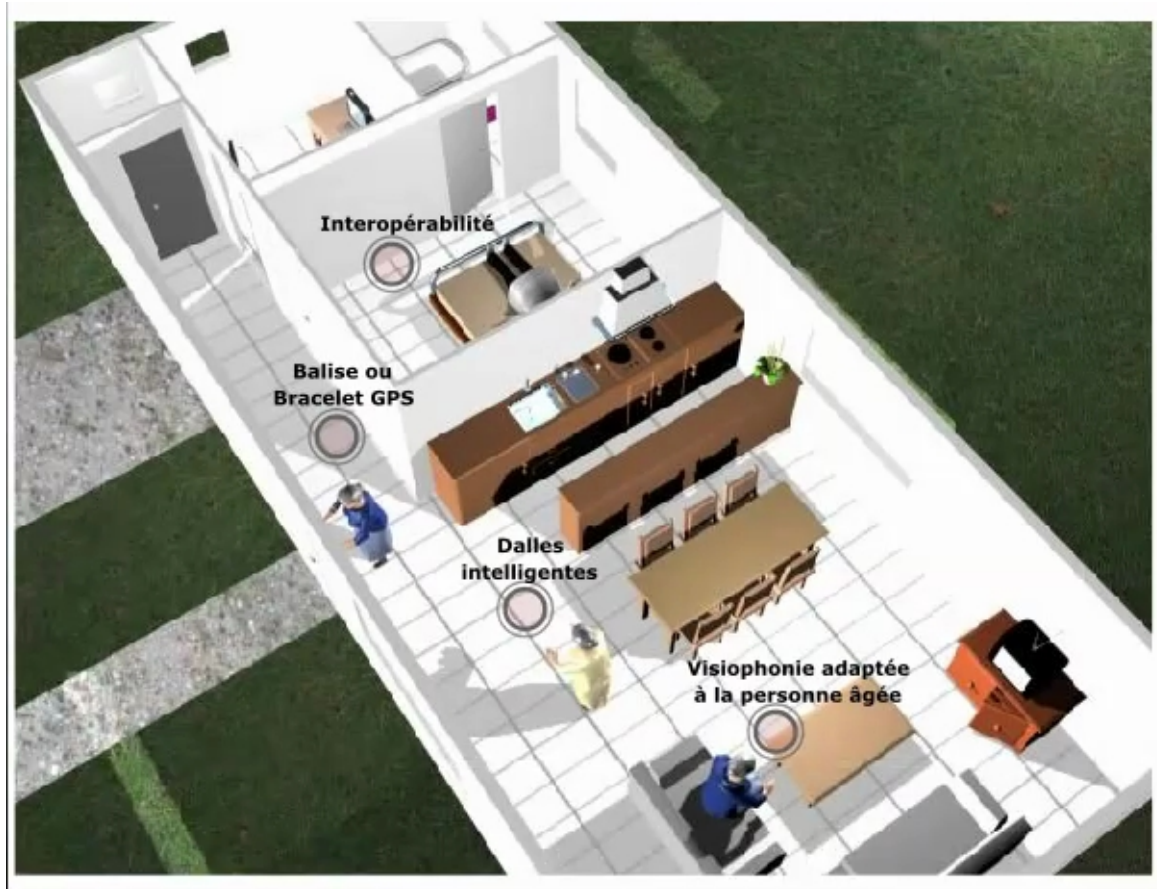- able to Compute
- able to Act

Approach

- Distributed sensors
- Wireless comm.
- Spatial computing
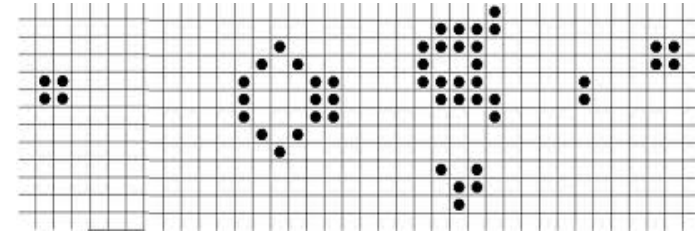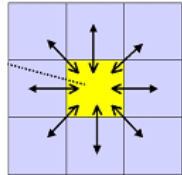- Robots

Intelligent Tiles

iTiles : an illustrative scenario

II. a word on Spatial Computing

Spatial computing ?
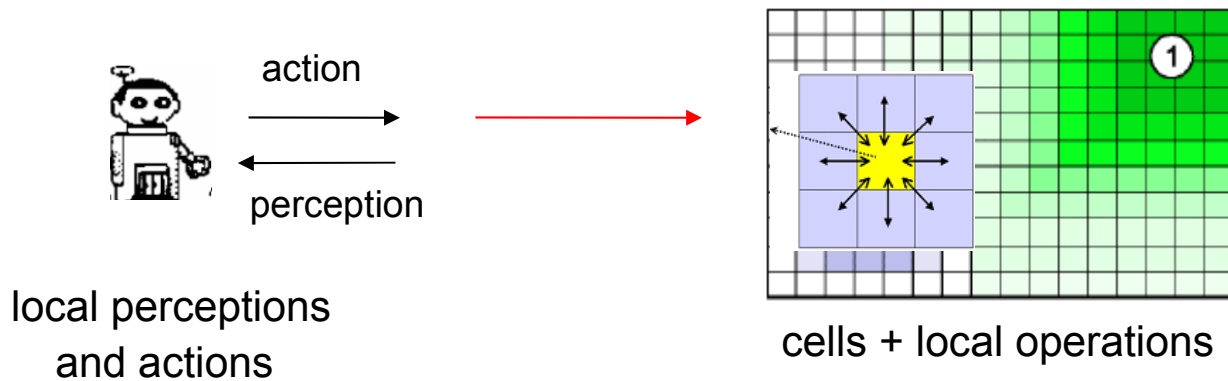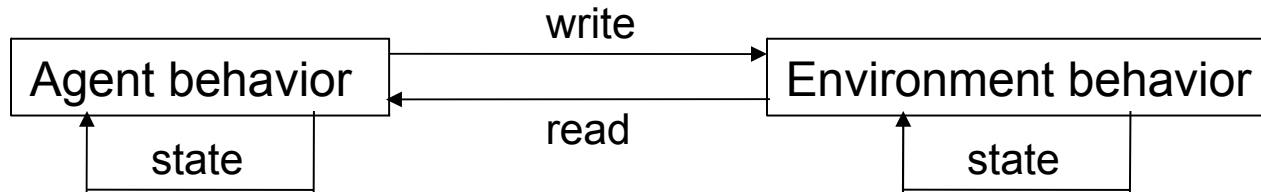
Computation is massively parallel

- Cellular Automata (CA)

- Reactive multi-agent systems

  → Computation is local to cells/agents

  → Emergence of global organization/functions

Supports are also massively parallel or distributed

- GPU, FPGA

- Node/Sensor Networks

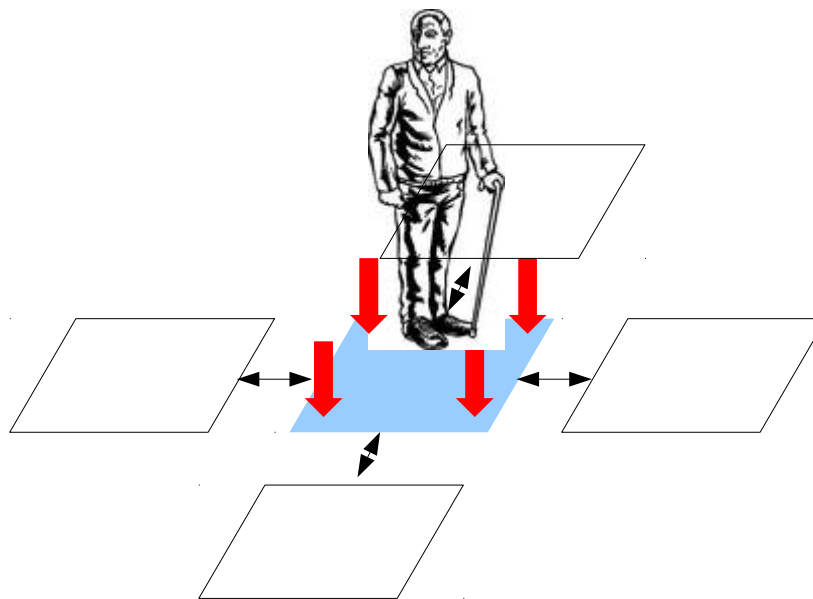- Swarm robotics

Agents & Spatial computing

III. *iTiles* model

i-Tile : a sensitive cell

Each tile owns

- 4 **weight sensors**
- 4 **connexions** with **neighbouring** tiles
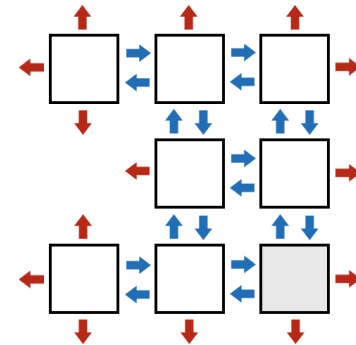- a **wireless communication** with the "walker" (human or robot)

i-Tile : a unit of computation..

Each tile

- executes a **small process (reaction to messages)**
- uses a **limited memory**

Hypotheses on the mesh

- tiles are **independent** processes,
- tiles do **not** require to be **synchronized**.
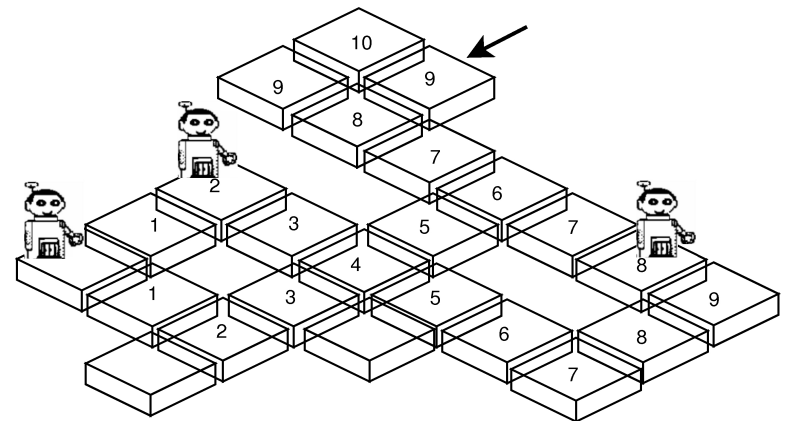
More details in [ICAART'09][CAR'09]

iTiles : expected functions

Surveillance of people

- Following, learning and analysing people **walk**
- Detection of **unusual** situations
- **Diffusion** of alarms

Interaction with assistant robots

- **Path** planning tasks
- Improved **perceptions**
- **Communication**

IV. Prototypes & Experiments

First prototype : interaction with robots

(2010)

Experimental device

Tiles **emulator**

- Tiles are represented on the floor

- Tiles' processes are emulated on a PC

Agents : Khepera III **robots**

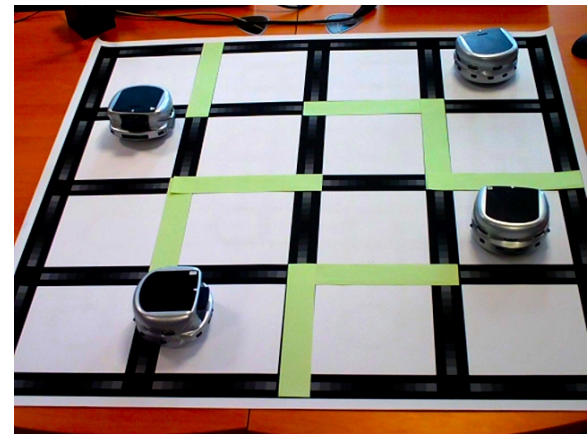- Autonomous

- no global positionning

Interacting with an active environment

Environment

–   **Evaporation** of pheromones

Robots

–   **Reading** and **marking** pheromones

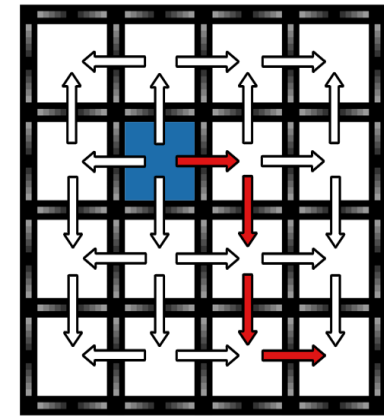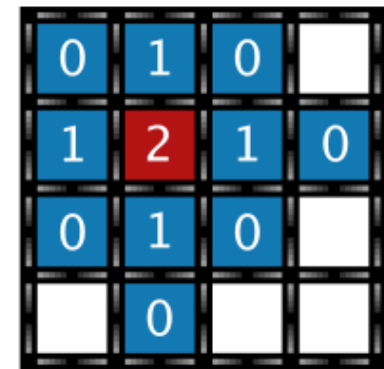

movie

Diffusion in the environment

Demo : signal diffusion and dynamic path planning

movie

(E,S,S,E)

nb_hop = 2 → 0

Second prototype : interaction with people

(2011)

Physical & Electronic Tiles prototype
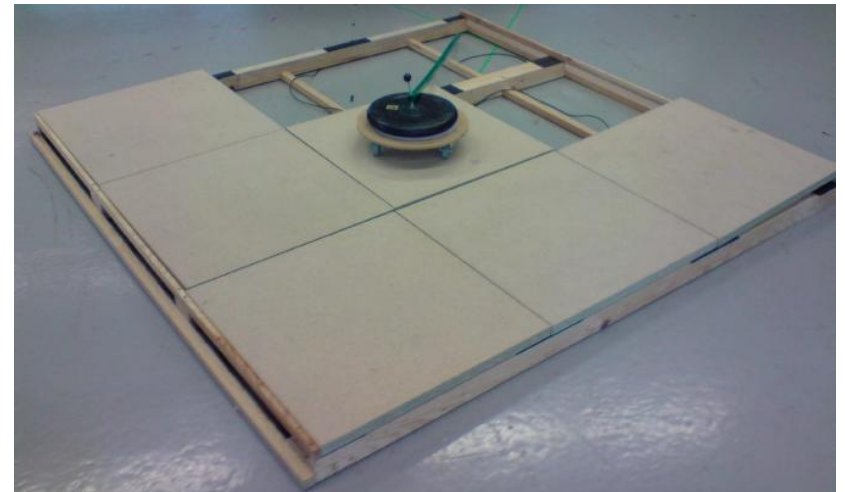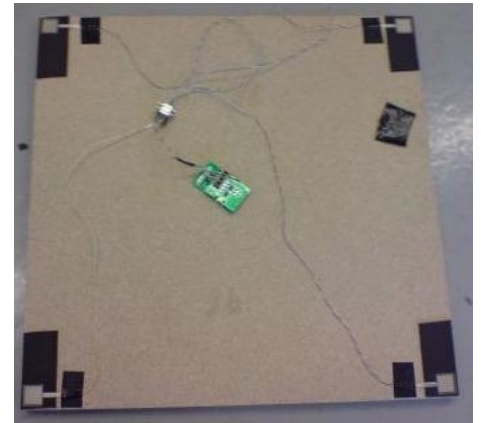
Designed with SED of INRIA Grenoble

Sensors

> 4 FSR weight sensor

Node

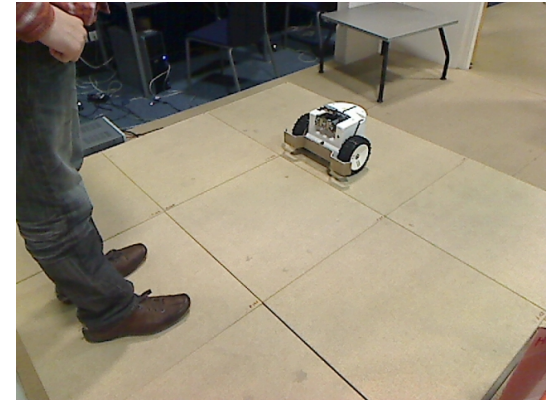> WSN 430 1.4

Communication

> Zigbee

First algorithms and experiments

Sensing and differentiating people and robots

- ➢ Computing centre of gravity

Robots following a person

- ➢ diffusing an attractive gradient from a person

- ➢ following by descending the negative of the gradient

V. Conclusion & Perspectives

Current work and further

Actimetry functions

> ➢ Detection of falls
>
> ➢ Analysing and recording the walk
>
> ➢ Learning people behaviour (activity – rooms – durations etc.)
>
> ➢ Detecting of unusual behaviours

Robot behaviours

> ➢ Following a person without risks (of collision, blocking)
>
> ➢ Communication and coordination between robots
>
> ➢ Search and transport of objects.

Actimetry and medical projects with ..

Nancy – Lorraine medical centres

- ➢ IRR Institut Régional de Réadaptation

- ➢ CHU Nancy Brabois

- ➢ Institut de Réadaptation Florentin
OHS Office d'Hygiène Sociale de Meurthe et Moselle

PAL

- ➢ INRIA teams

- ➢ Smart room Supelec Metz

- ➢ PAL partners