

Robotic Validation of AFM, Scale-freeness, Local Communication etc.

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Outline

Introduction

Update since last meeting in Dec 2009

Short review

Robotic Validation of AFM

Centralized Communication Mode - Global attractive filed sensing

Local P2P Communication Model

Local attractive filed sensing and local P2P communication

Next: Scale-freeness, Random communication

Keeping the ratios of robots, tasks, area etc. constant

Software code, experiments, papers, Hardware up-gradation ...

- ▶ **Software code on *HEAD***
Hybrid Event-Driven Architecture on D-Bus
- ▶ **AFM validation experiments:**
using centralized and local communication
(approx. 15 hours, with 8 and 16 robots)
- ▶ **Three conference papers:**
 - ANTS 2010 (Belgium): *accepted*
 - IROS 2010 (Taiwan)
 - Control 2010 (UK)
- ▶ **Extending robot hardware:**
Bluetooth → Wifi for 16 to 40 robots
- ▶ **Only 3-4 months left:** to wrap-up everything...:-)

What is self-organization... ?

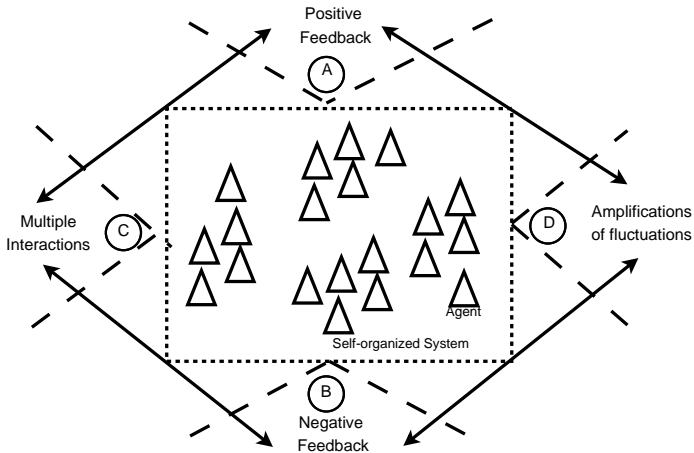
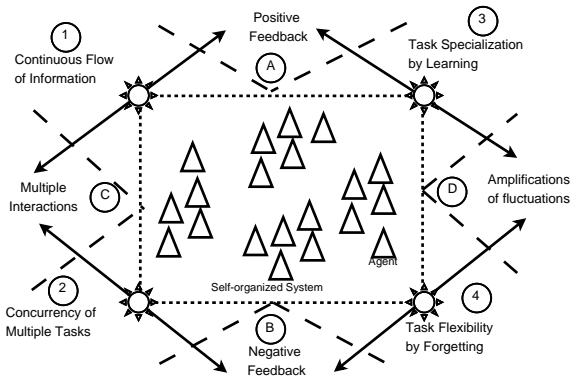


Figure: The 4 perspectives

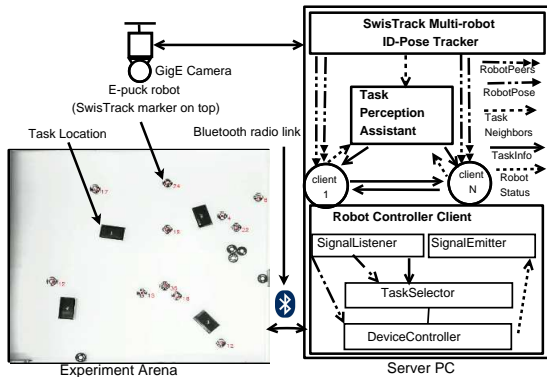
Self-regulation of an agent



So, AFM: the 4 stars in sky of self-organization?



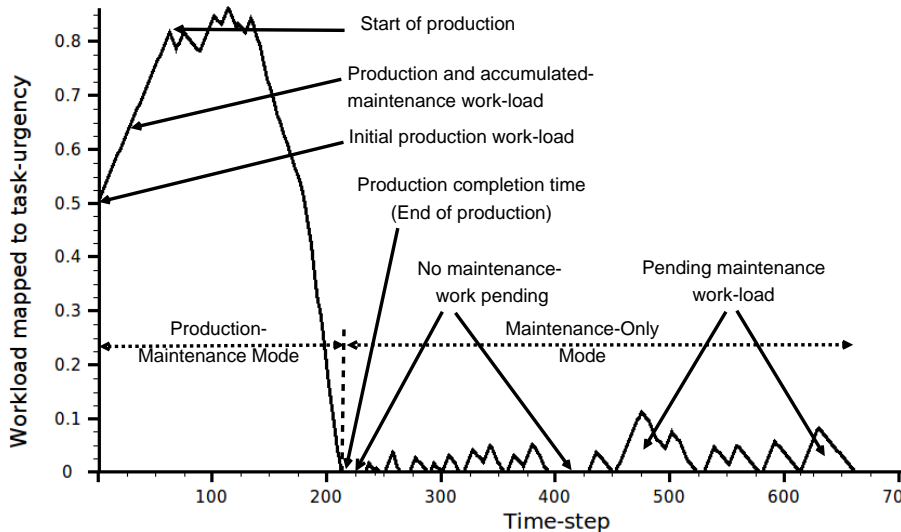
Robotic Validation of AFM



Robots, Tasks, Camera, Bluetooth and **beep beep beep...**

- ▶ 5 x Centralized comm. expt: 8 robots/ 2 tasks/ 2 sq. m. (60min)
- ▶ 5 x Centralized comm. expt: 16 robots/ 4 tasks / 4 sq. m. (40min)
- ▶ 3 x Local comm. mode expt : 16 robots, 1m radii of comm. (40min)
- ▶ 3 x Local comm. mode expt : 0.5m radii of comm. (40min)

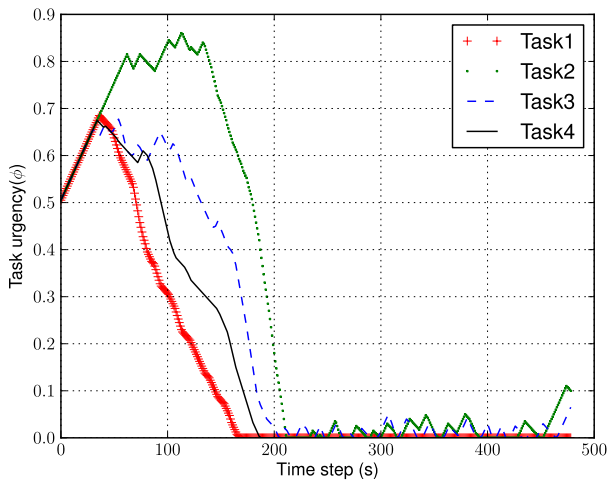
Virtual Manufacturing Shop-floor: **TODO** of Future



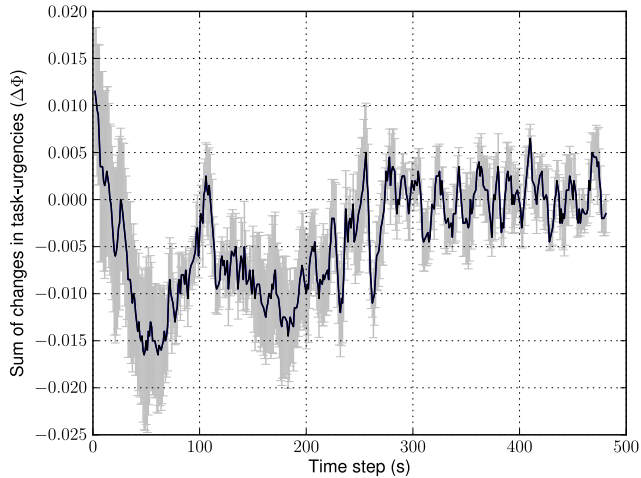
Experimental Parameters: Size doesn't matter

Parameter	Value
Total number of robots (N)	16
Total number of tasks (M)	4
Experiment area (A)	4 m^2
Initial production work-load/machine (Ω_j^p)	100 unit
Task urgency increase rate ($\Delta\phi_{INC}$)	0.005
Task urgency decrease rate ($\Delta\phi_{DEC}$)	0.0025
Initial sensitization (K_{INIT})	0.1
Sensitization increase rate (Δk_{INC})	0.03
Sensitization decrease rate (Δk_{DEC})	0.01
Task info update interval (ΔTS_u)	5s

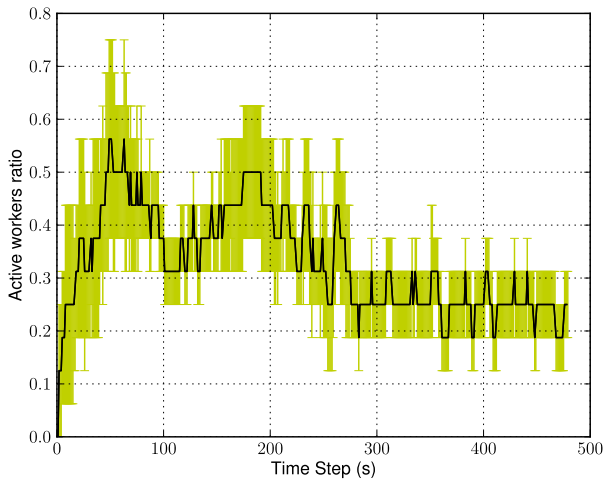
Snapshot of Task Urgencies: **Call for duty..**



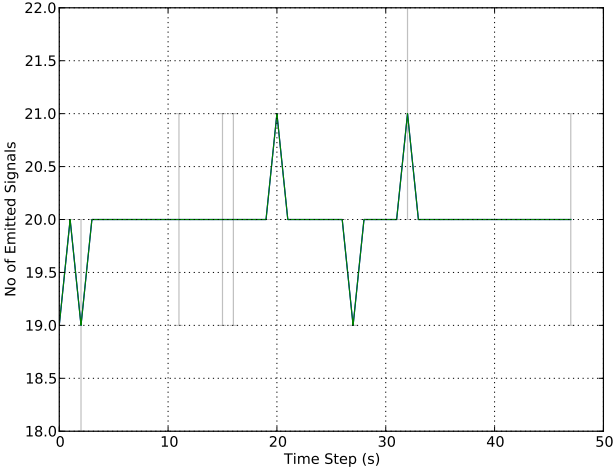
Workload: I'm free to wander or work...



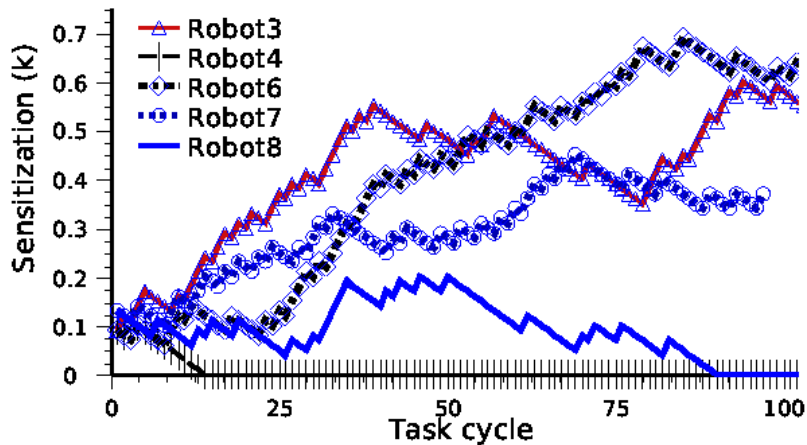
Workers: Ready to serve in your need



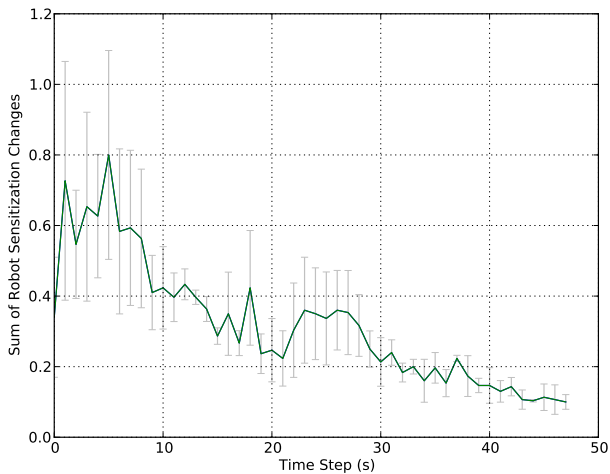
Global attractive filed: **that made us crazy**



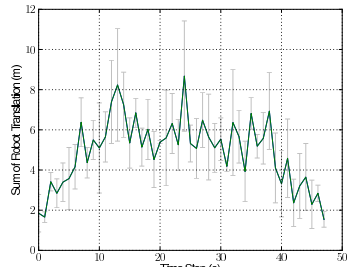
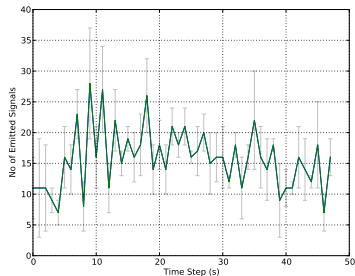
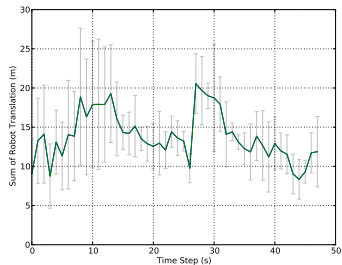
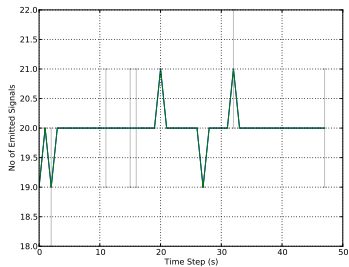
Who did the work: Oh! yes some of us...



Forget about everything: **we need some rest**



Local sensing/comm.: **Talk less, Move less, Work more**



Next: **sky is the limit...**

Hardware upgrade, More experiments, publishing ...

- ▶ Local communication with **random peer selection**
- ▶ Scale-freeness: **Compare 4 sets of expt: 40, 32, 16, 8 robots**
- ▶ Virtual Shop-floor \Leftarrow **real-task implementation** etc.

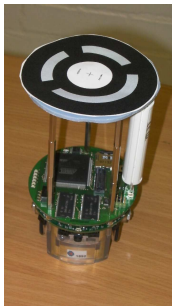


Figure: New Epuck robot with Wifi and Linux extension board

32 robots in action: Camera ready, blind closed ..

Applications Places System Mon 12 Apr, 12:42 PM


RL-Epuck-Expt - SwiTrack

File View Output Help

New Open Save Production Stop Step Reset

Particles

No component selected.



Step 642, 4872x3248, 12:42:24

Component	Trigger	Input	Color image	Grayscale image	Binary image	Particles	Tracks	ShopFloor	Robots	Tasks	Enabled	Step duration	Messages
InputCameraGigE	T	W									yes	114.509 ms	
ConvertToGray		R		W							yes	0.011 ms	
ThresholdGray				R	W						yes	15.471 ms	
BlobDetectionMinMax					R	W					yes	115.538 ms	
IDReaderRing				R		E					yes	265.248 ms	
OutputParticles		R									yes	0.675 ms	
DBusServer						R					yes (% 2)	4.612 ms	

100%

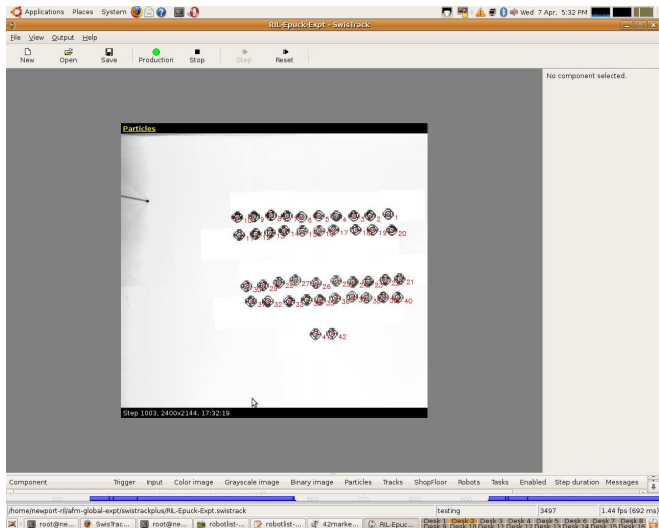
/home/newport-rl/ufm-global-expt/swiTrackplus/RL-Epuck-Expt.swiTrack

testing 3497 1.11 fps (890 ms)

root@newport-rl-serv... RL-Epuck-Expt - SwiTrack

Desk 1: Desk 2: Desk 3: Desk 4: Desk 5: Desk 6: Desk 7: Desk 8: Desk 9: Desk 10: Desk 11: Desk 12: Desk 13: Desk 14: Desk 15: Desk 16:

Tracking all 40 robots: Camera ready, light up ..



Conclusion: our story ends when they start living happily :)

Journey towards self-regulation

- ▶ Robots can do self-regulation of tasks by *listening* attractive field, concurrency, learning, forgetting
- ▶ **Plasticity and task specialization** : DoL observed
- ▶ Without much dependence on any particular communication/sensing paradigm
- ▶ Now It's the time for **Solving real-world problems**