



Embodied Development for an Autonomous Delivery Robot

2011 ShanghAI Guest Lectures
1st December 2011

Xiaoan (Dustin) Li

School of Computer Science and Engineering (CSE)

Northwestern Polytechnical University (NPU)

Xi'an, Shaanxi, China

Outline

- Motivations
- Embodied Design to An Autonomous Delivery Robot
- Experimental demos
- Conclusions and Questions

Motivations

- How to design an autonomous robot?
- Background and Problems
 - Autonomous Delivery Robots working in an office building
 - Based on very limited sensors
 - Some incapacibilities of ADR
 - Straight walking control tasks
 - Obstacle avoidance
 -

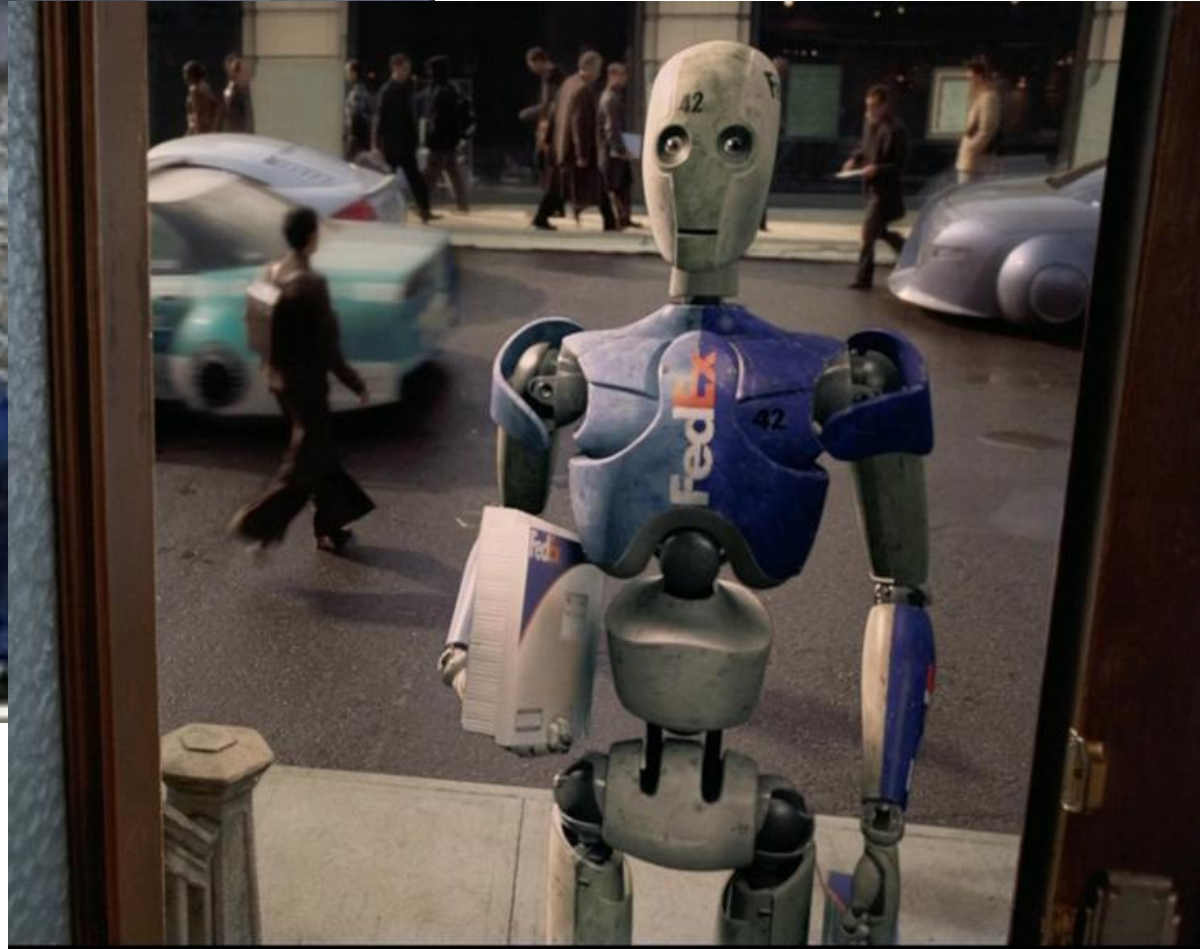
How to design an autonomous robot?

- **Developmental robotics**
 - *epigenetic robotics* (Metta & Berthouze, 2006)
 - *Autonomous Mental Developmental Robotics* (J.Weng, 2001)
 - *Morphogenetic robotics* (Jin & Meng, 2011)
- **Evolutionary robotics** (Nolfi & Floreano, 2006)
- ***Evolutionary Developmental Robotics***
 - *The Next Step to Go?*

Postman



Nowaday



Tomorrow?

Autonomous Delivery Robots(ADRobot)



DSR: from MARS-Lab,
CSE, NPU, China



ADRobot: from MARS-Lab, CSE, NPU, China



from MARS Lab, CSE, NPU, Xi'an, China

Embodied Design to An Autonomous Delivery Robot

- **Autonomy** of ADRobot
- **Situated** ADRobot
- **Interactive** ADRobot
- **Developmental** ADRobot

Autonomy of ADRobot

- **Actively perception**
 - Cameras based
 - Speech based
 - *Laser scanner*
 - *Infrared*
- **Actively interaction**
 - Simple speech
 - Ask help
 - Play music
- Decision-making based on DevES

Situated ADRobot

- Inside office building
- Corridor
- Office rooms
- Elevator
- Foot passengers
- Other robots

Interactive ADRobot

- Tutors
- Masters
- named consignee
- passengers

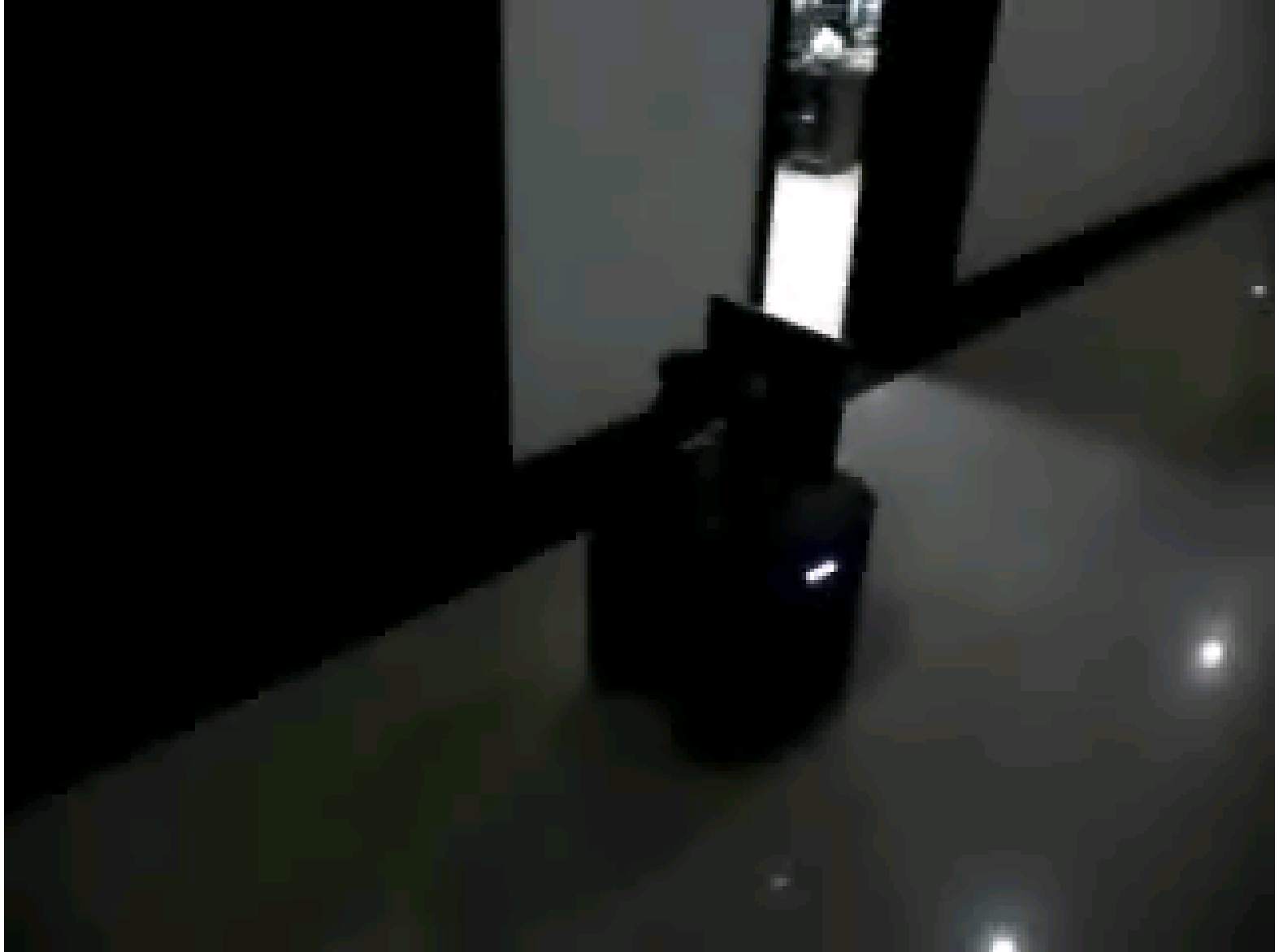
Developmental ADRobot

- How to position in the corridor?
- How to walk straight?
- Some discovery of Saliency based or Surprise based learning

Facets of Development [J.Weng]

- an incremental process
- a set of constraints
- a self-organizing process
- Degrees of freedom and motor activity
- Self-exploratory activity
- Spontaneous activity
- Anticipatory movements and early abilities
- Categorization and sensorimotor co-ordination
- Neuromodulation, value and neural plasticity
- Social interaction
- Intermediate discussion

Demo 1: ADR walking in corridor



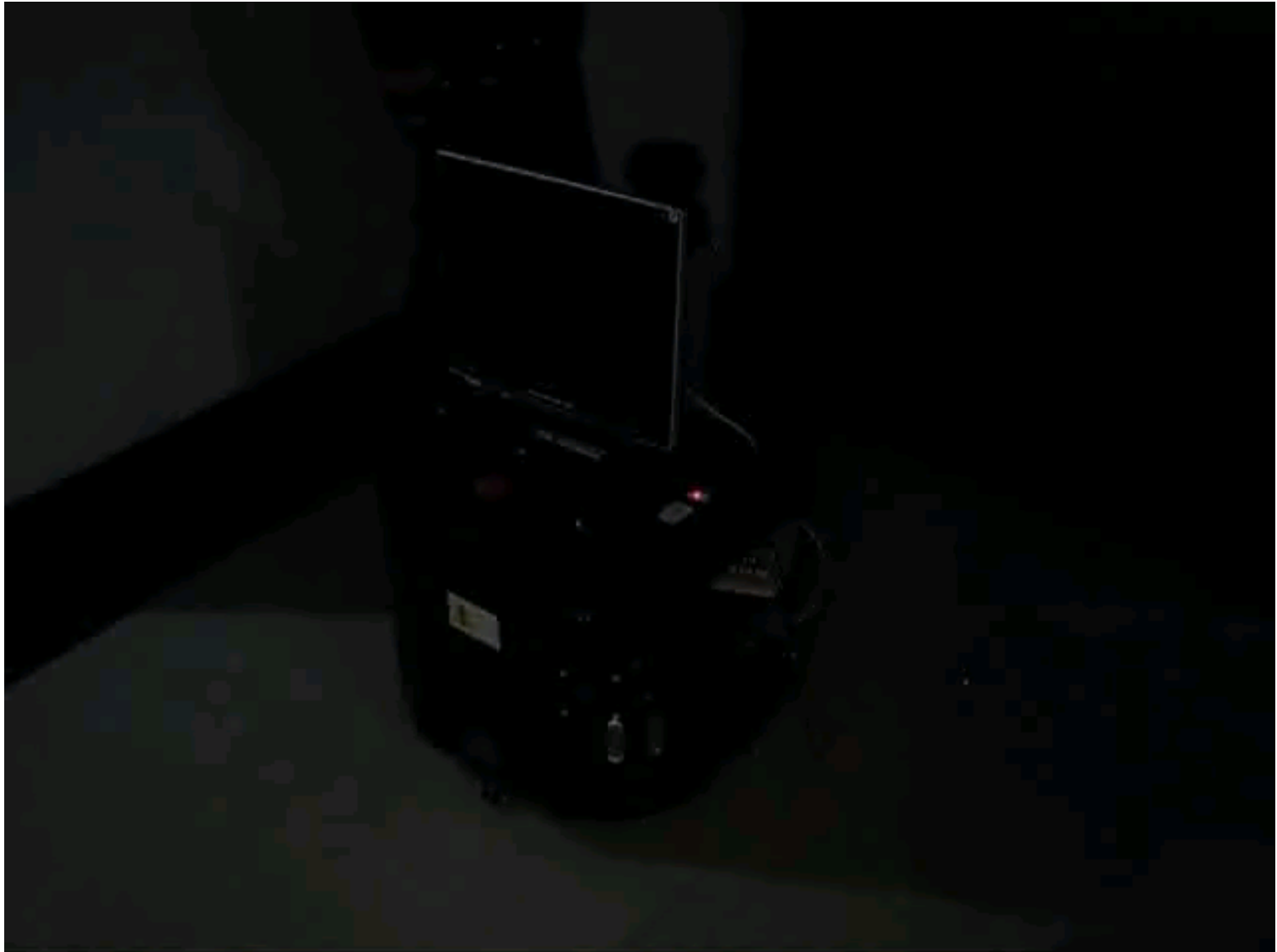
VIDEO 2: ADR performs straight-walk



VIDEO 3: ADR interact with passenger



VIDEO 4: ADR taking an elevator



ADRobot: positioning for Walking control



Positioning based on embedded camera

ADRobot: Straight-Walking control



Positioning based on embedded camera

Further Questions

- How the robot develop mentally or physically
- How the robot know the conceptions or rules?
- How to transfer or inherit what the robot learned?
- Developmental Learning
- Developmental program

Extremely Challenging!

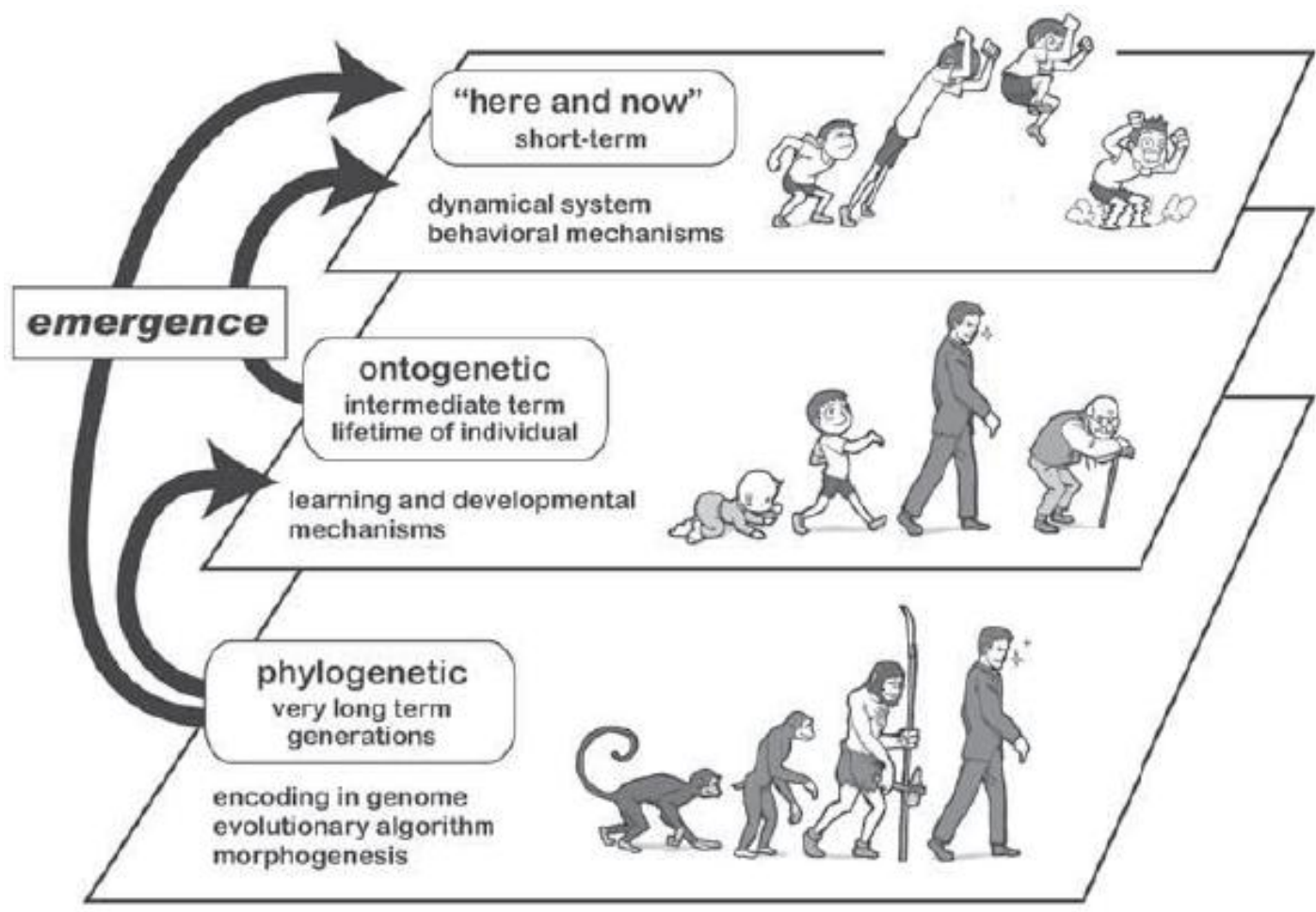
Conclusions and Questions

- The first step towards to an Autonomous Delivery Robots
- The **Cheap Design principle** provides a nice perspective to solve a practical difficult problem
- **Ecological Balance principle**
 - Different viewpoint to understand the environment
 - The contribution from Saliency-based attention
- The embodied autonomous delivery robot
 - Situated and interactive
- Many Further questions

Conclusions and Questions

- Extremely Challenging research!
 - the interaction between morphological and mental development
 - Evolutionary Developmental Robotics (AMD newsletters, v8n2)
 - What novel scientific and technological questions developmental robotics bring to HRI? – Are we ready for a loop? (AMD newsletters, v8n2)

Inspirations from Natural Intelligence





Acknowledgements

- Prof. J.Weng, EI-Lab, CSE, MSU, USA
- Members, MARS-Lab, SCSE, NPU, CHINA



Thanks!

Xiaoan LI
Director of Multi-Agent Robot
System (MARS) Lab
School of Computer Sci. and Eng.,
NPU, Xi'an, China
dustinli@nwpu.edu.cn