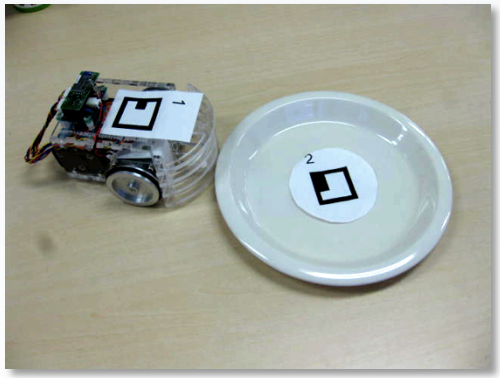
Week 7

Real World Interaction



Real World Interaction

User Interface for computing systems working in the real world (Robots)

Real World Interaction

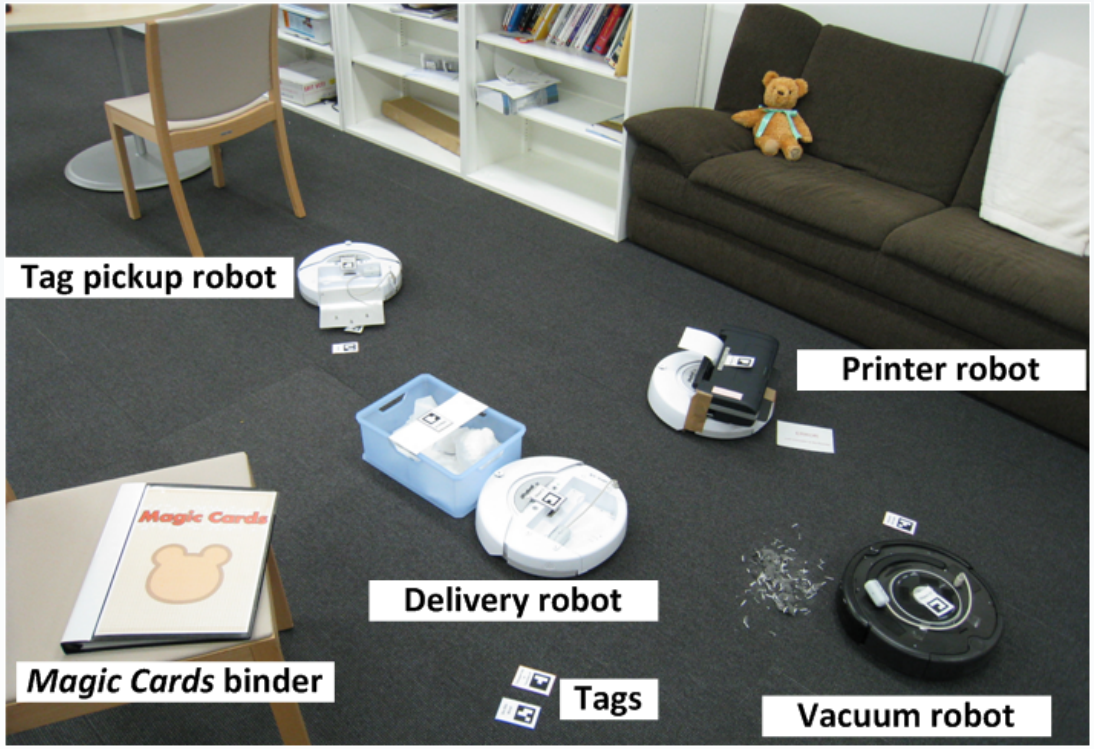
- Command Card Interface
- Style-by-Demonstration
- Actuated Puppet
- Robotic Light
- Fur Display

Real World Interaction

- Command Card Interface
- Style-by-Demonstration
- Actuated Puppet
- Robotic Light
- Fur Display

Magic Cards: A Paper Tag Interface for Implicit Robot Control

Shengdong Zhao, Koichi Nakamura, Kentaro Ishii, and Takeo Igarashi.

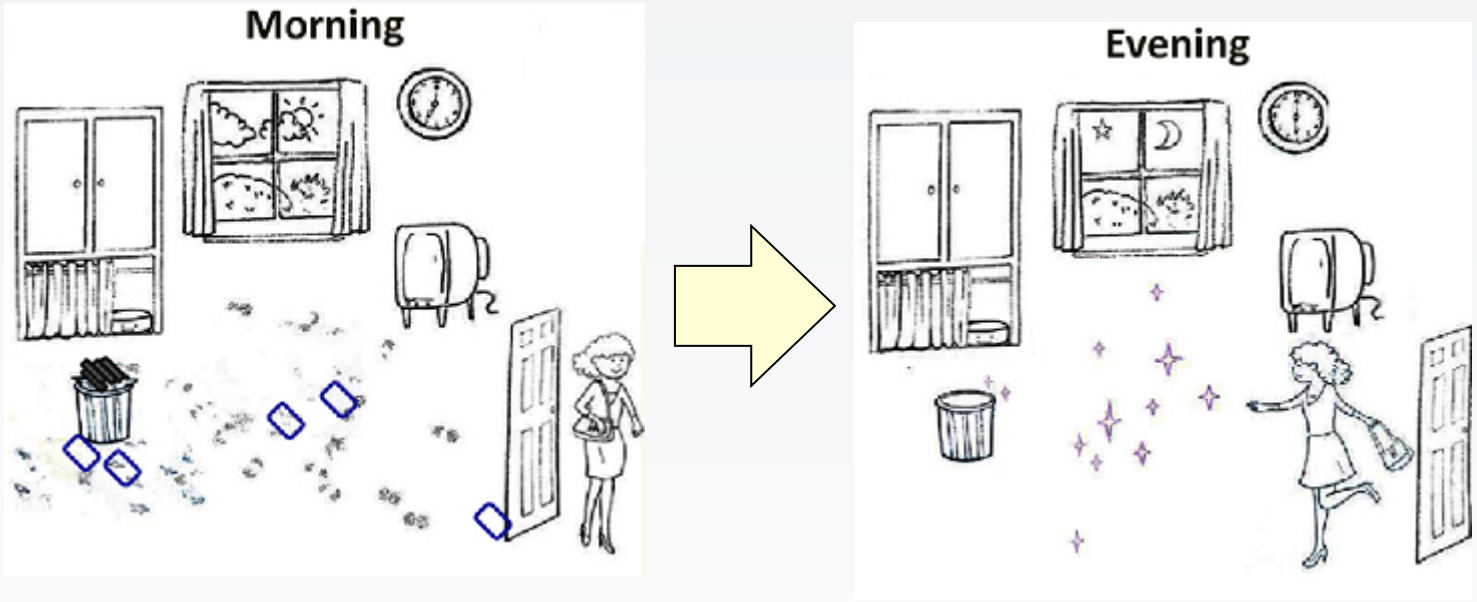


Motivation

“How to command a robot?”

- Speech or Gesture
  - Too abstract. Volatile. Need learning
- Direct control (Joystick)
  - Too low-level. Tedious.

Our Approach

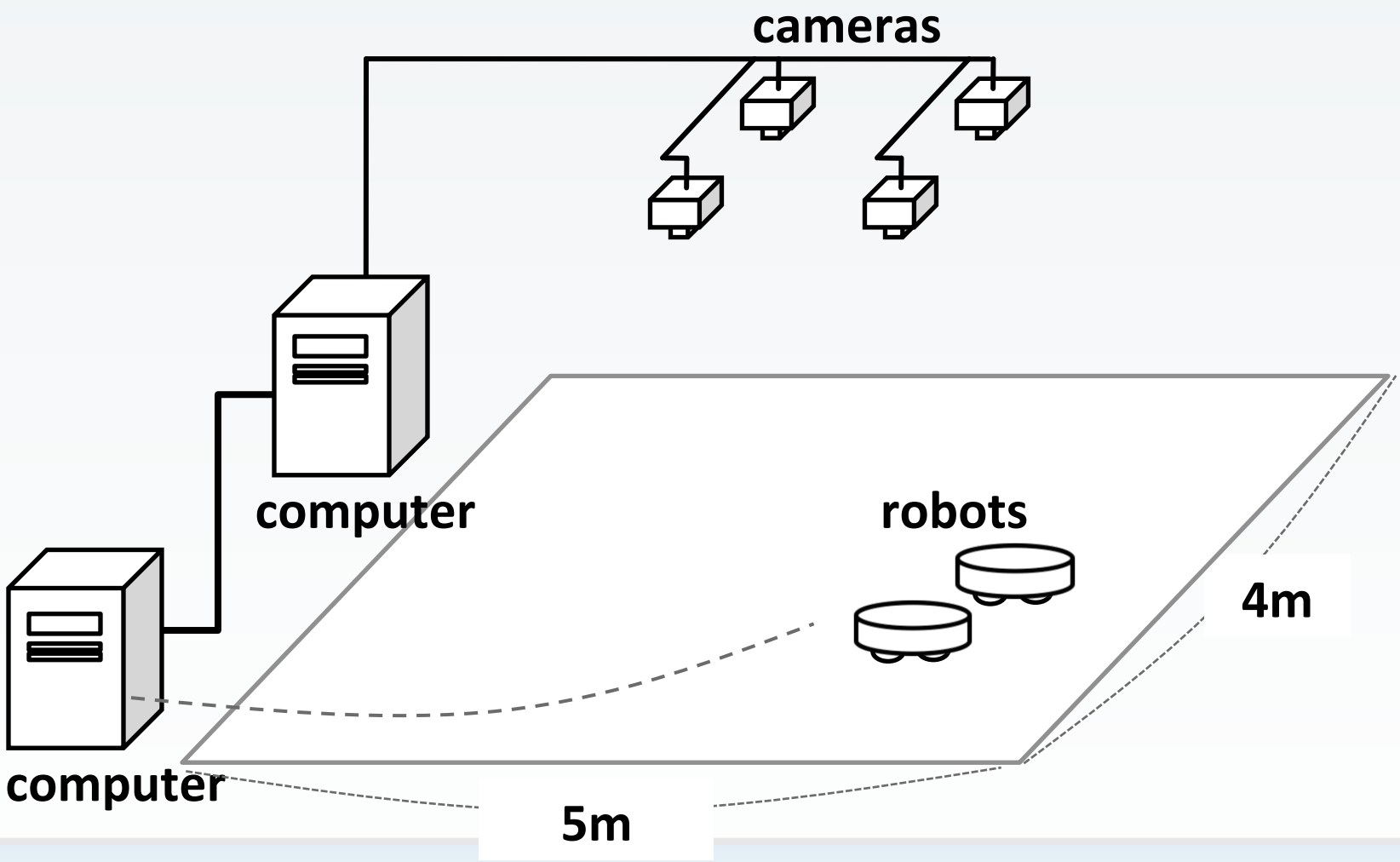


Paper card interface

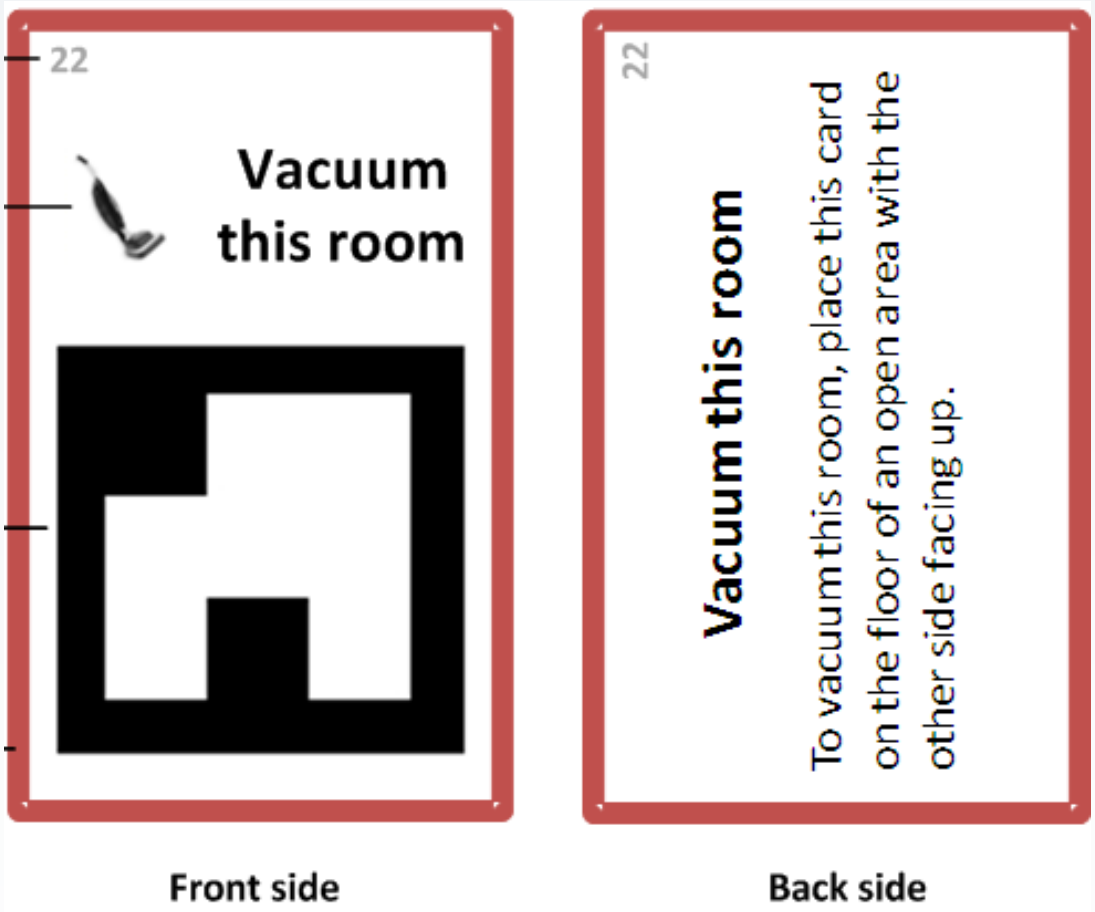
- The user puts instruction cards in the house
- The robot does the job while the user is out.

Video

Vision-based Environment

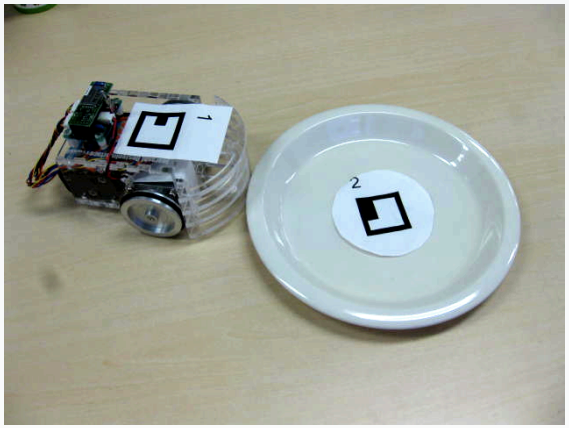


Magic Cards Visual Design



A Dipole Field for Object Delivery by Pushing on a Flat Surface

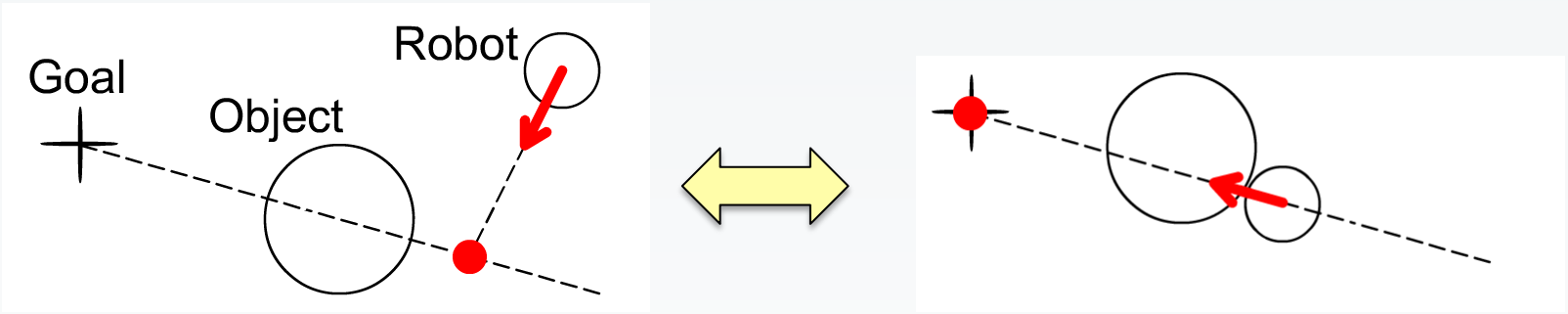
T. Igarashi, Y. Kamiyama, M. Inami (2010)



Stable, non-prehensile pushing

Pushing Algorithm

Typical approach: binary states.



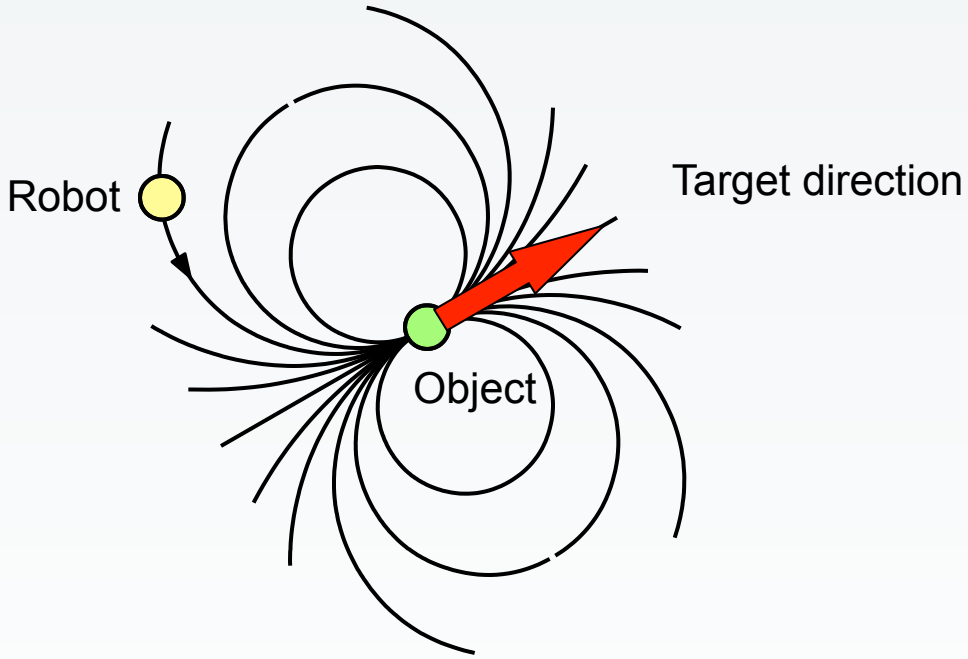
Go behind

Push

Unstable. Need parameter tweaking.

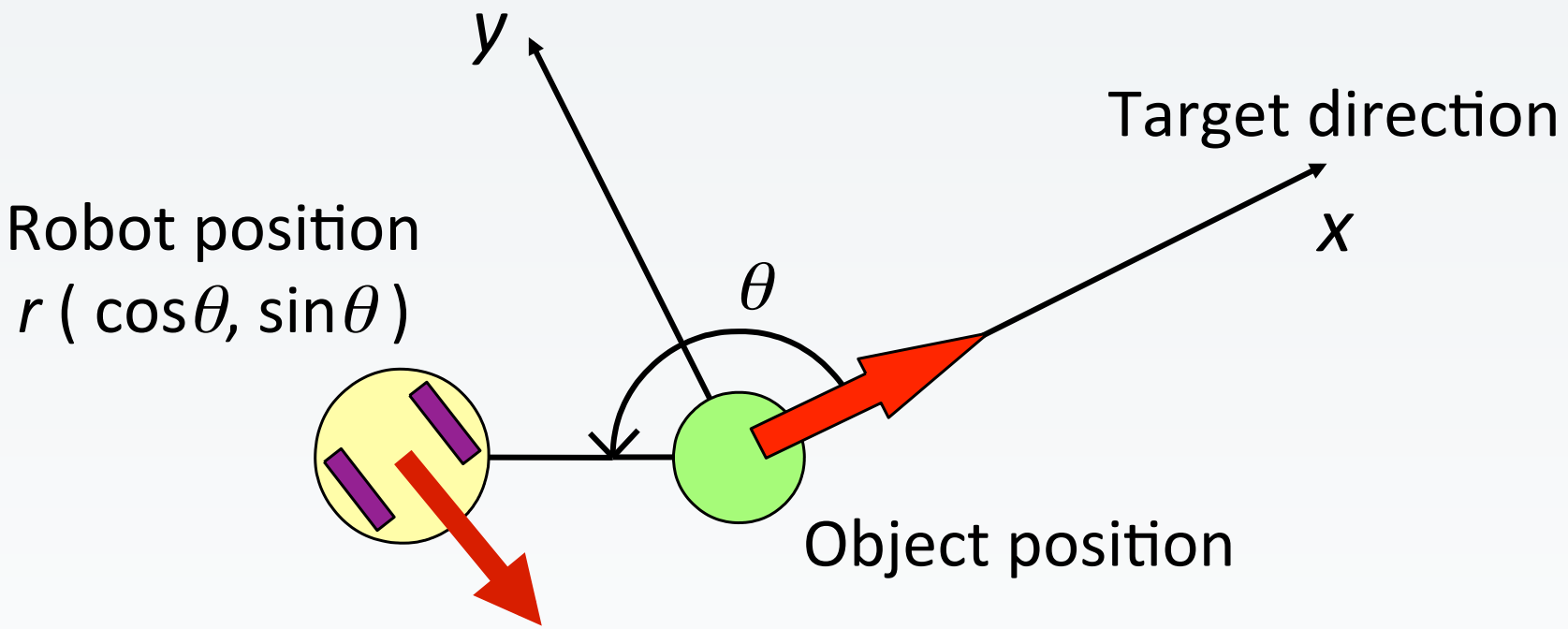
Our Approach

Robot follows **a dipole field** around the object.



Benefit: No mode switching
Scale invariance

Algorithm


y
Target direction
x
Robot position
r (cosθ, sinθ)
θ
Object position
Robot movement
(cos2θ, sin2θ)

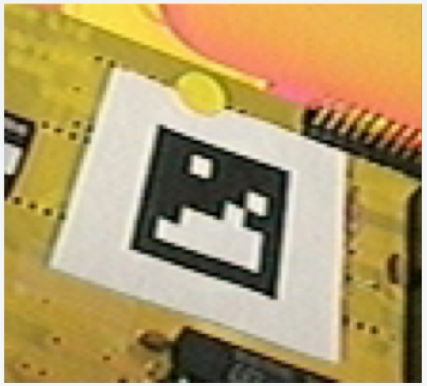
Video

push

To Learn More…

The original paper:

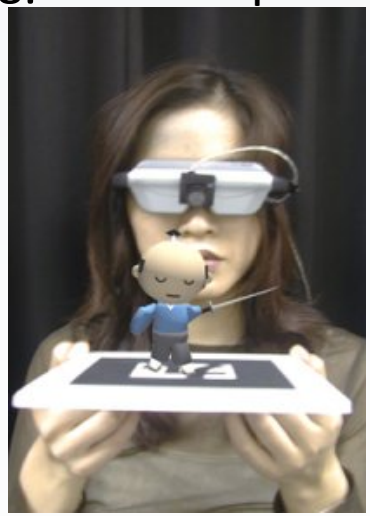
- Zhao, et al. Magic Cards: A Paper Tag Interface for Implicit Robot Control. CHI 2009.



[Rekimoto 1998]
(Figure obtained from the author with permission)

Paper ID :

- Rekimoto. Matrix: A Realtime Object Identification and Registration Method for Augmented Reality. APCHI 1998.
- ARToolKit. http://artoolkit.sourceforge.net/



ARToolKit
http://artoolkit.sourceforge.net/

Pushing Algorithm :

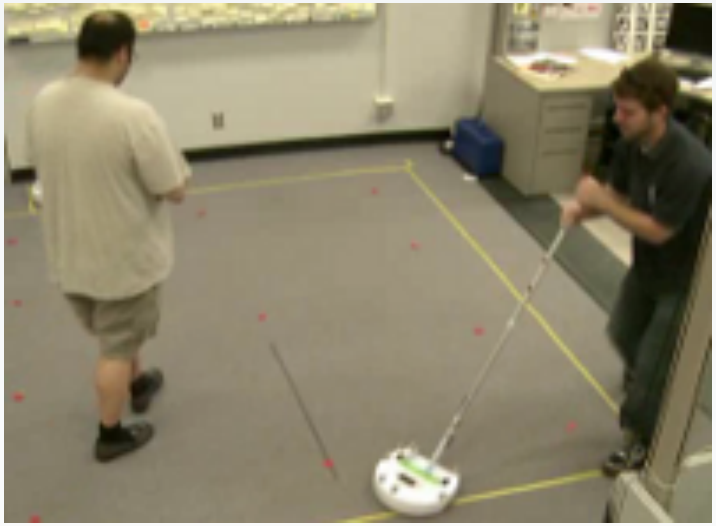
- Igarashi, et al. A Dipole Field for Object Delivery by Pushing on a Flat Surface. ICRA 2010.

Real World Interaction

- Command Card Interface
- Style-by-Demonstration
- Actuated Puppet
- Robotic Light
- Fur Display

Style by Demonstration:

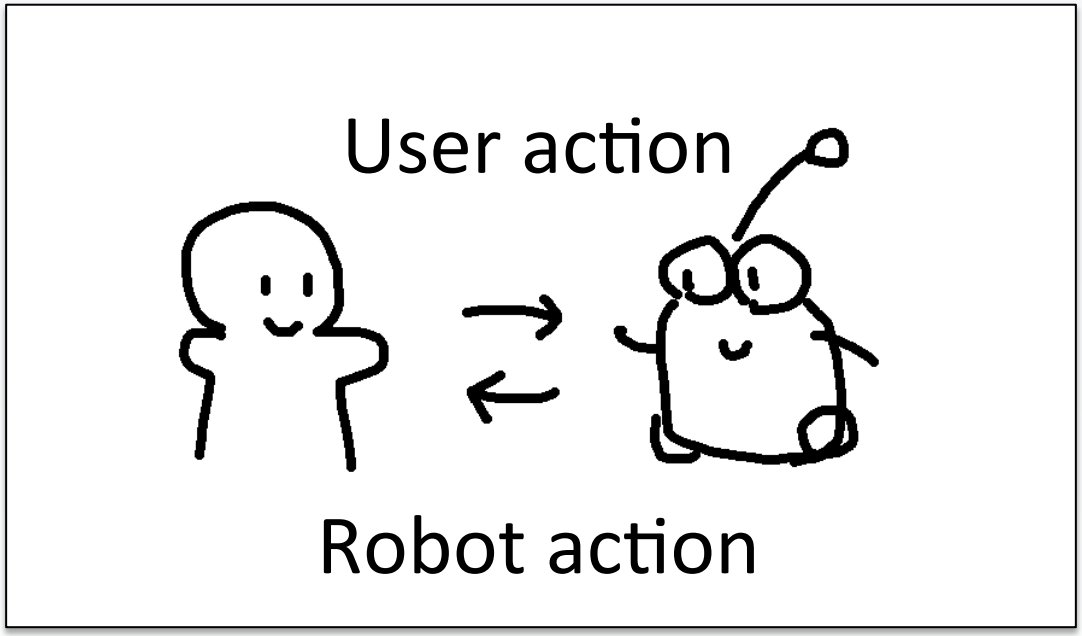
Teaching Interactive Movement Style to Robots



James E Young, Kentaro Ishii, Takeo Igarashi, Ehud Sharlin

Goal

Teaching “interactive” behaviors to a robot.

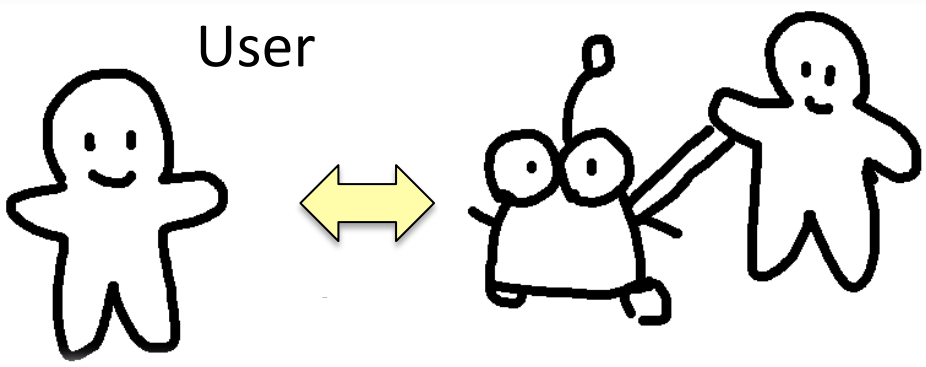


Traditional programming is difficult for designers.

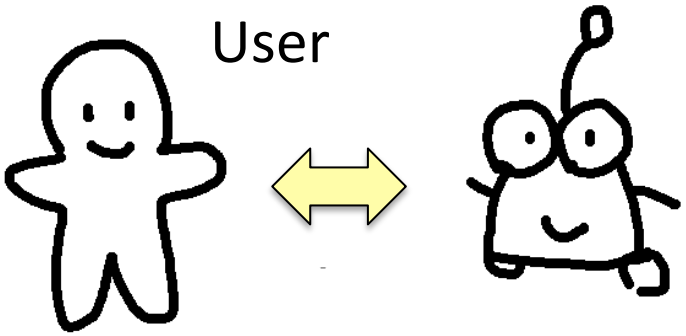
Our Approach

Programming by demonstration.

Training:



Run time:

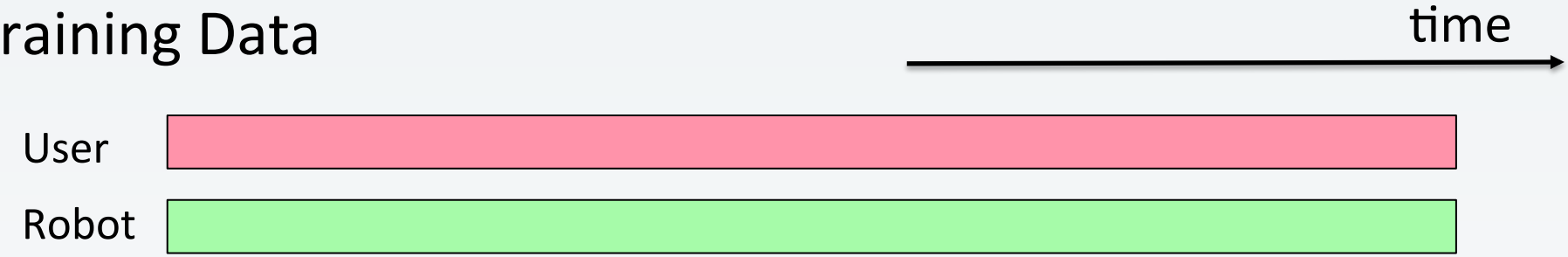


Video

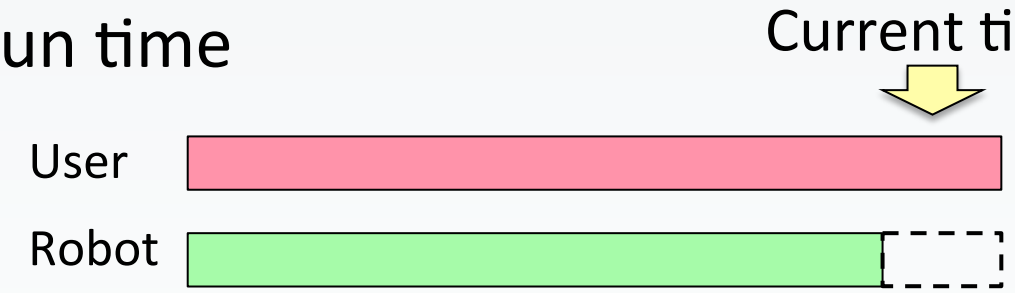
puppetmaster

Algorithm

Training Data

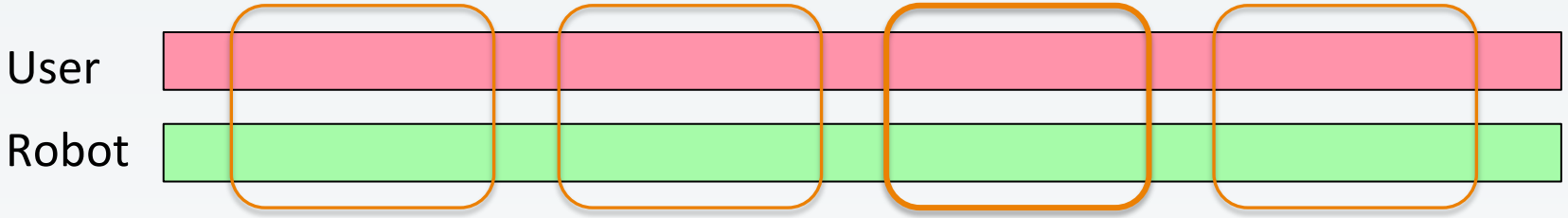


Run time

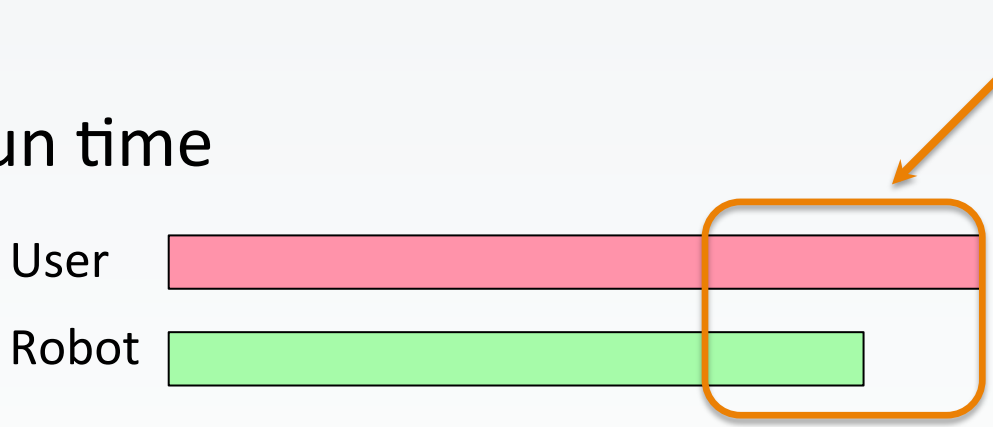


Algorithm

Training Data



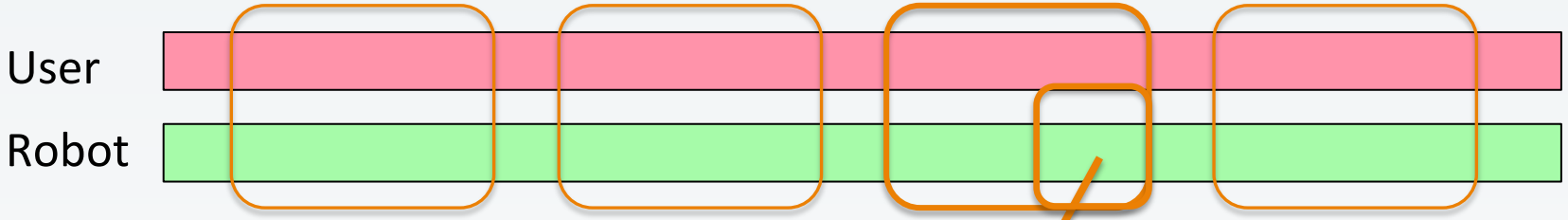
Run time



1) Find most *similar* motion in the training data.

Algorithm

Training Data



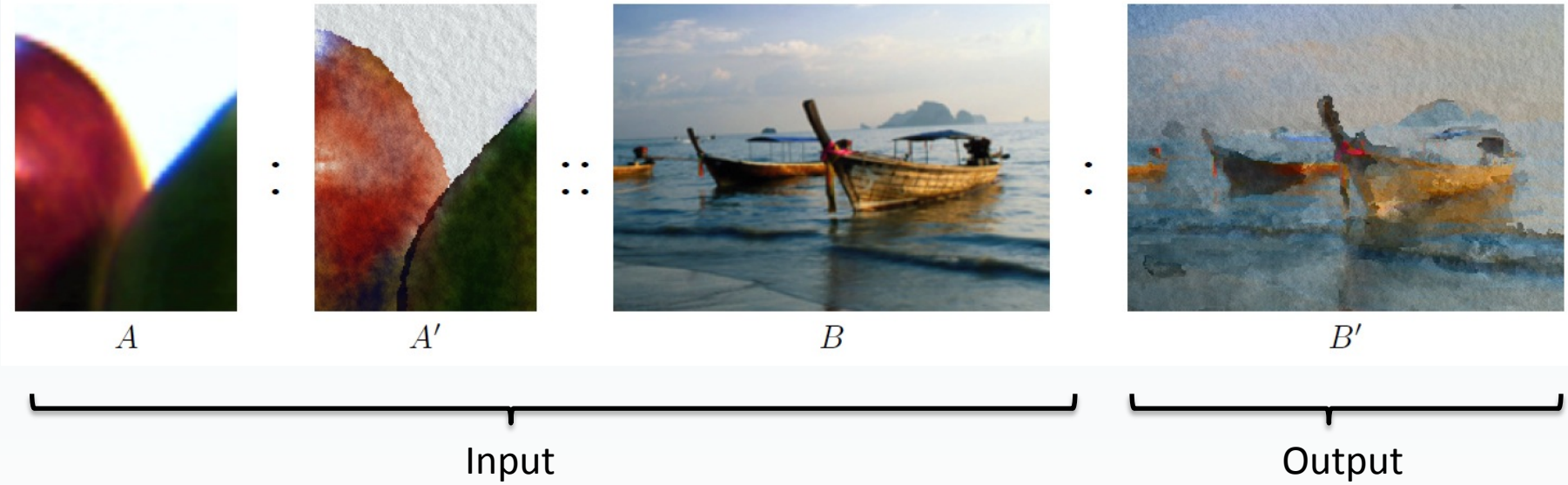
Run time

1) Find most *similar* motion in the training data.
2) Replicate the subsequent move.

Inspiration

Image analogies

[Hertzmann, et al. 2001]

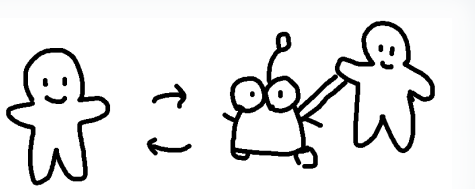


A+A’ defines a filter.

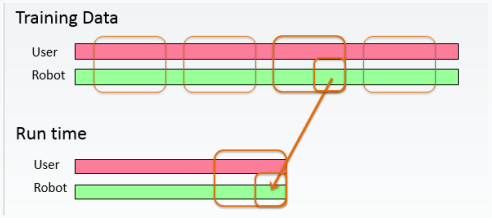
B’ is synthesized by applying the filter to B.

Summary

Teaching interactive behavior to a robot by demonstration.



Searches for similar data in the demonstration for deciding new move.



Inspiration from image analogies.

To Learn More…

The original paper:

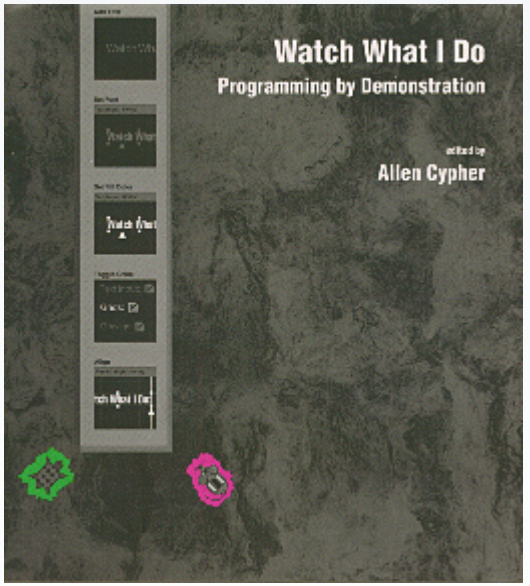
- Young, et al. Style by Demonstration: Teaching Interactive Movement Style to Robots. IUI 2011.

Image Analogies:

- Hertzmann, et al. Image Analogies. SIGGRAPH 2001.

Programming by Demonstration:

- Cypher and Halbert. Watch what I Do: Programming by Demonstration. MIT Press 1993.



[Cypher and Halbert 1993]

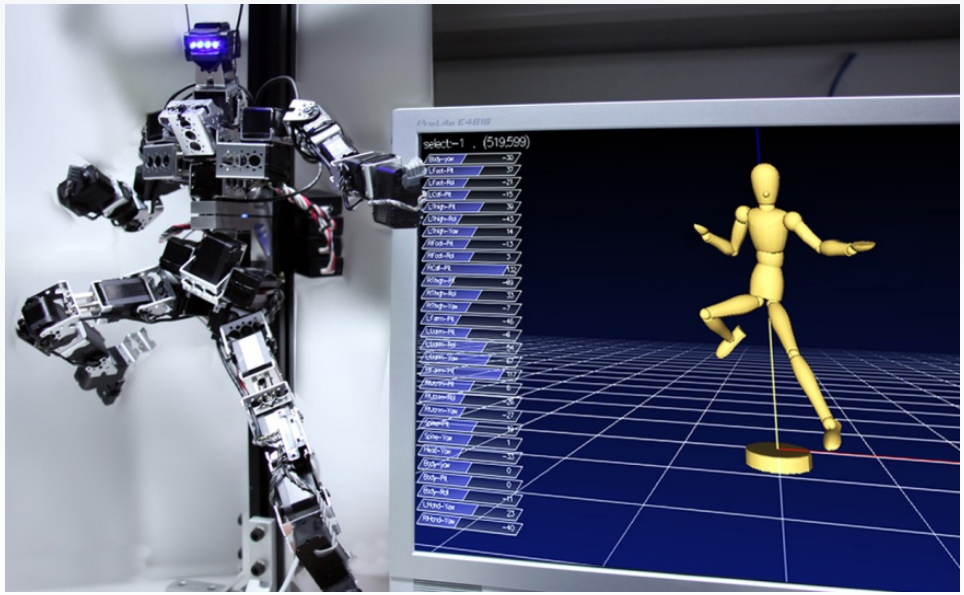
Real World Interaction

- Command Card Interface
- Style-by-Demonstration
- Actuated Puppet
- Robotic Light
- Fur Display

CHI 2012

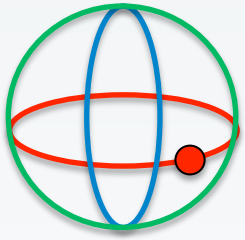
An Actuated Physical Puppet as an Input Device for Controlling a Digital Manikin

Wataru Yoshizaki, Yuta Sugiura, Albert C. Chiou, Sunao Hashimoto, Masahiko Inami, Takeo Igarashi, Yoshiaki Akazawa, Katsuaki Kawauchi, Satoshi Kagami, Masaaki Mochimaru



Motivation

3D character posing is difficult.



- **3D widgets**

  Tedious to control individual angles.

- **Motion capture**

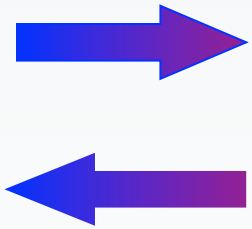
  Dedicated environment. Skilled Actor.

- **Physical Input Devices**

  Stiff. Need to manipulate all joints.

What We Propose:

Actuated Physical Puppet.



What We Propose:

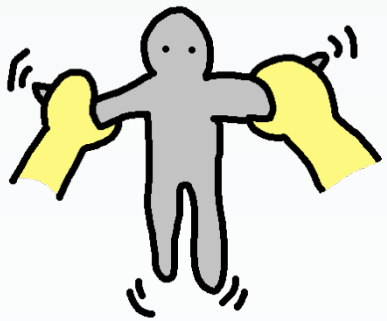
Features:

- Posture loading
- Intelligent gravitational compensation

What We Propose:

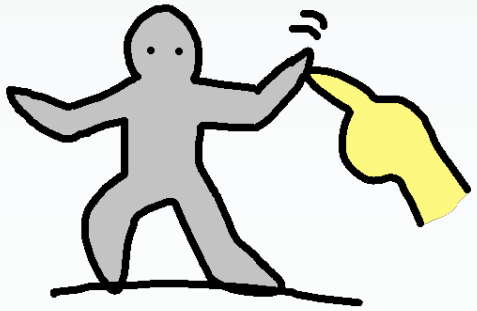
Features:

- Posture loading
- Intelligent gravitational compensation



Free
(always off)

Stiff
(always on)



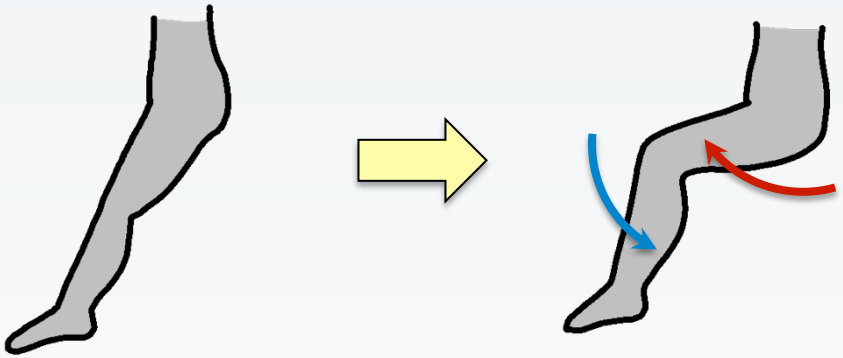
Adaptive
(on during manipulation)

What We Propose:

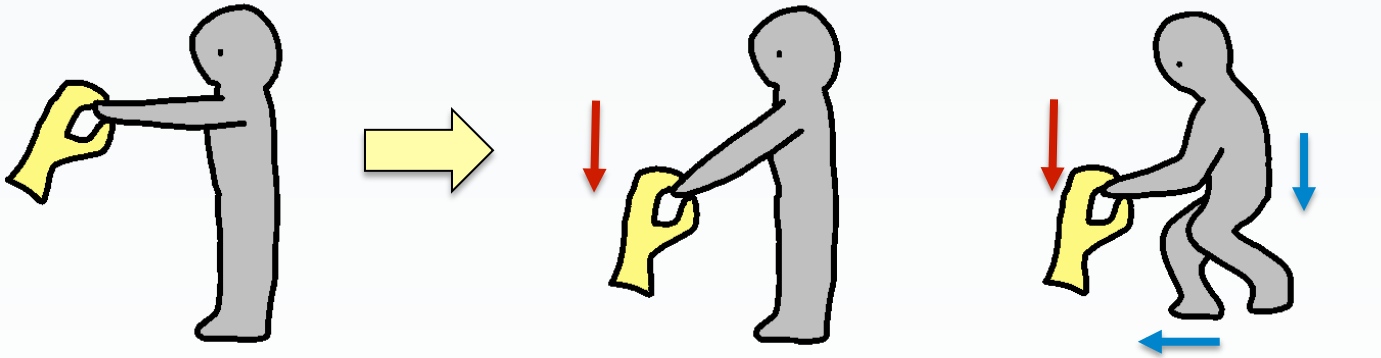
Features:

- Posture loading
- Intelligent gravitational compensation
- Active guidance using measured data
  - Joint coupling
  - Data-driven inverse-Kinematics

- Active guidance using measured data
  - Joint coupling



  - Data-driven inverse-Kinematics

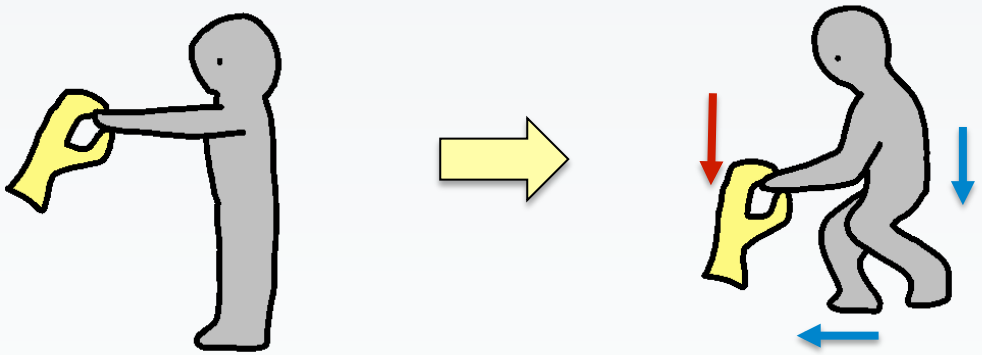


Video

puppet

Algorithm

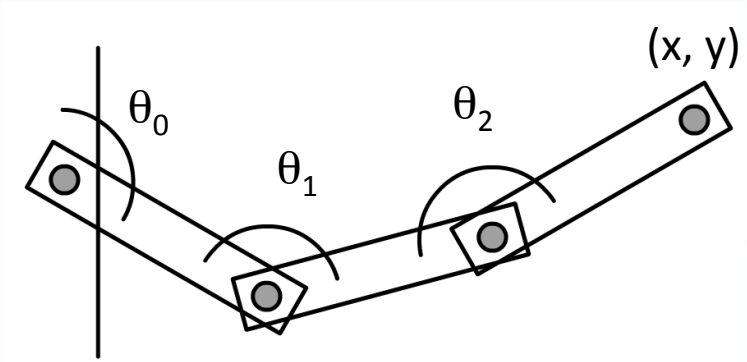
- Data-driven Inverse-Kinematics



Background

Forward Kinematics

$(\theta_0 , \theta_1 , \theta_2) \rightarrow (x, y)$



Inverse Kinematics

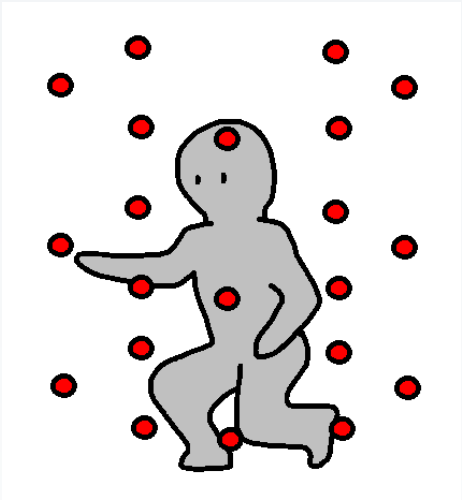
$(x, y) \rightarrow (\theta_0 , \theta_1 , \theta_2)$

Many algorithms:

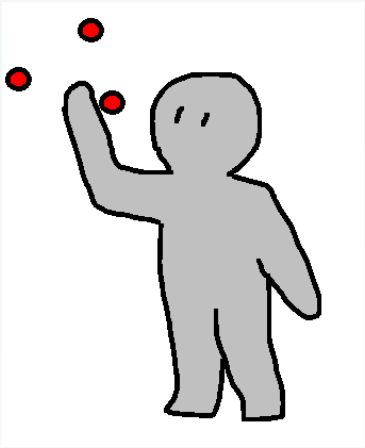
Geometric, physical, and data-driven

Data-driven Inverse-Kinematics

Capture



Runtime



Capture many reaching actions

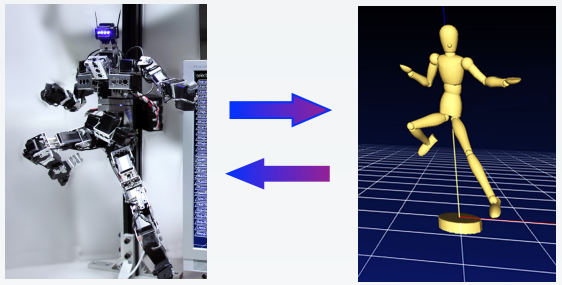
$(x, y, z) : \{ \theta_0 , \theta_1 , \dots \}$
$(x, y, z) : \{ \theta_0 , \theta_1 , \dots \}$
$(x, y, z) : \{ \theta_0 , \theta_1 , \dots \}$

Blend nearby poses

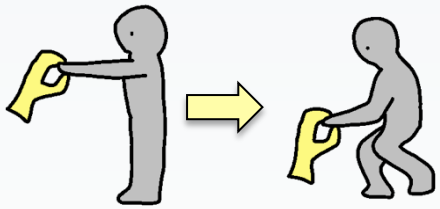
$\{ \theta_0 , \theta_1 , \dots \}$

Summary

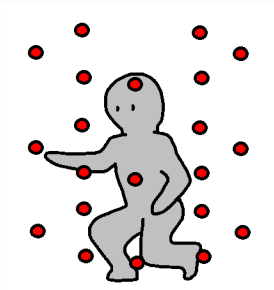
Actuated puppet device for character posing.



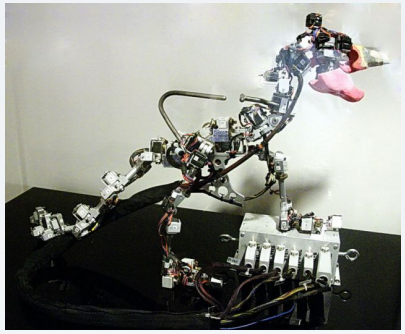
Intelligent gravity compensation and active guidance.



Data-driven inverse kinematics.



To Learn More…



[Knep, et al. 1995]
(Figure obtained from http://www.blep.com/rd/special-effects/dinosaur-input-device/ with permission)

The original paper:

- Yoshizaki, et al. An Actuated Physical Puppet as an Input Device for Controlling a DigitalManikin. CHI 2011.

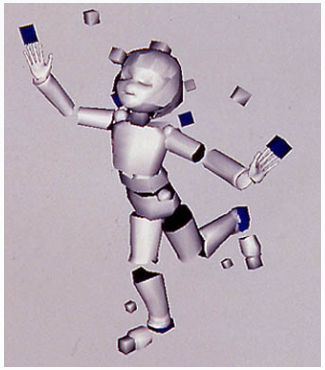
Passive puppet input device:

- Knep, et al. Dinosaur Input Device. CHI 1995.
- Esposito, et al. Of mice and monkeys: a specialized input device for virtual body animation. I3D 1995.

[Paley 1998]
Designing special-purpose input devices

Inverse kinematics:

- Rose, et al. Artist-directed inverse-kinematics using radial basis function interpolation. Computer Graphics Forum, 2001.
- Yamane and Nakamura. Natural Motion Animation through Constraining and De-constraining at Will. TVCG 2003.



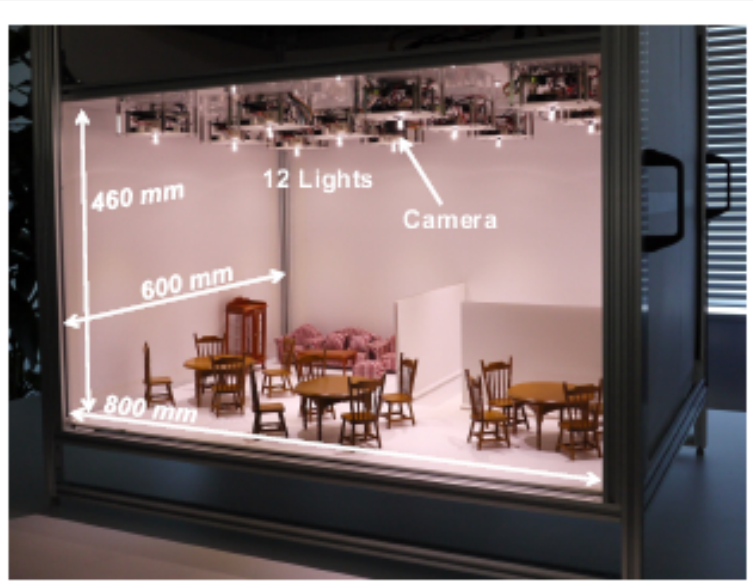
Animanium

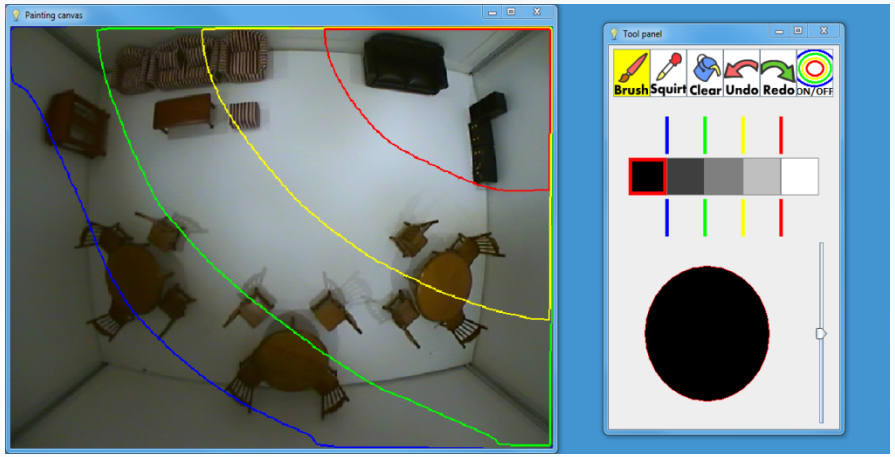
Real World Interaction

- Command Card Interface
- Style-by-Demonstration
- Actuated Puppet
- Robotic Light
- Fur Display

Lighty: A Painting Interface for Room Illumination by Robotic Light Array

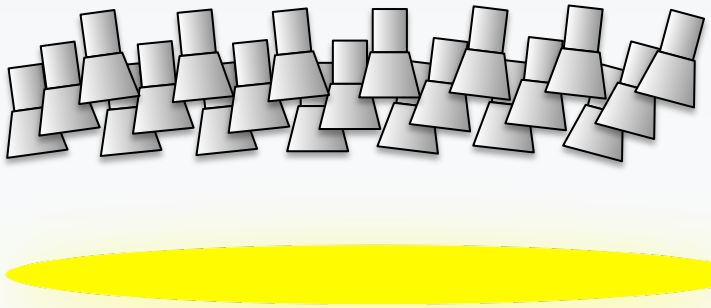
Seung-tak Noh, Sunao Hashimoto, Daiki Yamanaka,
Youichi Kamiyama, Masahiko Inami, Takeo Igarashi,





Motivation

It is difficult to control many lights



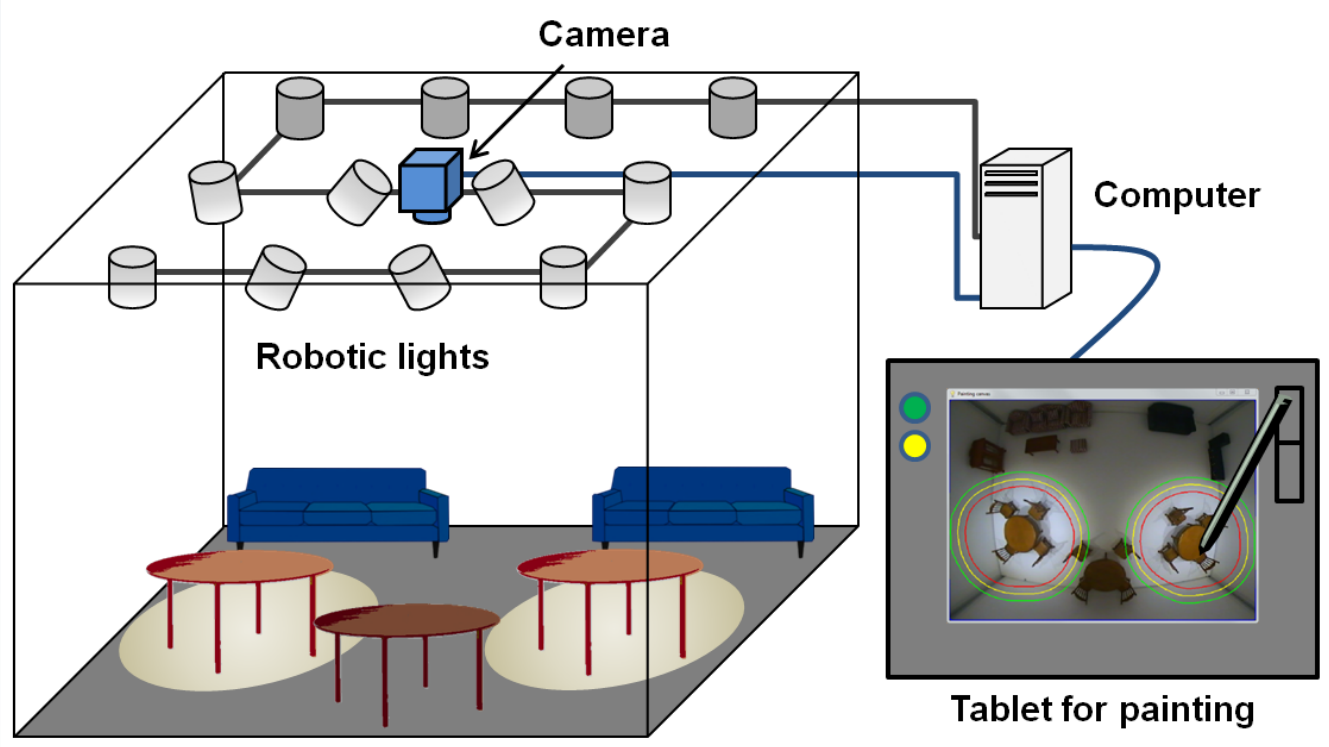
Brightness + Orientation

“Zero 88 Fat Frog lighting console”
by AV Hire London CC BY 2.0

Typical user interface

Our Approach

Painting user interface for light control



Video

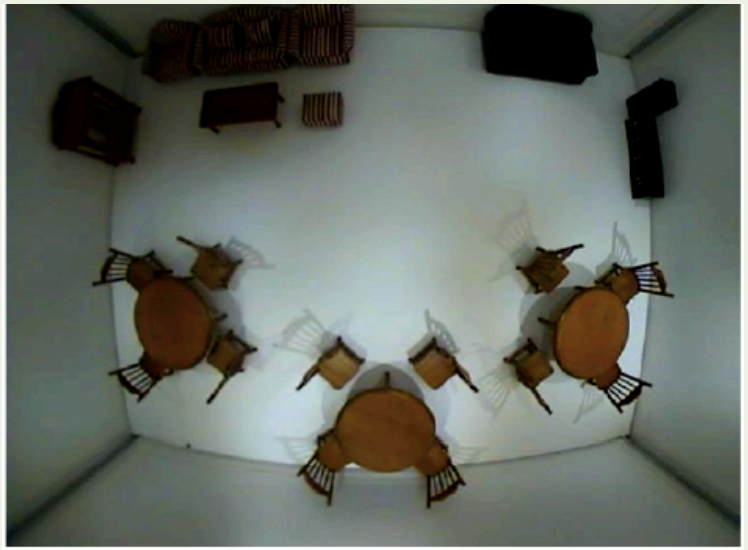
lighty

Benefit

In addition to make specific regions bright, you can also make specific regions dark (negative light).

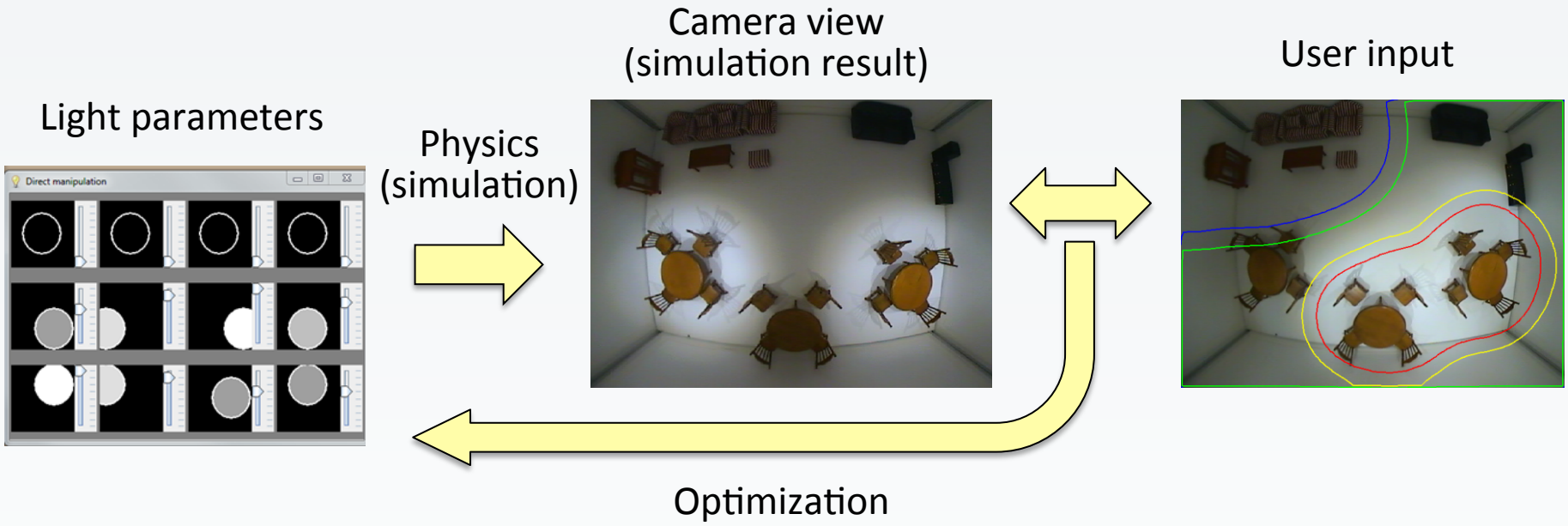
Example: make upper left corner dark.

Painting



Traditional Controller

Algorithm

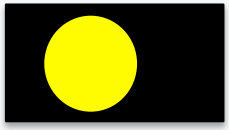
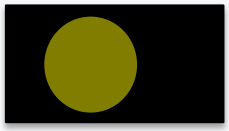
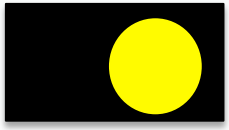
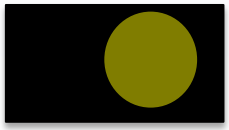


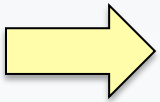
The physical process is too complicated to obtain an analytic model.

→ We use a data-driven prediction method.

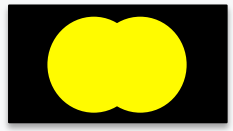
Data-driven Lighting Simulation

Recorded data

Parameters	Camera view
(0.5 , 0)	
(0.3 , 0)	
…	…
(0 , 0.5)	
(0 , 0.3)	
…	…



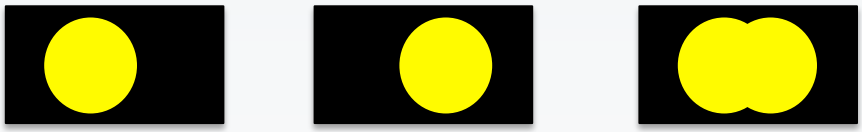
Simulation

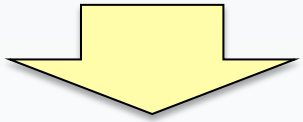
Parameters	Predicted result
(0.5 , 0.5)	

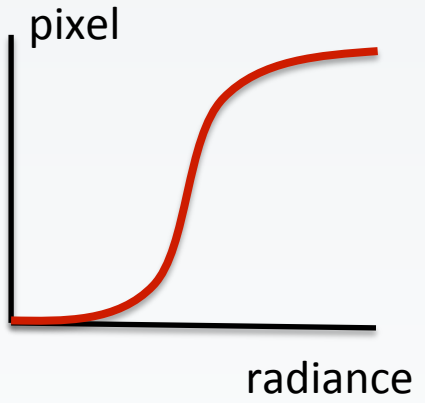
Data-driven Lighting Simulation

Naïve summation of pixel values does not work.

pixel(A) + pixel(B) ≠ pixel(A+B)





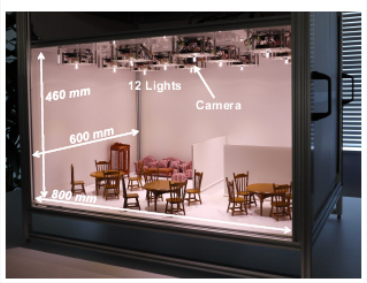


Pixel values should be converted to radiance value.

radiance(A) + radiance(B) = radiance(A+B)

Summary

Robotic lighting system with painting interface



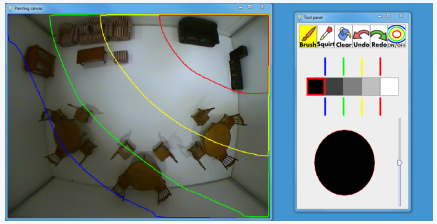
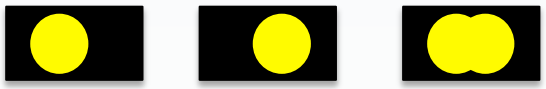
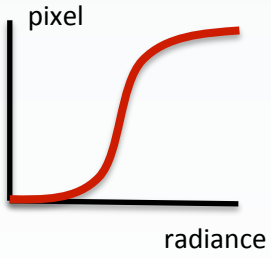


Image-based lighting simulation in radiance space.

pixel(A) + pixel(B) ≠ pixel(A+B)





To Learn More…

The original paper:

- Noh, et al. Design and enhancement of painting interface for room lights. The Visual Computer 2013.

Radiance Capture (high dynamic range image):

- Debevec and Malik. Recovering high dynamic range radiance maps from photographs. SIGGRAPH 1997.

[Debevec and Malik 1997]

Light Control for 3D Graphics:

- Pellacini, et al. Lighting with paint. SIGGRAPH 2007.

[Pellacini, et al. 2007]

Real World Interaction

- Command Card Interface
- Style-by-Demonstration
- Actuated Puppet
- Robotic Light
- Fur Display

Graffiti Fur: Turning Your Carpet into a Computer Display

Yuta Sugiura, Koki Toda, Takayuki Hoshi, Masahiko Inami, Takeo Igarashi

Inspiration

Finger drawing on fur.

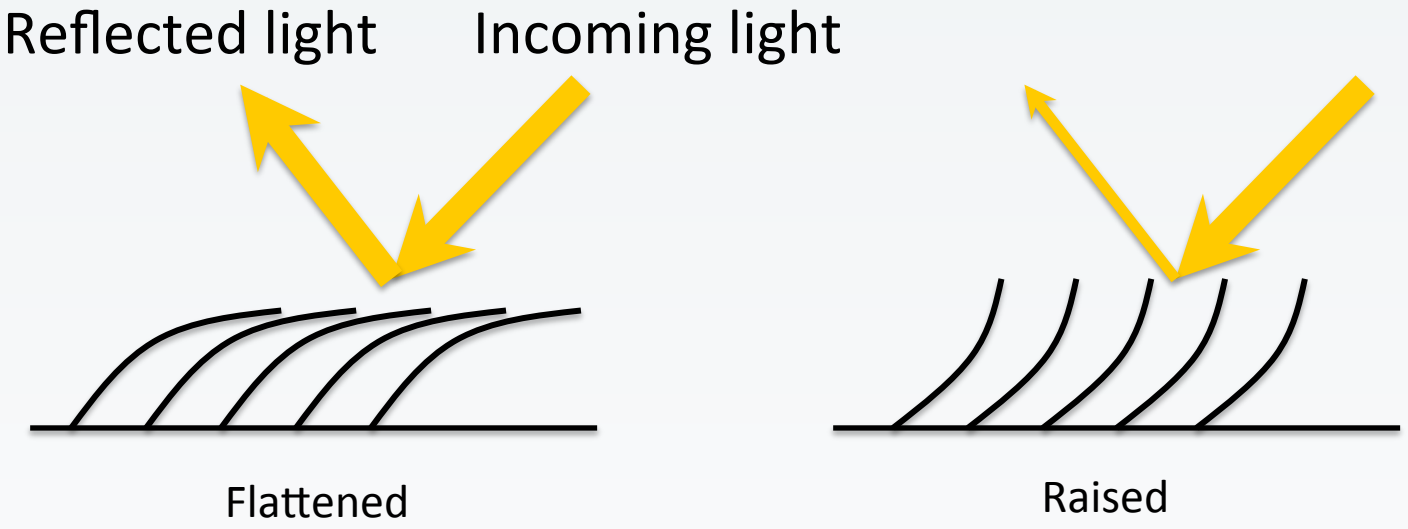
What we do

Devices for drawing on fur.

Video

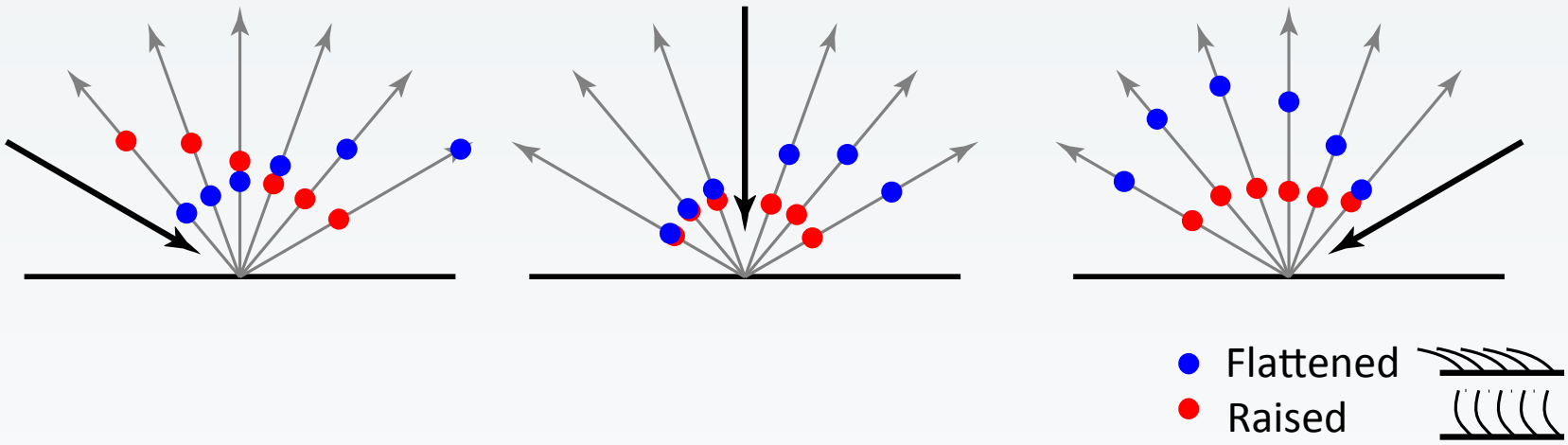
fur

Principle



Raised and flattened furs show different reflectance property.

Measurement Result



In graphics, they are modeled as
BRDF (bi-directional Distribution Function)

http://www.cs.princeton.edu/~smr/cs348c-97/surveypaper.html

To Learn More…

The original paper:

- Sugiura, et al. Graffiti Fur: Turning Your Carpet into a Computer Display. SIGGRAPH 2014 e-tech.

Cooperative Fabrication:

- Rivers et al. Position correcting tools for 2D digital fabrication. SIGGRAPH 2012.

[Rivers et al. 2012]

(Figure obtained from http://www.alecrivers.com/positioncorrectingtools/ with permission)

- Zoran and Paradiso. FreeD: a freehand digital sculpting tool. CHI 2013.

[Zoran and Paradiso 2013]

To Learn More…

"Physical" Displays

- Rozin, D. Wooden Mirror.
  http://www.smoothware.com/danny/woodenmirror.html
- Saakes, et al. Shader printer. SIGGRAPH e-tech 2012

Wooden Mirror At the Israel Museum

Rozin 1999] (Figure obtained from http://www.smoothware.com/danny/woodenmirror.html with permission)

Real World Interaction

User Interface for computing systems working in the real world (Robots)

Real World Interaction

- Command Card Interface
- Style-by-Demonstration
- Actuated Puppet
- Robotic Light
- Fur Display