

Design of safe consumer product
based on children behavior model
constructed from behavior
observation :

case study of playground equipment

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Project page:
<http://www.cipec.jp>

Recent trend of cause of child death

The leading cause is unintentional injury (accidents)

-959 children (<19 year-old) died par year in Japan

Age	First(%)	Second (%)	Third (%)	Forth(%)	Fifth (%)
0	Birth defect (35.1)	Respiratory disturbance (14.1)	Sudden death syndrome (5.7)	Unintentional injuries (4.9)	Fetal hemorrhagic disorder (3.9)
1-4	Birth defect (17.7)	Unintentional injuries (16.4)	Malformation neoplasm (9.6)	heart disease (7.2)	Pneumonia (4.8)
5-9	Unintentional injuries (25.8)	Malformation neoplasm (20.8)	Heart disease (7.3)	Birth defect (5.4)	Neoplasm (5.2)
10-14	Malformation neoplasm (19.5)	Unintentional injuries (18.9)	Suicide (11.3)	Neoplasm (7.0)	Heart disease (6.0)
15-19	Unintentional injuries (31.2)	Suicide (31.2)	Malformation neoplasm (9.7)	Heart disease (4.8)	Cerebrovascular disease (2.6)



(2009, Japan)

Products related to injury

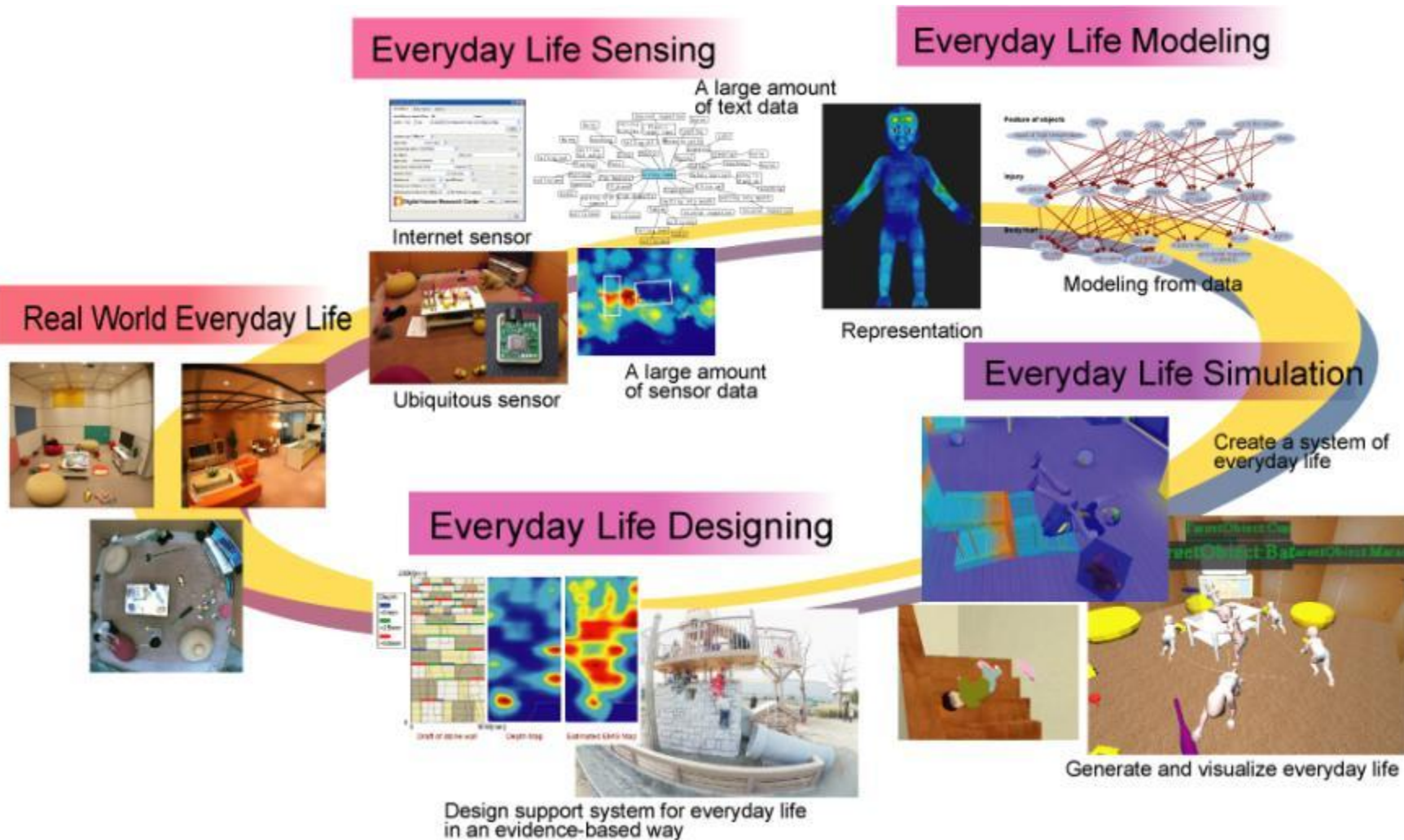
	First		Second		Third		Forth		Fifth				Total	
0-4 year-old	Chair		Stair		Bed		Table, Desk		Bicycle					
	340	8.3%	319	7.8%	271	6.6%	220	5.4%	212	5.2%	2718	66.6%	4080	
0	Bed		Chair		Stair		Small object		Table, Desk					
	158	18.1%	65	7.4%	41	4.7%	37	4.2%	35	4.0%	537	61.5%	873	
1	Chair		Stair		Table, Desk		Bicycle		Cigarette					
	128	10.5%	111	9.1%	67	5.5%	54	4.4%	48	3.9%	809	66.5%	1217	
2	Stair		Chair		Table, Desk*		Bicycle*		Playground					
	96	10.9%	79	8.9%	49	5.5%	49	5.5%	46	5.2%	564	63.9%	883	
3	Bicycle		Playground		Table, Desk		Chair		Stair					
	51	8.2%	50	8.0%	43	6.9%	36	5.8%	32	5.1%	411	66.0%	623	
4	Bicycle		Playground		Stair		Chair		Table, Desk					
	51	10.5%	49	10.1%	39	8.1%	32	6.6%	26	5.4%	287	59.3%	484	
5-9 year-old	Bicycle		Playground		Stair		Door		Car					
	169	14.4%	136	11.6%	72	6.1%	65	5.5%	48	4.1%	685	58.3%	1175	
5	Bicycle		Stair		Playground		Door		Chair					
	31	9.3%	29	8.7%	24	7.2%	19	5.7%	17	5.1%	214	64.1%	334	
6	Playground		Bicycle		Door		Stair		Car					
	43	14.2%	42	13.9%	24	7.9%	15	5.0%	13	4.3%	165	54.6%	302	
7	Bicycle		Playground		Stair		Car		Chair					
	38	17.2%	29	13.1%	11	5.0%	9	4.1%	8	3.6%	126	57.0%	221	
8	Bicycle		Playground		Stair*		Door*		Car					
	30	16.7%	25	13.9%	8	4.4%	8	4.4%	7	3.9%	102	56.7%	180	
9	Bicycle		Playground		Stair		Ball		Door					
	28	20.3%	15	10.9%	9	6.5%	8	5.8%	7	5.1%	71	51.4%	138	
10-14 year-old	Bicycle		Ball		Car		Playground		Stair					
	64	15.6%	57	13.9%	30	7.3%	29	7.1%	11	2.7%	218	53.3%	409	
15-19 year-old	Bicycle		Ball *1		Car *1		Door*2		Sporting equipment*2					
	6	12.5%	4	8.3%	4	8.3%	2	4.2%	2	4.2%	30	62.5%	48	

	Products	%
1st	Bicycle	7.9%
2nd	Stair	7.1%
3rd	Chair	6.7%
4th	Play-ground	5.9%
5th	Bed	5.1%

Data : 8,334 cases
(November, 2006 to October, 2009)

New design approach

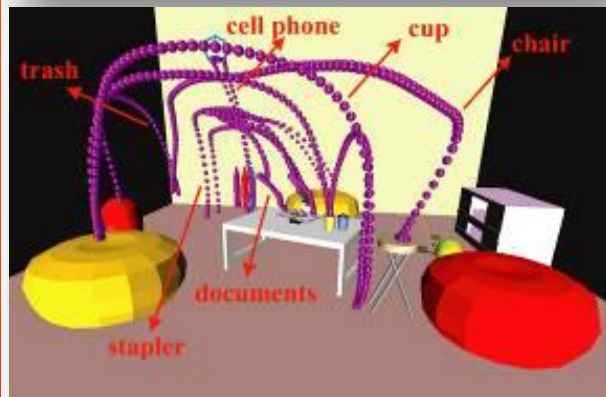
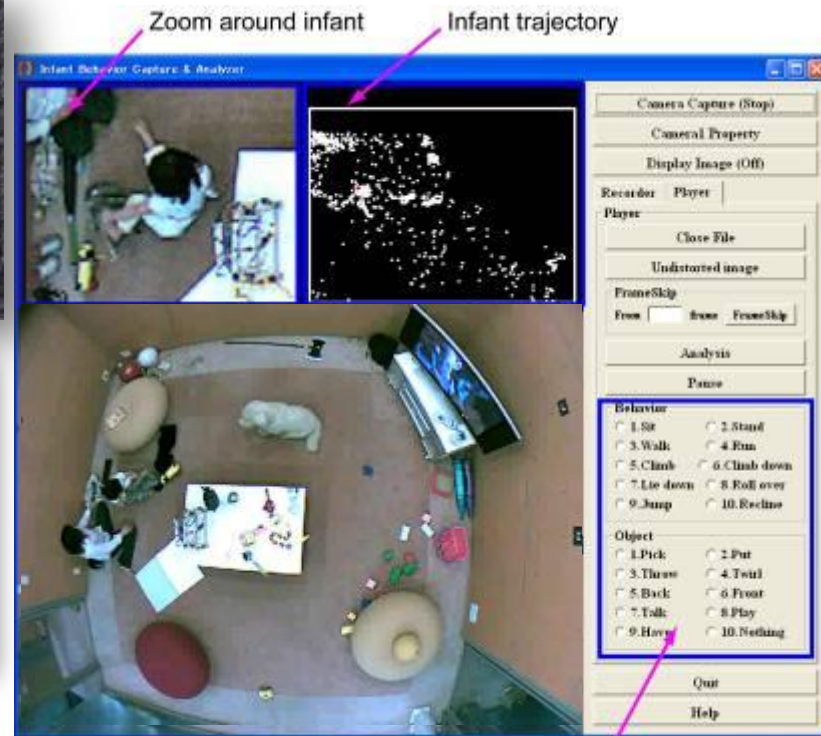
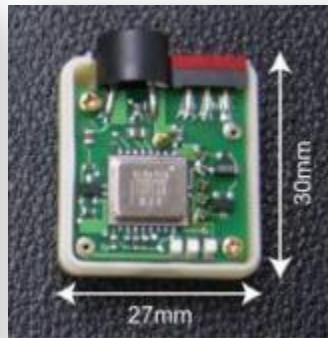
Consumer product design based on everyday life behavior modeling



Ubiquitous Sensor for observing everyday life behavior

- Observe child's everyday behavior data by sensorizing home environment
- Develop quantitative model of child behavior

Ultrasonic location sensor (ultrasonic, low-cost GPS)



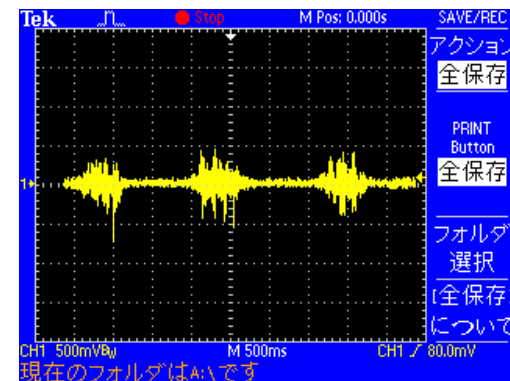
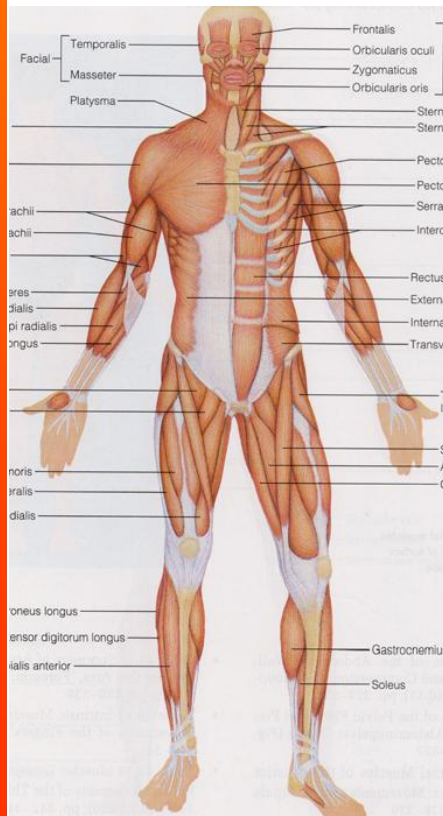
Cognitive/Behavior/Object label

Wearable Sensor

for observing everyday life behavior

- Observe child's everyday behavior data by attaching small device onto child body
- Develop quantitative model of child behavior

Wearable EMG sensor for child (small, wireless EMG)

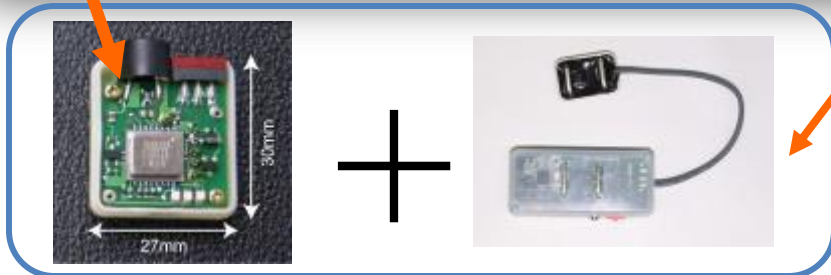
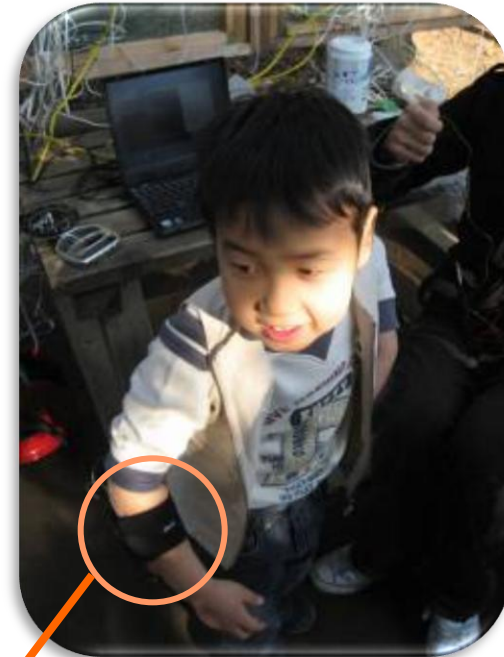


For example,

- How many times does child grasp?
- How many times does child fall?
- When does child perform a certain behavior?

Case study: behavior-model-based playground equipment design

"Stone wall" type of play equipment



Ultrasonic 3D Tag
(location sensor)

Wearable EMG
(physiological data)



50 children
(3 to 6 year-old)

Data collection in kindergarten

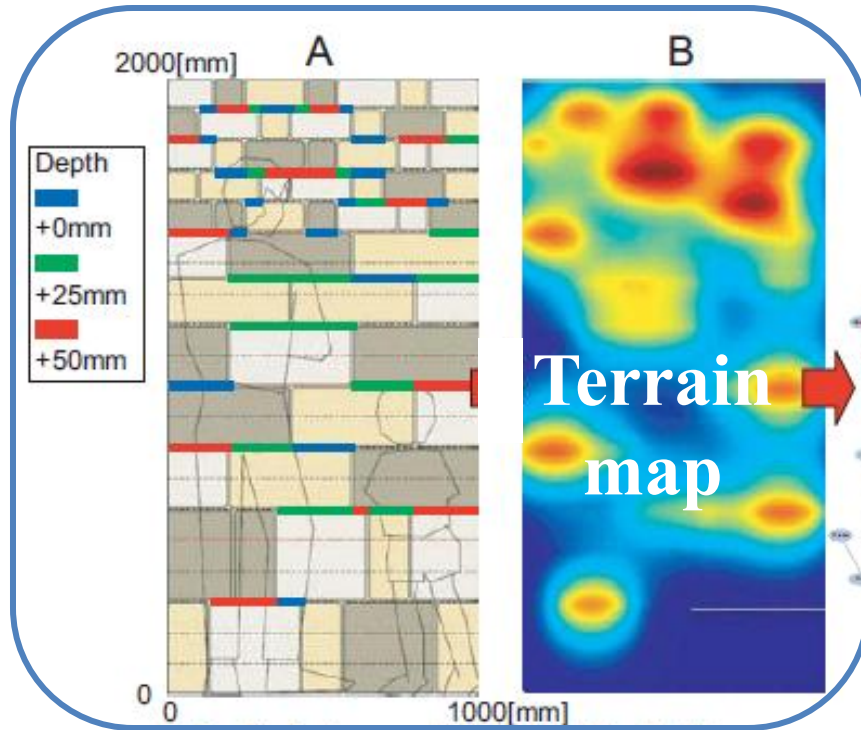
In Situ Measure “Playing” Child
(location, EMG, and image
sensor)



3D Shape Model
(3D Laser Scanner)

Simulation of Playing Behavior

New design

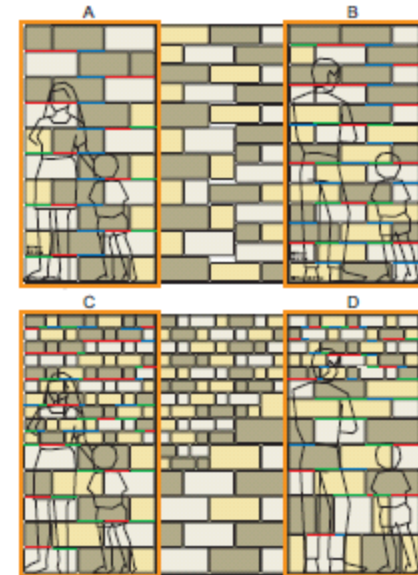


Easy part

Difficult part

New design of playground equipment based on child's behavior mode

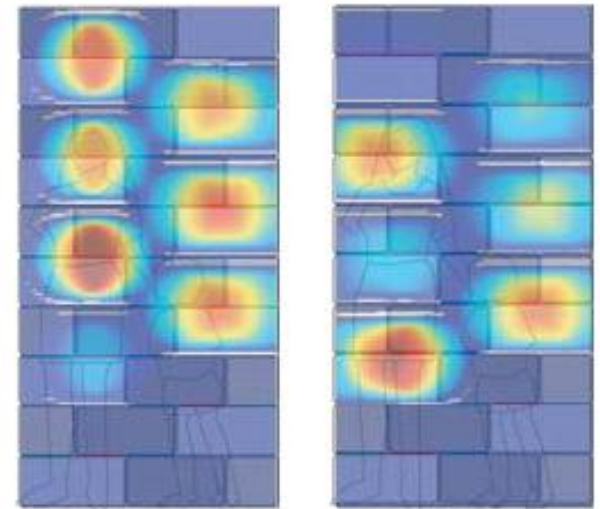
New stone wall play equipment



Evaluation ■ 4 Cameras were installed



Probability of Location



Observed

Predicted

4 months result

Behavior data were accumulated for 3 years since Sep. 2007

-About 30% behavior are predictable using the model.

-So far, there have been no serious injuries due to fall for 3 years.



Summary

- New design approach
“Behavior model based approach”
- New sensing and modeling technology
 - Ubiquitous sensing technology and wearable sensing technology
(e.g., low-cost location sensor, tiny EMG sensor)
 - Probabilistic modeling technology
(e.g., large-scale Bayesian network)
- Case study of designing playground equipment using the proposed approach