

HCI/ComS 575X:
Computational Perception

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http://www.cs.iastate.edu/~alex/classes/2007_Spring_575X/

Motion Energy & Motion History

February 7, 2007

*HCI/ComS 575X: Computational Perception
Iowa State University, SPRING 2007
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A. F. Bobick and J.W. Davis

“An appearance-based
representation of action”.

In Proceedings of IEEE International
Conference on Pattern Recognition
1996,
August 1996, pp. 307-312.

A. Davis, J. and A. Bobick

“The Representation and
Recognition of Action Using
Temporal Templates”,

In Proceedings of IEEE Conference
on Computer Vision and Pattern
Recognition,
June 1997, pp. 928-934.

The Authors



Aaron Bobick

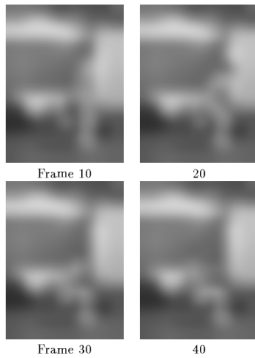


James Davis

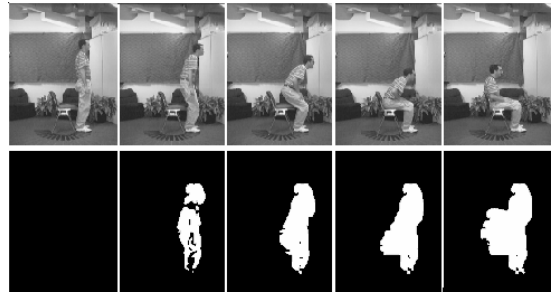
What is this?



What action is being performed?

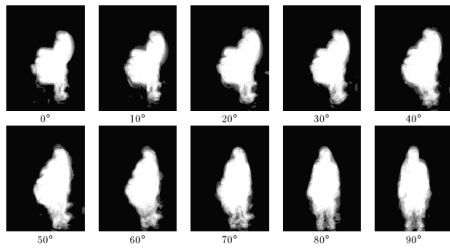


Motion Energy Image (MEI)

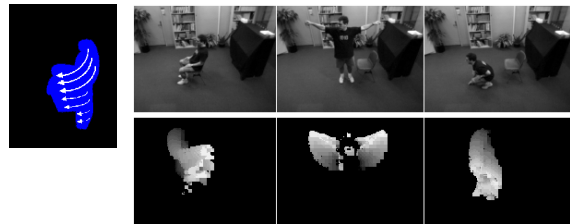


[<http://www.cse.ohio-state.edu/~jwdavis/CVL/Research/MHI/mhi.html>]

Average MEI for various viewing angles



Motion History Image (MHI)



[<http://www.cse.ohio-state.edu/~jwdavis/CVL/Research/MHI/mhi.html>]

Definitions

- Image Sequence $I(x, y, t)$
- Binary Images $D(x, y, t)$
indicating regions of motion
- Binary Motion Energy Image $E_\tau(x, y, t)$

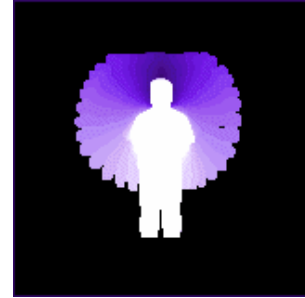
Motion Energy

$$E_\tau(x, y, t) = \bigcup_{i=0}^{\tau-1} D(x, y, t - i)$$

Motion History

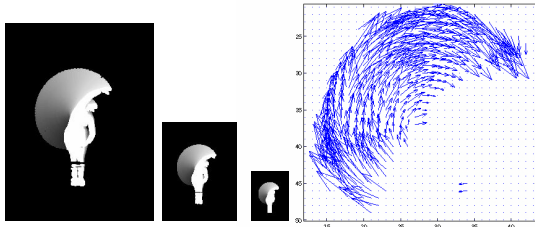
$$H_{\tau}(x, y, t) = \begin{cases} \tau & \text{if } D(x, y, t) = 1 \\ \max(0, H_{\tau}(x, y, t - 1) - 1) & \text{otherwise} \end{cases}$$

The result: more recently moving pixels appear brighter



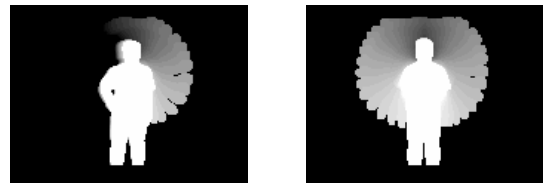
[<http://www.cse.ohio-state.edu/~jwdavis/CVL/Research/MHI/mhi.html>]

MHI pyramid

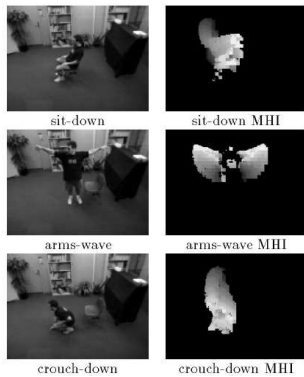


[<http://www.cse.ohio-state.edu/~jwdavis/CVL/Research/MHI/mhi.html>]

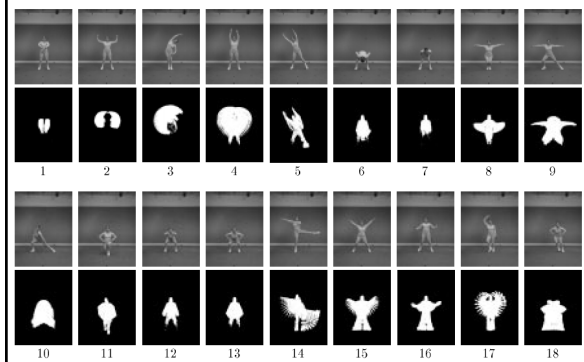
Motion templates for finishing LEFT-ARM-RAISE and FAN-UP-ARMS.



[<http://www.cse.ohio-state.edu/~jwdavis/CVL/Research/VirtualAerobics/aerobics.html>]



Aerobics Dataset



Results for 30° off center camera location

	Closest Dist	Closest Move	Correct Dist	Median Dist	Rank
Test 1	1.43	4	1.44	2.55	2
2	3.14	2	3.14	12.00	1
3	3.08	3	3.08	8.39	1
4	0.47	4	0.47	2.11	1
5	6.84	5	6.84	19.24	1
6	0.32	10	0.61	0.64	7
Test 7	0.97	7	0.97	2.03	1
8	20.47	8	20.47	35.89	1
9	1.05	8	1.77	2.37	4
10	0.14	10	0.14	0.72	1
11	0.24	11	0.24	1.01	1
12	0.79	12	0.79	4.42	1
Test 13	0.13	6	0.25	0.51	3
14	4.01	14	4.01	7.98	1
15	0.34	15	0.34	1.84	1
16	1.03	15	1.04	1.59	2
17	0.65	17	0.65	2.18	1
18	0.48	10	0.51	0.94	4

OpenCV Demo

- If you want to try this at home just compile and run the motempl.c file in the ../samples/c directory

Applications

A. Bobick, S. Intille, J. Davis, F. Baird, C. Pinhanez, L. Campbell, Y. Ivanov, A. Schutte, and A. Wilson (1999)

“The Kidsroom: A Perceptually-Based Interactive and Immersive Story Environment”

Presence: Teleoperators and Virtual Environments, Vol. 8, No. 4, 1999, pp. 367-391.

The Kid’s Room



[Bobick et al. 1996]

The Kid’s Room



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

The Kid's Room



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

The Kid's Room



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

Monsters



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

Scavenger Hunt



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

Scavenger Hunt



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

The Blue Monster



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

Spin in place



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

3 Kids Spin on a Rug



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

The River Vorls



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

The Technology

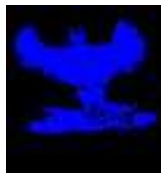


[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

Motion History Templates



Making a 'Y'



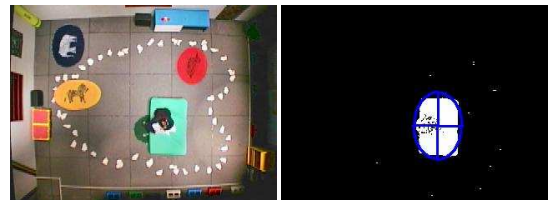
Flapping



Spinning

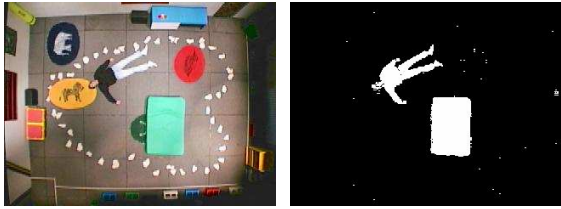
[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

Detecting the Bed



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

Man Overboard Detector



[<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>]

Movies

- The quality of the movies is not very good
- You can download them from:

<http://vismod.media.mit.edu/vismod/demos/kidsroom/kidsroom.html>

J. Davis and A. Bobick

``Virtual PAT: A Virtual
Personal Aerobics Trainer",

Workshop on Perceptual User
Interfaces, November 1998,
pp. 13-18.

Interactive Virtual Aerobics Trainer



[<http://www.cse.ohio-state.edu/~jwdavis/CVL/Research/VirtualAerobics/aerobics.html>]

Interactive Virtual Aerobics Trainer



[<http://www.cse.ohio-state.edu/~jwdavis/CVL/Research/VirtualAerobics/aerobics.html>]

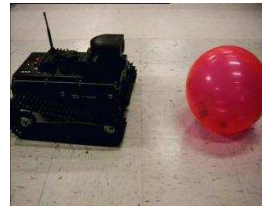
Interactive Virtual Aerobics Trainer



[<http://www.cse.ohio-state.edu/~jwdavis/CVL/Research/VirtualAerobics/aerobics.html>]

Movies

The Personal Pet Project



Pepe

*Joint work with
Rawesak Tanawongsuwan*

Tanawongsuwan, R., Stoytchev, A.,
and Essa, I.,

"Robust Tracking of People by a
Mobile Robotic Agent",
Technical Report GIT-GVU-99-19.

Project Goals

- build an intelligent, adaptive, user-friendly agent
- build an agent that has a personality
- make the interaction between the user and the agent as natural as possible

Gesture Recognition



Pointing gesture



Motion Profile
Calculation

Face and Hands
Segmentation



Neural
Network

Gesture Recognition

Hidden Markov
Models

Motion History/Energy

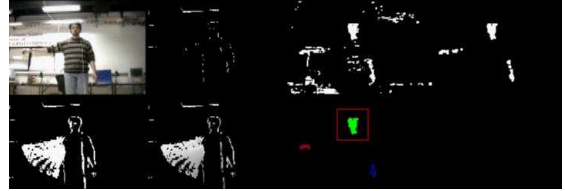
- Perform a frame-by-frame subtraction (image differencing) and accumulate the results over the history window.
- Motion energy is a binary version of motion history
- Technique from Bobick and Davis.



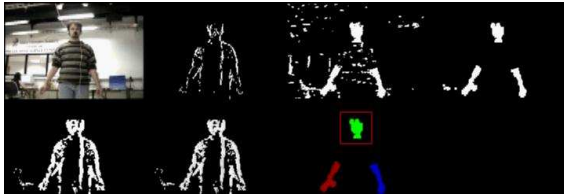
Gesture recognition



Gesture Recognition



Gesture recognition



Movie

THE END