SENSING TECHNOLOGIES

Exchange information

How to exchange information between the digital and the physical body?

Let's look at the gesture communication in Picture This!

Reference

Vaucelle, C. and Ishii, H. 2008. Picture this!: film assembly using toy gestures. In Proceedings of the 10th international Conference on Ubiquitous Computing. UbiComp '08, vol. 344. ACM, New York, NY, 350-359.

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14-11-2008

Gesture communication

Modes to control Picture This!

Rehearsing mode: The live video feed comes from the camera attached to the doll and is continuously displayed on a screen in front of the child

Recording mode: If a doll wants to be in the video, the doll needs to move. If it wants to be recorded it has to move three times quickly and the doll's conversation partner will start the recording.

Playback mode: To play back the movie, the two dolls have to be moved in synchrony, in essence, jumping horizontally together.

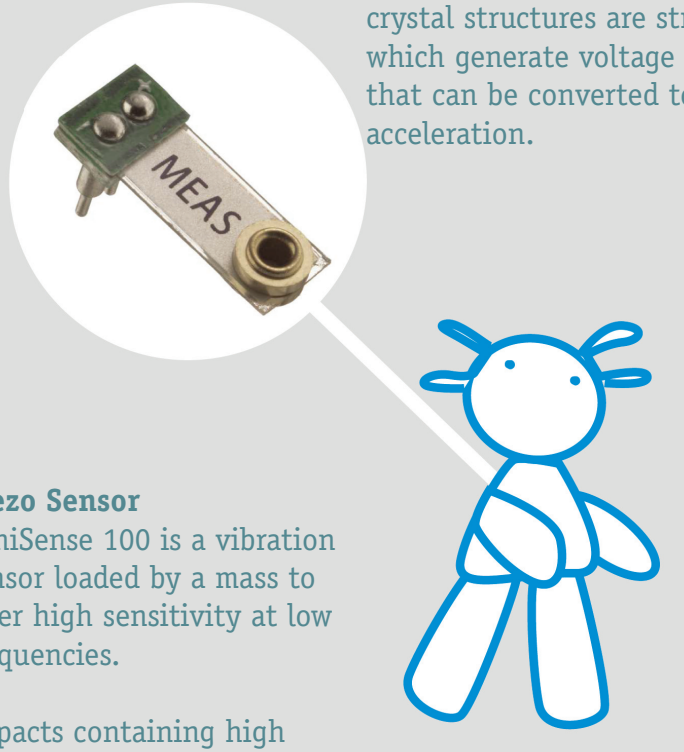
Motions / Input		Output
Doll 1 (D1)	Doll 2 (D2)	
Mode (a) Preview		
Vertical motion	*No motion*	Live video feed from D2
No motion	Vertical motion	Live video feed from D1
Vertical motion	Vertical motion	Continue live video feed
Mode (b) Record This mode blocks (a) until either (c) or (d) is triggered.		
Vertical motion 3 times in < 1s	*No motion*	Live video feed from D2 is recorded, indexed and associated with D2.
No motion	Vertical motion 3 times in < 1s	Live video feed from D1 is recorded, indexed and associated with D1.
Vertical motion 3 times in < 1s	Vertical motion 3 times in < 1s	Nothing happens
Mode (c) Stop Record		
Horizontal motion	No motion	This mode stops the current recording and goes back to (a) with corresponding video life feed from doll.
No motion	Horizontal motion	
Mode (d) Stop Playback This mode blocks (a) (b) (c) until the movie played back reaches its end. It then goes back to mode (a).		The software had concatenated the video segments captured in (b). It now plays back the entire movie on display.
Horizontal motion	Horizontal motion	

Piezo vibration sensor

To distinguish between motions

[] In Picture This! we use a Piezo vibration sensor (PVDF). We distinguish between vertical and horizontal motions while our sensor is a single axis accelerometer --detects mechanical stress.

[] We detect small variations of the off-axis motion with the on-axis accelerometer and are able to categorize strong motion in one axis and weak motion in the orthogonal axis.



In the piezo vibration sensor, crystal structures are stressed which generate voltage that can be converted to acceleration.

Piezo Sensor
MiniSense 100 is a vibration sensor loaded by a mass to offer high sensitivity at low frequencies.

Impacts containing high frequency components will excite the resonance frequency (1oohz).

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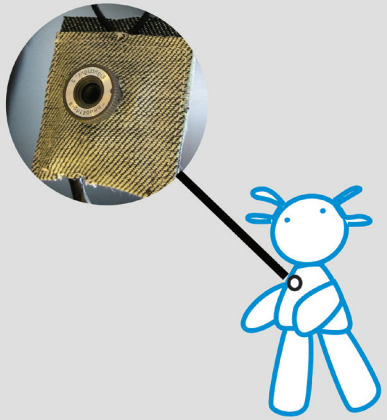
Hardware versus software

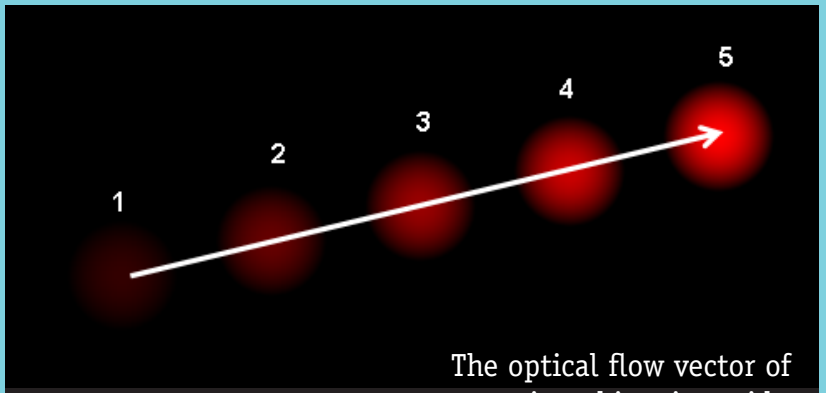
Piezo sensor vs optical flow calculation

Why use a Piezo film?
A Piezo vibration sensor is low-cost, easy to use and it offers a nice signal, but it is sensitive to temperature variations.

Why not use optical flow calculation?
Because the doll wears a camera, we could take advantages of the camera as input to detect when it is moving ...



The camera is on the doll. To be recorded the doll has to shake! "film me!"



The optical flow vector of a moving object in a video sequence.

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Hardware versus software

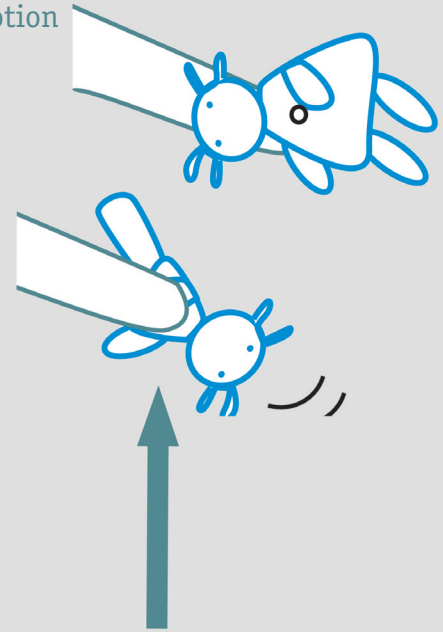
Avoiding the problem of line of sight

Why not use optical flow calculation?

[] we avoid the problem of line of sight from the optical flow calculation.

[] with a Piezo sensor, we can select the strong variations in a short period of time (not the medium variations that occur during play).

There is a problem with the optical flow method: the child can easily occlude the camera because she shakes the doll that will not record, thus does not have a direct feedback for motion detection occlusion.



Camera optical flow occlusion

Generalizing Picture This!

Picture This! on new platforms

We can generalize Picture This! technology to new platforms

Using a software-based Picture This! can democratize film making with toys.

Example
Mum and Dad's cherished objects become the platforms of a child's perspective taking, i.e. imagining Picture This! on cell phones.

A Piezo vibration sensor can be a constraint, requiring the purchase of a peripheral for the toys.

We can be hopeful, lots of camera phones now have an integrated accelerometer!

Children already use stuffed animals cell phone holder!

Picture This! could easily be integrated within these character looking holders!

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Hardware methods

To detect gestures

Let's look at other hardware methods to detect gestures with toys and wearable:

[] Tilt mechanical switch: ON/OFF.

[] Capacitive sensing: measuring the distance between an object and its reference point. Change in capacitance related to acceleration.

[] Piezo resistive effect: Resistance changes with acceleration.

[] Hall effect: Motion converted to an electrical signal detecting change in magnetic fields.

[] Heat transfer: Location of heated mass tracked during acceleration by sensing temperature.

[] Magnetoresistive: Material resistivity changes in presence of magnetic field

Mapping data

What kind of actuation to select?

How to exchange information between the digital and physical body?

[] Sensing technology initiated with the physical body and output to the digital body:

e.g. gesture, touch, pressure.

[] Sensing technology from the digital body mapped onto the physical body:

e.g. actuation could be identified as “tiring”, “annoying” or “relaxing”. Actuation can be based on vibration; temperature: Peltier junction; pressure: pneumatics.

Mapping information
Methods for mapping data

How to find the right mapping between the digital and physical body?

[] User study: testing the mechanism of actuation.

[] Measuring the relationship between stimulus and sensation (psychophysics).

[] Allowing user customization of the technology: give users control and study it!

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CONCLUSION