Natural Interaction Is “In Hand”

SensorsCon March 6, 2013

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Hillcrest Labs: Experts in Motion

**Founded:** 2001  
**Based:** Rockville, MD, USA  
**Industries:** Smart TV, Mobile, PC, Gaming, Industrial, Specialty  
**Summary:** Market leader in multiplatform motion software and products. Provides motion solutions under the Freespace® brand.

- 10+ years of experience developing motion technologies and new user experiences  
- 200+ patents filed worldwide covering essential methods for effective motion control  
- 250+ man-years delivering motion control products and motion-enabled applications  
- Millions of units with Freespace® MotionEngine™ software shipped annually

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*LG*, *TCL*, *Logitech*, *Sony*, *Roku*, *Universal Electronics*, *SMK*
Let’s Talk About TV for a Change
TV Is HUGE!

Couch Potatoes Create...

... Billions in Direct Revenues...

... and Billions in Downstream Revenues

Source: Forbes.com $500 Billion TV Market New Battlefield For Internet Companies
But today’s TV UIs are too complicated. A simpler and more intuitive interaction paradigm is needed.

“Consumers complained Google TV was too complicated”
LA Times, 10/28/11

“I’d relegate Google TV to the category of a geek product, not a mainstream, easy solution ready for average users. It’s too complicated, in my view, and some of its functions fall short.” Walt Mossberg, 11/17/2010

[Major TV is]
“a confusing UI nightmare”
Engadget, 1/8/11

[Xfinity guide] “too complex for me”
liliwings, Comcast, 9/13/2010

“Poor user interfaces (UI) are standing in the way of high level, social interaction on TV.”
Lee Yi, 6/17/11

We call what’s needed Natural Interaction
Other Examples of Natural Interaction

Smart Phones

Tablets
Four Common Interactions

- Point and Select
- Pinch
- Swipe/Gesture
- Drag and Drop
So can you interact like that with your TV?
Yes you can.

Natural Interaction is In Hand
**Tablet Interaction**

- **Point/Select Action**
- **Swipe Action**
- **Pinch Action**
- **Drag Action**

**TV Interaction**

- **Pointing (+ motion stabilization)**
- **Swipe gesture**
- **Rotation of remote, like dial**
- **Hold down selection button + drag**
Inertial Sensors Provide the Foundation

**Gyroscope**
- Responsive measurement of angular velocity
- Provides foundation for cursor movement and rotational gestures

**Accelerometer**
- Long-term stable measurement of 2/3 of angular position
- Used for orientation, wake on motion, and certain gestures (shake)

**Magnetometer (optional)**
- Long-term stable measurement of 2/3 of angular position
- Used for orientation
But Creating a Tablet-like Experience Goes Well Beyond Just Picking Sensors

It means understanding consumer behavior and the “living room” environment
What does it really mean to be Natural?
Natural Starts with Comfort
And Natural Also Means **Intuitive**
Relative Pointing Is Primary Interaction Paradigm

- Original mouse was created in the 1960s and first used by consumers in the 1980s
- The mouse solves the fundamental problem of easy to learn point-and-click control of a GUI
- Relative pointing means that there are line of site requirements and users are not required to point directly at the TV.

Relative pointing addresses intuitiveness and comfort.
Relative Pointing Enables Non-Linear Ballistics

- When user moves cursor fast, the cursor accelerates
- When user moves cursor slow, the cursor decelerates
- Allows user to move quickly across screen but also more effectively hit smaller targets
Orientation Compensation

Natural, relaxed hand position can vary more than 25° rotation across a range of users even in when using standard sitting positions.

Therefore, “horizontal” movement by the user will result in a diagonal line in the absence of Orientation Compensation.
Finally Natural Means Being in Complete Control

- Solution should be **accurate** and **responsive**
- Impediments include
  - Drift and minimum velocity
  - Unintended motion
  - Latency
Gyro ZRO Tracking and Compensation

Gyro Zero Rate Offset (ZRO) -- Definition

The inherent gyro sensor bias. This value is greatly dependent on temperature and aging and can vary widely during normal use scenarios.

- Changing ZRO is major cause of drift
- A ZRO tracking algorithm MUST compensate for time and temperature variations
- A ZRO tracking algorithm MUST work while device is in use (moving)
Minimum Velocity

The behavior of an in-air pointing device at low speeds can differ significantly from its behavior at higher speeds.

Perfect device behavior would linearly track all motion down to 0°/s and eliminate unintentional motion like hand tremors; in the real world this is impossible to achieve.
Minimum Velocity Breakdown

- Slow Motion Profile A - Good
- Slow Motion Profile B - Poor

“Dead Zone A”

“Dead Zone B”

Velocity “Leap” B
Unintended Motion – Button Pressing

- **PC Mouse**
  - Has benefit of residing on a flat surface with friction
  - Cursor is stable when using mouse buttons

- **Air Mouse**
  - Cursor can be moving when using remote control buttons
  - Natural button press movement moves remote control down causing movement of the cursor

Solution – Disable motion processing when user presses RC buttons
Unintended Motion – Physiological Tremor

Targeting improves substantially when we remove tremor.

Smaller values are better.
Latency Considerations

- Instantaneous to most people
- Perceptible delay to some people
- Perceptible delay to most people

TARGET LATENCY

Latency (milliseconds)

0 10 20 30 40 50 60 70 80 90 100

Delay
Final Thoughts On Measuring Performance
Measuring Accuracy and Throughput

“Fitts Test”

Hillcrest developed a test which compiles with ISO 9241-9, Multi-directional tapping test B.6.2.2

Test Elements:

- Its applications include (1)
  - a) repositioning a cursor at different areas on the screen
  - b) selecting randomly located icons
- Subject is required to move the cursor across a circle to sequentially numbered targets (1)
- Standard requires a range of difficulties (1) - four ranges of difficulty used including target size and target distance variances
- Test results calculated using section B.5 (1)

(1) International Standard ISO 9241-9 Ergonomic requirements for office work with visual display terminals (VDT’s) – Part 9: Requirements for non-keyboard input devices
Measuring Latency

- Use high speed camera to measure latency
- Camera captures both impulse movement of the RC and movement of the cursor on the screen in the same view
- You can easily count frames in the video to measure system latency
Measuring Real Movement vs. Calculated Movement

- IR is emitted, reflected by remote control under test and captured by grid of cameras.
- Is used to capture and analyze real motion vs. processed motion
Key Takeaways

- New methods of interaction are necessary to unlock the value of interactive TV – **Natural Interaction**
- Natural Interaction is “In Hand”
- Natural is not a word to take lightly – it means comfortable, intuitive, and extremely high performance
- Performance can be measured quantitatively not just subjectively
Questions?
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