Device Research Report

Team Physion

04-15-2010

Conclusion

One of the most important factors we considered during our search is user convenience and availability of real time data exchange. In addition, we will focus on software development rather than hardware building, seeing as there is a good selection of biofeedback devices already available for purchase.

For real time data exchange, PC connection and Programming Source Availability is also essential.

Considering the factors, we will try to use three devices: **IOM, Emotiv and Wiimote**. All of them are able to exchange data in real time and are convenient to the user. Neurosky is more user convenient, but due to its instability, we chose Emotiv.   *Attached: Comparison of Neurosky and Emotiv*

	GoWear	IOM	Mindset	Emotiv	ProComp2	GSR/Temp2	IDEEA	Wiimote
PC connection	O	O	O	O	O	O	O	O
Real time Data Exchange	X	O	O	O	O	X	X	O
Programming Source	X	O	O	O	O	O	O	O
Programming Stability		O	X	O				O
Cost	160	330	200	500	3000+	160	4900	60
Affordability	O	O	O	O	X	O	X	O
Wireless	O	X	O	O	X	X	O	O
*User Convenience	O	O	O	o	O	O	X	O
Skin Temperature	O				O	O		
Sweat Gland	O	O			O	O		
Brain Waves			O	O	O			
Heartbeat Rate		O			O			
Motion	O						O	O
Respiration					O			
Use in Project	**X**	**O**	**X**	**O**			**X**	**O**

O: Available, X: Not Available

* User Convenience: Is the device comfortable during game play?

1. GoWear/SenseWear

Description:

- Manufacturer: BodyMedia
- Cost: GoWear $160 / SenseWear $2500
- Sensor: Skin Temperature, GSR(Sweat Gland), Heat Flux, Accelerometer (Motion)

Pros:

- Can help improve experience according to player's potential action.

Cons:

- Expensive.

Progress:

- There is no provided SDK or a way to get raw data with the device that we have (GoWear).
- They suggested to us to buy another product of theirs, SenseWear (BMS). BMS originally costs $3,500 including professional software. After university discount, it became $2,500. There might be a little room for price negotiation.

Contact Point:

- Rachel Jackson
  Clinical Research Coordinator
  (412) 543-1311
  http://www.bodymedia.com

2. IOM

Description:

- Manufacturer: Wild Divine
- Cost: $ 330
- Sensor: GSR(Sweat Gland), Heart beat

Pros:

- GSR is very salient biofeedback.
- Non-invasive to the player.
- Player is able to control both biofeedback to a certain extent.

Cons:

- It is not wireless.

Progress:

- Wild Divine requested us to sign SDK agreement.
- Made data collection tool
- Real time data is integrated in game.

Contact Point:

- tori@wilddivine.com
  (866) 594-9453 option "1"
  http://www. wilddivine.com

3. MindSet

Description:

- Manufacturer: Neuro Sky
- Cost: $ 200
- Sensor: Brainwave

Pros:

- It is wireless with Bluetooth.
- The company provides SDK on its web site.
- Real time data exchange.

Cons:

- The sensor sends data once a second. It might feel as lagging.
- The programming stability is low occasionally. Player could feel it's hard to control the brain wave accurately.

Progress:

- Succeeded in making a simple demo.

- We met them during GDC 2010. They were quite interested in our project and provided sample project using in Unity 3D which works in stable. However, the code doesn't work well for us. After weeks of struggle, we decided not to use.
  http://developer.neurosky.com/docs/doku.php?id=app_notes_and_tutorials

Contact Point:

- info@neurosky.com
  (408) 200-6677

4. Emotiv

Description:

- Manufacturer: Emotiv Systems, Inc
- Cost: $ 500 (developer edition)
- Sensor: EEG, gyro, facial expression

Pros:

- Wireless with Bluetooth.
- Fast data refresh rate
  Emotiv detections are mostly updated 4 times per second.
- Various data detection
  Expressiv: real-time detection of blinks, left/right winks, horizontal glances left/right, eyebrow raise, furrow, smile, smirk left/right, clench teeth, laugh
  Affectiv: Excitement (short-term and long-term), Engagement/Boredom, Meditation, Frustration.
  Cognitiv: NEUTRAL plus up to four trained actions selected from forward and backward motions on each of 3 axes, clockwise and anticlockwise rotations about each of 3 axes (12 detections)
  Gyro: 2-axis gyro detects accelerations (nodding, shaking head)
  EEG (Research, Education and Enterprise Plus licenses only): 14 channel data at 128 samples per second
- Real time data exchange.

Cons:

- It takes 10minutes to setup the device.
- Moist 16 sensors around head could make player uncomfortable.
- Player could feel it's hard to control the brain wave accurately.
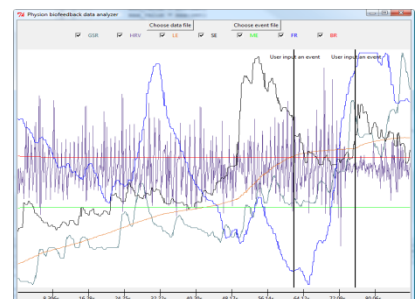
Progress:

- Made data collection tool
- Real time data is integrated in our game.

Contact Point:

- Geoff Mackellar
  geoff@emotiv.com
  +1 631 676 1623
  http://www.emotiv.com/

Detecting Emotion:

- **Instantaneous Excitement** is experienced as an awareness or feeling of physiological arousal with a positive value. Excitement is characterized by activation in the sympathetic nervous system which results in a range of physiological responses including pupil dilation, eye widening, sweat gland stimulation, heart rate and muscle tension increases, blood diversion, and digestive inhibition.
  Related emotions: titillation, nervousness, agitation
  Scoring behavior: In general, the greater the increase in physiological arousal the greater the output score for the detection. The Instantaneous Excitement detection is tuned to provide output scores that more accurately reflect short-term changes in excitement over time periods as short as several seconds.

- **Long-Term Excitement** is experienced and defined in the same way as Instantaneous Excitement, but the detection is designed and tuned to be more accurate when measuring changes in excitement over longer time periods, typically measured in minutes.

- **Engagement** is experienced as alertness and the conscious direction of attention towards task-relevant stimuli. It is characterized by increased physiological arousal and beta waves (a well-known type of EEG waveform) along with attenuated alpha waves (another type of EEG waveform). The opposite pole of this detection is referred to as "Boredom" in Emotiv Control Panel and the Emotiv API; however, please note that this does not always correspond to a subjective emotional experience that all users describe as boredom.
  Related emotions: alertness, vigilance, concentration, stimulation, interest
  Scoring behavior: The greater the attention, focus and cognitive workload, the greater the output score reported by the detection. Examples of engaging video game events that result in a peak in the detection are difficult tasks requiring concentration, discovering something new, and entering a new area. Deaths in a game often result in bell-shaped transient responses. Shooting or sniping targets also produce similar

transient responses. Writing something on paper or typing typically increase the engagement score, while closing the eyes almost always rapidly decreases the score.

5. ProComp

Description:

- Manufacturer: Thought Technology
- Cost: $ 1700 ~ 6000
  - To use, an encoder and a sensors are required. 2-channel encoder can use 2 sensors.
  - 2-channel encoder: $ 1700
  - 5-channel encoder: $ 3000
  - 10-channel encoder: $ 6000
  - Sensor: $200 ~ $300
- Sensor: EEG, EMG, EKG, Blood Volume Pulse, Skin Conductance Sensor, Respiration, Temperature, Force, etc.
- It costs $2300 if we want to use GSR and skin temperature sensor.

Pros:

- Various sensors are available.
- Real time data exchange
- It provides SDK and API with purchase of hardware.
- 10% student discount.

Cons:

- Expensive

Progress:

- Before considering the purchase, we would like to examine the software. We contacted the company and they might send us trial software.

Contact Point:

- William Chen
  william@thoughttechnology.com
  (514) 489-8251
  http://www.thoughttechnology.com/

6. GSR/Temp2

Description:

- Manufacturer: Thought Technology
- Cost: $ 160
  - Software costs $75 (made by Beyond VR)
- Sensor: GSR, skin temperature
- Also made by Thought Technology, and much simplified one.

Pros:

- Low cost

Progress:

- We contacted Mr. Gordon of MindGrowth, the US distributor. Gordon said it might be possible to get raw data in real time. We sent questions to Gordon and he would contact the software developer company Beyond VR.

Contact Point:

Distributor

- Gordon Klein
  email@mindgrowth.com
  (800) 435-5354 (USA/Canada) or (416) 209-2495
  http://www.mindgrowth.com/store/index.php?cPath=23
  http://www.mindgrowth.com/store/product_info.php?cPath=1&products_id=34

7. IDEEA

Description:

- Manufacturer: Minisun
- Cost: $ 4900

- Sensor: Motion

Pros:

- Can get various motion information
  - Identifies 40+ types of physical activity, including lying, sitting, walking, climbing stairs, running, jumping.
- Lightweight and portable

Cons:

- Expensive. It's professional research device and costs $ 4900
  - The price is including H/W and S/W. It's a university price with discount.
- May not able to get date in real time.

Progress:

- Price is high and real time data exchange is not available.
- For these reasons, we might not use it.

Contact Point:

- Meteen
  gexin@yahoo.com
  (559) 285-5393
  http://www.minisun.com/

8. Wiimote

Description:

- Manufacturer: Nintendo
- Cost: $ 60 (controller $40, sensor bar $20)
- Sensor: Motion

Pros:

- Simple motion information (direction, swing, movement)
- Lightweight.
- Have experience in programming.

Cons:

- Limited movement. Need to point to the sensor bar.

Progress:

- Made data collection tool
- Real time data is integrated in game.

Contact Point:

- http://www.wiiworldstore.com

9. Beyond VR

Description:

- Software developing company for various biofeedback hardwares.
- Its software supports GSR/Temp2.
- They will launch new SDK for Mindset at GDC 2010.
- They developed software for IOM but didn't publish yet.
- According to website, their 'Cybernetic Interface System' is the only platform with multi-system support for biofeedback-controlled 3D graphics.

Progress:

- We had a conference call with Jon, the CEO. He was willing to give advice about our project.
- He provided us development kit and tools so that we can examine.
- Also he said it was possible to make a custom kit that will combine multiple hardware sensors such as Wild Divine and NeuroSky headset.
- Detail information is available at CIS Report.

Contact Point:

- Jon Meadows
  jon@beyondvr.net
  (785)228-2930
  http://beyondvr.net/

10. Emsense

Description:

- 24 EEG brain sensor, the Emband24, which is used for market research and advertising
- Emband 24 can be used without the gel on the sensor contacts

- According to the web, EPOC is designed for consumer use and has a ton of software support for BCI applications. The EmSense product is clearly not targeted at the BCI space, much more at consumer reactions in market research studies. They serve quite different markets. http://www.emsense.com

Comparison of Neurosky and Emotiv

Although it's not as comfortable for the player, Emotiv performs better in programming and data acquisition. We think these are important for our research purpose. If we make commercial game, Neurosky could be reconsidered.

PROGRAM STABILITY

NeuroSky is unstable to connect. It is often that the program cannot connect with the device, and the whole program was stuck at this time. Also, it is often that the connection becomes bad when we are using the device. Even NeuroSky's own sample program sometimes cannot work well. Emotiv is much easier to connect with program. Even though sometime the program stopped suddenly and cannot disconnect, the device can solve this problem by itself.

DATA ACQUISITION
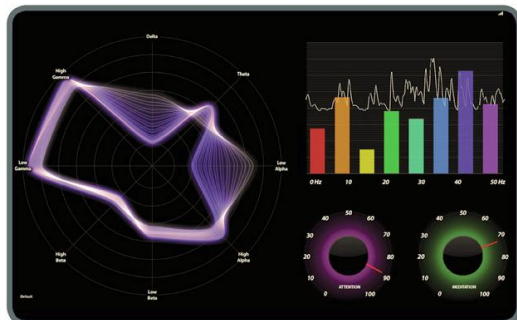
< Neurosky- Data visulazation>

<Emotiv- Control Panel>
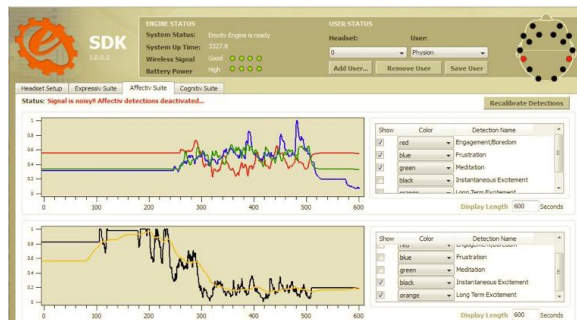
NeuroSky's data lagged for a few second, and acquires less data than Emotiv. The data we can use from NeuroSky are attention and meditation value, which refresh once per second.

Emotiv can provide more data, including long term excitement, short term excitement, meditation, frustration, and boredom, which refresh 4 times per second.

USER CONVENIENCE

<Neurosky Mindset>

<Emotiv EPOC>

Neurosky has two sensor spot. One is for ear and one is for forhead. It's easy to setup and play. It has Bluetooth headphone.

Emotiv needs to use 16 moist sensors around the head. It's less comfortable to play. It requires 10 minutes to setup the sensors.