

Interactive System インターラクティブシステム特論(1)

Hiroyuki Kajimoto
kajimoto@hc.uec.ac.jp
Twitter ID kajimoto

言語 / Language

- 講義は日本語、資料は英語。
- ✓ 専門用語は併記
- Lecture in Japanese, handouts in English.

小テスト/ Mini Test

- ・ 講義の目的の一つが「基礎知識を得ること」なので、各回 小テストを行います。
- ・ Google Formに入力する形で回答。
<https://goo.gl/forms/85xfEx2mLheNncR2>
- ・ 回答テキストをフォームにコピペして提出してください
- ・ 締め切り: 次回の授業開始まで
- ・ E-mail report based mini tests are done every time.
- ・ Upload to
<https://goo.gl/forms/85xfEx2mLheNncR2>
- ・ Deadline: Before the beginning of the next lecture

発表/ Presentation Your PowerPoint Presentation is required.

- ・ 英語の論文を一つ読み、その内容を発表。
(読む候補はこちらで用意します)

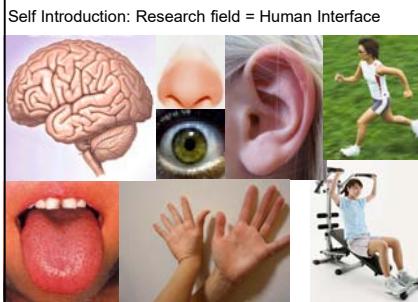
Read a paper and do presentation.
(candidate papers will be announced)

– 今のところ発表8分、質疑4分。

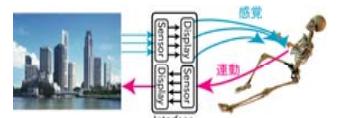
- ・ 発表は全員で評価

The presentation is evaluated by all attendees

- 1. 発表内容に対する理解度
- 2. 発表用資料(パワーポイント)の分かりやすさ
- 3. 発表の分かりやすさ
- 4. 質問に対する受け答え
- 5. 総合的な印象



Necessary Knowledge for the research



- ・ヒトの特性／Human perception
- ・最新技術(センサ)／Today's sensing technology
- ・最新技術(ディスプレイ)／Today's display technology

This Lecture aims to roughly sketch
"optimal design method based on human perception"

評価/ Evaluation

- ・点数=出席(40%)+小テスト(5%×8)+発表(20%)
- ・ただし発表をすることが評価の前提条件
- ・電通大以外の場合(スーパードラム連携大学院)=Attendance (60%) + Mini Test (5% × 8)
- ・Evaluation=Attendance (40%) + Mini Test (5% × 8) + Presentation (20%)
- ・Presentation is required

Handouts on the web

<http://kaji-lab.jp/ja/index.php?people/kaji/interactive>

–現在は2017年版がおかれています。徐々に変えていきます。
–Temporary, 2017 Japanese version. Will be replaced progressively.

–こちらのpdfには動画のリンク先(Youtube等)が埋め込まれているので、紙資料よりも便利。次回から紙資料は配布せず、講義の1時間前までにアップロードします。必要な事前にダウンロードしてください

–From next time, lecture handouts will be online 1 hour before the lecture. Print it if necessary.

Outline of the lecture



1. 人間計測手法／Measuring Human
2. 視覚／Human Vision System
3. 視覚センシング／Visual Sensing
4. 視覚ディスプレイ／Visual Display
5. 聴覚、聴覚インターフェース／Auditory Interface
6. 觸覚、触覚インターフェース基礎／Tactile Interface Basics
7. 觸覚、触覚インターフェース応用／Tactile Interface Applications
8. 力覚、力覚インターフェース／Haptic Interface
9. 移動感覚インターフェース／Locomotion Interface

Schedule

- 10/5 • 講義(lecture)
- 10/12 • 講義(lecture)
- 10/19 • 講義(lecture)
- 10/26 • 講義(lecture)
- 11/2 • 講義(lecture)
- 11/9 • 休講
- 11/16 • 休講
- 11/23 • 銀杏祭期間、11/25(日)オープンラボ研究室見学(任意)
- 11/30 • 講義(lecture)
- 12/7 • 講義(lecture)
- 12/14 • 休講
- 12/21 • 講義(lecture)
- 1/11 • 講義(lecture)
- 1/18 • センター試験準備日
- 1/25 • プレゼンテーション(presentation)1
- 2/1 • プレゼンテーション(presentation)2
- 2/8 • プレゼンテーション(presentation)3

Today's Topic: 人間計測手法／Measuring Human



- ヒトの計測:
- ・インラクティブシステムの構成要素
 - ・インラクティブシステムを評価するためにも必須

Measurement of human action/reaction
•To be used as parts of the interactive system
•To evaluate the system

人間計測手法／Measuring Human



意志から行動までの「どの経路を測るか」で5つの段階
Five layers, from our initial will to our perception.

- 脳活動計測／Measure brain activity.
- 神経・筋活動計測／Measure nerve activity.
- 自律神経系計測／Measure autonomic nerve related phenomenon.
- 運動計測／Measure motion.
- 心理物理実験／Ask the user (psychophysics)

History of Brain Function Observation(1)

- Theory of localization of brain function:
 - 1909: ブロードマン Broadmann made "map" of the brain by visual observation. (microscope)
 - WWI: Better guns = many patients with "partial" brain damage



Broadmann's map:
52 regions of the cortex defined
based on organization of cells.

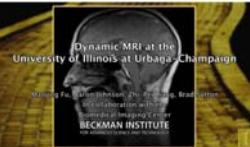
History of Brain Function Observation(2)

- 1933: ペンフィールド Penfield
Before Brain surgery for epilepsy, he stimulated brain directly by electrical needle. while the patients were awake.
Result: Many functional region were found, including memory, sensory, and action.
- 1940: ロボトミー Lobotomy
Cut frontal lobe of the brain for mental disease, especially for violent patients.
Result: Became calm, but also became like "robot" ⇒ Frontal lobe seems to be related to "emotion"
- 1960: X-ray CT gave clear view of the brain, without surgery.



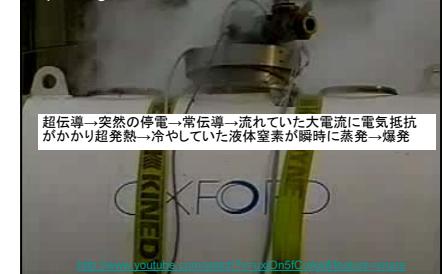
X-ray CT

100fps MRI



- <http://japanese.encoded.org.com/2015/04/23/100fps-mri/>
- イリノイ大学アーバンシャンペーン校のベックマン先端科学技術研究所が、秒間100コマの撮影が可能なMRI技術を開発しました。
- ベックマン研究所が開発した技術を大雑把に説明すれば、単純にフレームレートを上げただけではありません。これは、通常のMRIでは、1枚の画像を取得する特徴的な取扱方法を開発・利用していること。これにより撮像時間は従来のおよそ10倍、約100fpsにまで高められています。
- 論文は Magnetic Resonance in Medicine誌 "High-resolution dynamic speech imaging using sparse rank and sparsity constraints" (Meiqing Fu, Bo Zhao, Christopher Cargan, Ryan K. Shosted, Jamie L. Penny, David P. Kuehn, Zhi-Pei Liang, and Bradley P. Sutton)

Exploding MRI



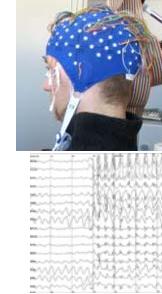
<http://www.youtube.com/watch?v=auxOn5fCoAw&feature=share>

脳機能計測／Measurement of Brain Function

- Not the measurement of brain, but brain function. Must be done during some work. (see, touch, think)
- State-of-the-art measurement technologies are used.
 - Measure "Electrical Activity"
 - 脳波／EEG(brain wave), 1929～
 - 脳磁／MEG, 1972～
 - Measure "Blood Flow"
 - fMRI(functional MRI), 1973～
 - PET, 1965～
 - NIRS, 1994～
 - Active method
 - Use magnetic stimulator

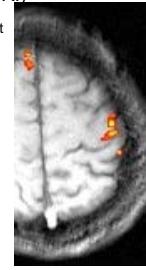
EEG (Brain Wave)

- EEG: Electroencephalogram
21~60 electrodes on the skull skin.
- Good points
 - Cheap!
 - Very fast (ms)
- Bad points
 - Low spatial resolution.
 - Skin-electrode conductance is unstable.
 - Can measure "surface", but cannot measure "deep region".
- Still used in many interactive systems



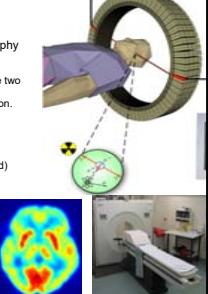
fMRI =functional MRI(機能的MRI)

- We must measure brain "activity", not shape.
 - By using MRI, measure "blood flow", by measuring two hemoglobins' ratio.
 - Hemoglobin: container of oxygen.
 - Red = many oxygen.
 - Blue = few oxygen.
- Good point
 - Location is very accurately determined.
- Bad point
 - Requires a few minutes for single shot.
- Current standard for brain functional imaging.



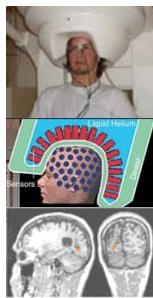
PET(ポジトロン断層法)

- PET = Positron Emission Tomography
 - Inject Radioactive ingredient as a "tracer" (C15).
 - The tracer collapses, and generate two γ waves in the opposite direction.
 - The detector detects the phenomenon.
 - Position is determined by timing measurement.
 - Blood flow can be measured.
- Good point
 - A little faster than fMRI(a few second)
- Bad points
 - radioactive ingredient is necessary.
 - Lower resolution than MRI



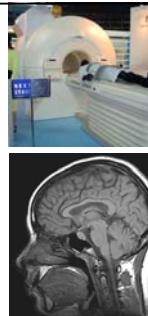
MEG

- MEG: Magnetoencephalography
- Similar to EEG, but measure magnetic field induced by electrical current.
- Very, very tiny magnetic field** (about $1/10^8$ of the earth's magnetic field)
- Superconducting technology is used (SQUID: Superconducting Quantum Interference Device)
- Good points
 - Very Fast (similar to EEG)
 - Can measure deep region. (magnetic field penetrates everything).
- Bad points
 - Surface sensors = 2D
 - Current sources = 3D mathematically very difficult to solve (almost impossible)



MRI(核磁気共鳴画像法)

- MRI: Magnetic Resonance Imaging
 - Very strong magnetic field make protons to "emit" electromagnetic waves.
 - By measuring these waves, we can obtain 3D structures.
- Good points (compared to X-ray CT)
 - No X-ray (=good for body)
 - Bone is not an obstacle
 - 3D data are obtained (X-ray CT: 2D)
- Bad points
 - Very strong magnet (3T): metal cannot be carried on.
 - Takes a few seconds for a single shot (now improving).
- Current standard for "brain imaging"



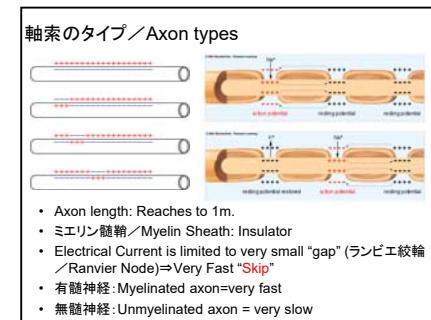
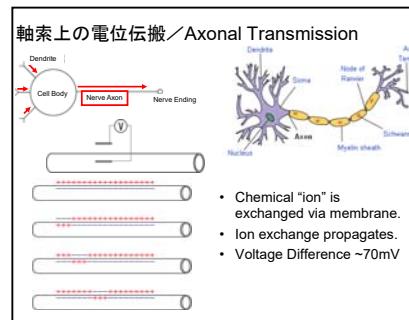
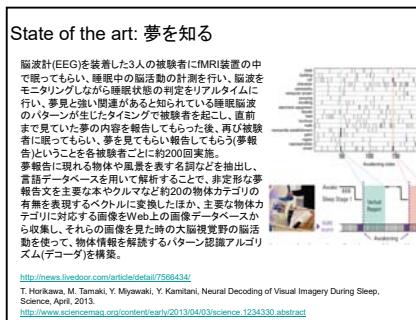
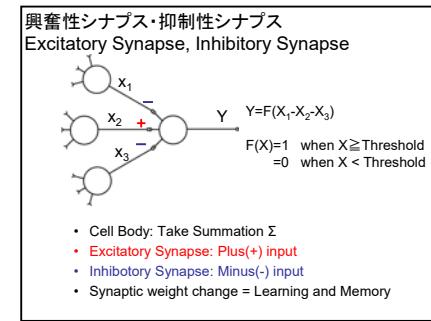
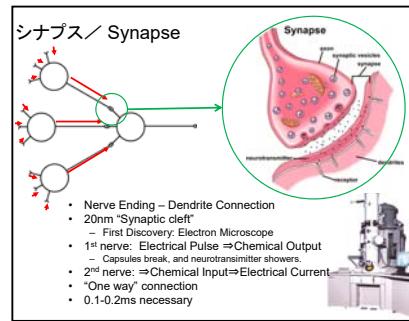
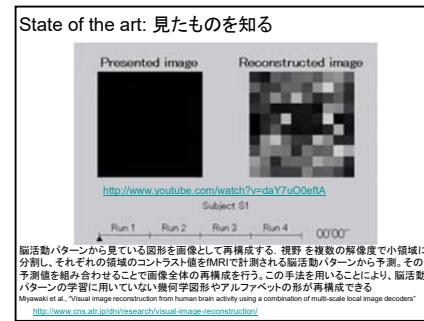
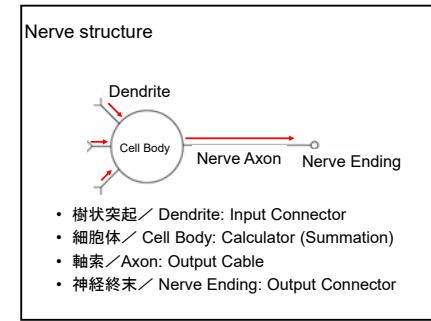
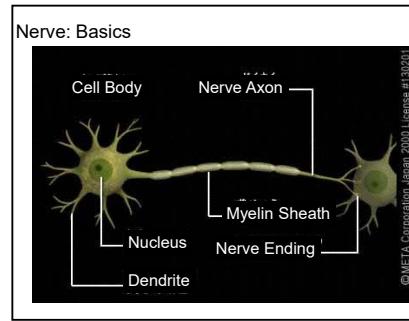
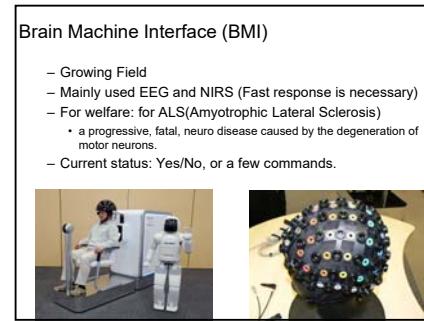
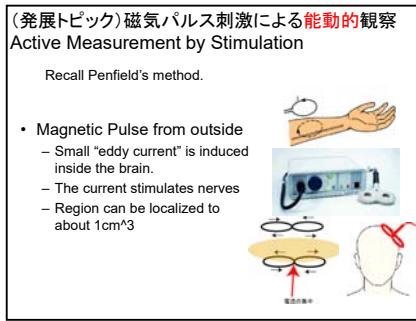
NIRS(近赤外分光法)

- NIRS=Near InfraRed Spectroscopy
 - Skull bone is transparent to Infrared light.
 - Put Infrared light, and obtain brain surface image.
 - Hemoglobin: container of oxygen.
 - Red = many oxygen.
 - Blue = low oxygen.
- Good points
 - No invasive. Easy to use.
- Bad points
 - Low spatial resolution
 - A few seconds are necessary



Summary of Brain Functional Imaging

手法 Method	観察対象 Observe	空間解像度 Spatial Resolution	時間解像度 Temporal Resolution
EEG	Electric	Low	High
MEG	Electric	Low	High
fMRI	Blood	High	Low
PET	Blood	Mid	Mid
NIRS	Blood	Mid	Mid



信号伝搬速度／Conduction Velocity

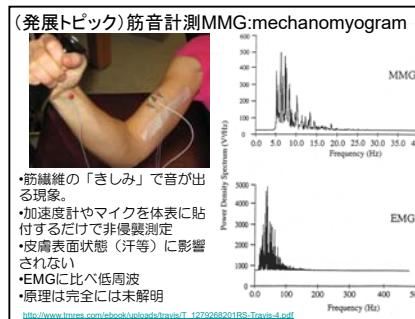
	name	diameter(μm)	velocity(m/s)	role
有髓神経 Myelinated	A _a	15	100	Many muscle nerves
	A _B	8	50	Many sensory nerves
	A _y	5	20	Some muscle and sensory nerves
	A _s	3	15	Fast pain
無髓神経 Unmyelinated	C	0.5	1	Slow pain, heat, cold sensation, etc

- Rule: Thicker = Faster
- Myelinated Axon: Invention of vertebrate animals (animals with back-bone).
- Other animal's strategy: Thicker the better.
 - ex) Squid's gigantic nerve (diameter: 0.5mm)

Conduction velocity and diabetic (糖尿病)

Nerve fiber (axon)
Myelin sheath
Normal Myelin Sheath
Damaged Myelin Sheath

- Diabetic: Quite common disease by taking too much sugar.
- It damages Myelin Sheath so that nerve conduction is inhibited.
- Finally, one cannot sense anything (blind, etc)
- Inspection: measure conduction velocity



EMPress: Practical Hand Gesture Classification with Wrist-Mounted EMG and Pressure Sensing, CHI2016 Jess McIntosh, Charlie McNeill, Mike Fraser, Frederic Kerber, Markus Löchtefeld, Antonio Krüger

EMPress:

Practical Hand Gesture Classification with Wrist-Mounted EMG and Pressure Sensing

Jess McIntosh¹, Charlie McNeill¹, Mike Fraser¹, Frederic Kerber², Markus Löchtefeld², Antonio Krüger²
¹Bristol Interaction Group, University of Bristol
²German Research Center for Artificial Intelligence (DFKI) and Stanford University
This research was supported by grants from the European Union through grant EUREGIO2014.
Contact Us: big.cs.bris.ac.uk/projects/empress

手のジェスチャ認識において、圧力分布と筋電分布を合わせて使うと正答率が上がる

Information Coding by the Nerve

- Repetition Ratio
 - Strong Stimulus → High Frequency
 - Single pulse means nothing.
- Timing
 - One nerve is activated when two inputs come simultaneously (at the same time).
(ex) Owl's Sound-Source Detection Mechanism

筋電計測 Measurement of muscle fiber activity

- Muscle Nerve → Muscle Fiber Activity
- Relatively easy with differential amplifier circuit (差動増幅回路).
- Problem: Conductive Gel is required.

人間計測手法／Measuring Human

意志から行動までの「どの経路を測るか」で5つの段階
Five layers, from our initial will to our perception.

- 脳活動計測／Measure brain activity.
- 神経・筋活動計測／Measure nerve activity.
- 自律神経系計測／Measure autonomic nerve related phenomenon.
- 運動計測／Measure motion.
- 心理物理実験／Ask the user (psychophysics)

自律神経／Autonomic Nervous System

Nervous system that acts as a body control system.
Composed of Sympathetic nervous system(SNS:交感神経) and Parasympathetic nervous system(PSNS:副交感神経).

(ex) 笑いの増幅 Augmentation of Laugh

- Take initial laugh timing by measuring muscle activity.
- Enhance the laugh by using "empathy effect"

最先端の筋電計測 State-of-the-art Muscle Measurement

Figure 1: Illustration of the muscle forearm muscles. The right side shows a cross section of the forearm to the muscle between the two tendons. The left side shows the forearm with the following labels: 1. Flexor pollicis longus, 2. Flexor digitorum profundus, 3. Flexor digitorum superficialis, 4. Flexor pollicis brevis, 5. Flexor digitorum brevis, 6. Flexor digitorum communis, 7. Flexor pollicis longus, 8. Flexor digitorum profundus, 9. Flexor digitorum superficialis, 10. Flexor pollicis brevis, 11. Flexor digitorum brevis, 12. Flexor digitorum communis, 13. Flexor pollicis longus, 14. Flexor digitorum profundus, 15. Flexor digitorum superficialis, 16. Flexor pollicis brevis, 17. Flexor digitorum brevis, 18. Flexor digitorum communis, 19. Flexor pollicis longus, 20. Flexor digitorum profundus, 21. Flexor digitorum superficialis, 22. Flexor pollicis brevis, 23. Flexor digitorum brevis, 24. Flexor digitorum communis, 25. Flexor pollicis longus, 26. Flexor digitorum profundus, 27. Flexor digitorum superficialis, 28. Flexor pollicis brevis, 29. Flexor digitorum brevis, 30. Flexor digitorum communis, 31. Flexor pollicis longus, 32. Flexor digitorum profundus, 33. Flexor digitorum superficialis, 34. Flexor pollicis brevis, 35. Flexor digitorum brevis, 36. Flexor digitorum communis, 37. Flexor pollicis longus, 38. Flexor digitorum profundus, 39. Flexor digitorum superficialis, 40. Flexor pollicis brevis, 41. Flexor digitorum brevis, 42. Flexor digitorum communis, 43. Flexor pollicis longus, 44. Flexor digitorum profundus, 45. Flexor digitorum superficialis, 46. Flexor pollicis brevis, 47. Flexor digitorum brevis, 48. Flexor digitorum communis, 49. Flexor pollicis longus, 50. Flexor digitorum profundus, 51. Flexor digitorum superficialis, 52. Flexor pollicis brevis, 53. Flexor digitorum brevis, 54. Flexor digitorum communis, 55. Flexor pollicis longus, 56. Flexor digitorum profundus, 57. Flexor digitorum superficialis, 58. Flexor pollicis brevis, 59. Flexor digitorum brevis, 60. Flexor digitorum communis, 61. Flexor pollicis longus, 62. Flexor digitorum profundus, 63. Flexor digitorum superficialis, 64. Flexor pollicis brevis, 65. Flexor digitorum brevis, 66. Flexor digitorum communis, 67. Flexor pollicis longus, 68. Flexor digitorum profundus, 69. Flexor digitorum superficialis, 70. Flexor pollicis brevis, 71. Flexor digitorum brevis, 72. Flexor digitorum communis, 73. Flexor pollicis longus, 74. Flexor digitorum profundus, 75. Flexor digitorum superficialis, 76. Flexor pollicis brevis, 77. Flexor digitorum brevis, 78. Flexor digitorum communis, 79. Flexor pollicis longus, 80. Flexor digitorum profundus, 81. Flexor digitorum superficialis, 82. Flexor pollicis brevis, 83. Flexor digitorum brevis, 84. Flexor digitorum communis, 85. Flexor pollicis longus, 86. Flexor digitorum profundus, 87. Flexor digitorum superficialis, 88. Flexor pollicis brevis, 89. Flexor digitorum brevis, 90. Flexor digitorum communis, 91. Flexor pollicis longus, 92. Flexor digitorum profundus, 93. Flexor digitorum superficialis, 94. Flexor pollicis brevis, 95. Flexor digitorum brevis, 96. Flexor digitorum communis, 97. Flexor pollicis longus, 98. Flexor digitorum profundus, 99. Flexor digitorum superficialis, 100. Flexor pollicis brevis, 101. Flexor digitorum brevis, 102. Flexor digitorum communis, 103. Flexor pollicis longus, 104. Flexor digitorum profundus, 105. Flexor digitorum superficialis, 106. Flexor pollicis brevis, 107. Flexor digitorum brevis, 108. Flexor digitorum communis, 109. Flexor pollicis longus, 110. Flexor digitorum profundus, 111. Flexor digitorum superficialis, 112. Flexor pollicis brevis, 113. Flexor digitorum brevis, 114. Flexor digitorum communis, 115. Flexor pollicis longus, 116. Flexor digitorum profundus, 117. Flexor digitorum superficialis, 118. Flexor pollicis brevis, 119. Flexor digitorum brevis, 120. Flexor digitorum communis, 121. Flexor pollicis longus, 122. Flexor digitorum profundus, 123. Flexor digitorum superficialis, 124. Flexor pollicis brevis, 125. Flexor digitorum brevis, 126. Flexor digitorum communis, 127. Flexor pollicis longus, 128. Flexor digitorum profundus, 129. Flexor digitorum superficialis, 130. Flexor pollicis brevis, 131. Flexor digitorum brevis, 132. Flexor digitorum communis, 133. Flexor pollicis longus, 134. Flexor digitorum profundus, 135. Flexor digitorum superficialis, 136. Flexor pollicis brevis, 137. Flexor digitorum brevis, 138. Flexor digitorum communis, 139. Flexor pollicis longus, 140. Flexor digitorum profundus, 141. Flexor digitorum superficialis, 142. Flexor pollicis brevis, 143. Flexor digitorum brevis, 144. Flexor digitorum communis, 145. Flexor pollicis longus, 146. Flexor digitorum profundus, 147. Flexor digitorum superficialis, 148. Flexor pollicis brevis, 149. Flexor digitorum brevis, 150. Flexor digitorum communis, 151. Flexor pollicis longus, 152. Flexor digitorum profundus, 153. Flexor digitorum superficialis, 154. Flexor pollicis brevis, 155. Flexor digitorum brevis, 156. Flexor digitorum communis, 157. Flexor pollicis longus, 158. Flexor digitorum profundus, 159. Flexor digitorum superficialis, 160. Flexor pollicis brevis, 161. Flexor digitorum brevis, 162. Flexor digitorum communis, 163. Flexor pollicis longus, 164. Flexor digitorum profundus, 165. Flexor digitorum superficialis, 166. Flexor pollicis brevis, 167. Flexor digitorum brevis, 168. Flexor digitorum communis, 169. Flexor pollicis longus, 170. Flexor digitorum profundus, 171. Flexor digitorum superficialis, 172. Flexor pollicis brevis, 173. Flexor digitorum brevis, 174. Flexor digitorum communis, 175. Flexor pollicis longus, 176. Flexor digitorum profundus, 177. Flexor digitorum superficialis, 178. Flexor pollicis brevis, 179. Flexor digitorum brevis, 180. Flexor digitorum communis, 181. Flexor pollicis longus, 182. Flexor digitorum profundus, 183. Flexor digitorum superficialis, 184. Flexor pollicis brevis, 185. Flexor digitorum brevis, 186. Flexor digitorum communis, 187. Flexor pollicis longus, 188. Flexor digitorum profundus, 189. Flexor digitorum superficialis, 190. Flexor pollicis brevis, 191. Flexor digitorum brevis, 192. Flexor digitorum communis, 193. Flexor pollicis longus, 194. Flexor digitorum profundus, 195. Flexor digitorum superficialis, 196. Flexor pollicis brevis, 197. Flexor digitorum brevis, 198. Flexor digitorum communis, 199. Flexor pollicis longus, 200. Flexor digitorum profundus, 201. Flexor digitorum superficialis, 202. Flexor pollicis brevis, 203. Flexor digitorum brevis, 204. Flexor digitorum communis, 205. Flexor pollicis longus, 206. Flexor digitorum profundus, 207. Flexor digitorum superficialis, 208. Flexor pollicis brevis, 209. Flexor digitorum brevis, 210. Flexor digitorum communis, 211. Flexor pollicis longus, 212. Flexor digitorum profundus, 213. Flexor digitorum superficialis, 214. Flexor pollicis brevis, 215. Flexor digitorum brevis, 216. Flexor digitorum communis, 217. Flexor pollicis longus, 218. Flexor digitorum profundus, 219. Flexor digitorum superficialis, 220. Flexor pollicis brevis, 221. Flexor digitorum brevis, 222. Flexor digitorum communis, 223. Flexor pollicis longus, 224. Flexor digitorum profundus, 225. Flexor digitorum superficialis, 226. Flexor pollicis brevis, 227. Flexor digitorum brevis, 228. Flexor digitorum communis, 229. Flexor pollicis longus, 230. Flexor digitorum profundus, 231. Flexor digitorum superficialis, 232. Flexor pollicis brevis, 233. Flexor digitorum brevis, 234. Flexor digitorum communis, 235. Flexor pollicis longus, 236. Flexor digitorum profundus, 237. Flexor digitorum superficialis, 238. Flexor pollicis brevis, 239. Flexor digitorum brevis, 240. Flexor digitorum communis, 241. Flexor pollicis longus, 242. Flexor digitorum profundus, 243. Flexor digitorum superficialis, 244. Flexor pollicis brevis, 245. Flexor digitorum brevis, 246. Flexor digitorum communis, 247. Flexor pollicis longus, 248. Flexor digitorum profundus, 249. Flexor digitorum superficialis, 250. Flexor pollicis brevis, 251. Flexor digitorum brevis, 252. Flexor digitorum communis, 253. Flexor pollicis longus, 254. Flexor digitorum profundus, 255. Flexor digitorum superficialis, 256. Flexor pollicis brevis, 257. Flexor digitorum brevis, 258. Flexor digitorum communis, 259. Flexor pollicis longus, 260. Flexor digitorum profundus, 261. Flexor digitorum superficialis, 262. Flexor pollicis brevis, 263. Flexor digitorum brevis, 264. Flexor digitorum communis, 265. Flexor pollicis longus, 266. Flexor digitorum profundus, 267. Flexor digitorum superficialis, 268. Flexor pollicis brevis, 269. Flexor digitorum brevis, 270. Flexor digitorum communis, 271. Flexor pollicis longus, 272. Flexor digitorum profundus, 273. Flexor digitorum superficialis, 274. Flexor pollicis brevis, 275. Flexor digitorum brevis, 276. Flexor digitorum communis, 277. Flexor pollicis longus, 278. Flexor digitorum profundus, 279. Flexor digitorum superficialis, 280. Flexor pollicis brevis, 281. Flexor digitorum brevis, 282. Flexor digitorum communis, 283. Flexor pollicis longus, 284. Flexor digitorum profundus, 285. Flexor digitorum superficialis, 286. Flexor pollicis brevis, 287. Flexor digitorum brevis, 288. Flexor digitorum communis, 289. Flexor pollicis longus, 290. Flexor digitorum profundus, 291. Flexor digitorum superficialis, 292. Flexor pollicis brevis, 293. Flexor digitorum brevis, 294. Flexor digitorum communis, 295. Flexor pollicis longus, 296. Flexor digitorum profundus, 297. Flexor digitorum superficialis, 298. Flexor pollicis brevis, 299. Flexor digitorum brevis, 300. Flexor digitorum communis, 301. Flexor pollicis longus, 302. Flexor digitorum profundus, 303. Flexor digitorum superficialis, 304. Flexor pollicis brevis, 305. Flexor digitorum brevis, 306. Flexor digitorum communis, 307. Flexor pollicis longus, 308. Flexor digitorum profundus, 309. Flexor digitorum superficialis, 310. Flexor pollicis brevis, 311. Flexor digitorum brevis, 312. Flexor digitorum communis, 313. Flexor pollicis longus, 314. Flexor digitorum profundus, 315. Flexor digitorum superficialis, 316. Flexor pollicis brevis, 317. Flexor digitorum brevis, 318. Flexor digitorum communis, 319. Flexor pollicis longus, 320. Flexor digitorum profundus, 321. Flexor digitorum superficialis, 322. Flexor pollicis brevis, 323. Flexor digitorum brevis, 324. Flexor digitorum communis, 325. Flexor pollicis longus, 326. Flexor digitorum profundus, 327. Flexor digitorum superficialis, 328. Flexor pollicis brevis, 329. Flexor digitorum brevis, 330. Flexor digitorum communis, 331. Flexor pollicis longus, 332. Flexor digitorum profundus, 333. Flexor digitorum superficialis, 334. Flexor pollicis brevis, 335. Flexor digitorum brevis, 336. Flexor digitorum communis, 337. Flexor pollicis longus, 338. Flexor digitorum profundus, 339. Flexor digitorum superficialis, 340. Flexor pollicis brevis, 341. Flexor digitorum brevis, 342. Flexor digitorum communis, 343. Flexor pollicis longus, 344. Flexor digitorum profundus, 345. Flexor digitorum superficialis, 346. Flexor pollicis brevis, 347. Flexor digitorum brevis, 348. Flexor digitorum communis, 349. Flexor pollicis longus, 350. Flexor digitorum profundus, 351. Flexor digitorum superficialis, 352. Flexor pollicis brevis, 353. Flexor digitorum brevis, 354. Flexor digitorum communis, 355. Flexor pollicis longus, 356. Flexor digitorum profundus, 357. Flexor digitorum superficialis, 358. Flexor pollicis brevis, 359. Flexor digitorum brevis, 360. Flexor digitorum communis, 361. Flexor pollicis longus, 362. Flexor digitorum profundus, 363. Flexor digitorum superficialis, 364. Flexor pollicis brevis, 365. Flexor digitorum brevis, 366. Flexor digitorum communis, 367. Flexor pollicis longus, 368. Flexor digitorum profundus, 369. Flexor digitorum superficialis, 370. Flexor pollicis brevis, 371. Flexor digitorum brevis, 372. Flexor digitorum communis, 373. Flexor pollicis longus, 374. Flexor digitorum profundus, 375. Flexor digitorum superficialis, 376. Flexor pollicis brevis, 377. Flexor digitorum brevis, 378. Flexor digitorum communis, 379. Flexor pollicis longus, 380. Flexor digitorum profundus, 381. Flexor digitorum superficialis, 382. Flexor pollicis brevis, 383. Flexor digitorum brevis, 384. Flexor digitorum communis, 385. Flexor pollicis longus, 386. Flexor digitorum profundus, 387. Flexor digitorum superficialis, 388. Flexor pollicis brevis, 389. Flexor digitorum brevis, 390. Flexor digitorum communis, 391. Flexor pollicis longus, 392. Flexor digitorum profundus, 393. Flexor digitorum superficialis, 394. Flexor pollicis brevis, 395. Flexor digitorum brevis, 396. Flexor digitorum communis, 397. Flexor pollicis longus, 398. Flexor digitorum profundus, 399. Flexor digitorum superficialis, 400. Flexor pollicis brevis, 401. Flexor digitorum brevis, 402. Flexor digitorum communis, 403. Flexor pollicis longus, 404. Flexor digitorum profundus, 405. Flexor digitorum superficialis, 406. Flexor pollicis brevis, 407. Flexor digitorum brevis, 408. Flexor digitorum communis, 409. Flexor pollicis longus, 410. Flexor digitorum profundus, 411. Flexor digitorum superficialis, 412. Flexor pollicis brevis, 413. Flexor digitorum brevis, 414. Flexor digitorum communis, 415. Flexor pollicis longus, 416. Flexor digitorum profundus, 417. Flexor digitorum superficialis, 418. Flexor pollicis brevis, 419. Flexor digitorum brevis, 420. Flexor digitorum communis, 421. Flexor pollicis longus, 422. Flexor digitorum profundus, 423. Flexor digitorum superficialis, 424. Flexor pollicis brevis, 425. Flexor digitorum brevis, 426. Flexor digitorum communis, 427. Flexor pollicis longus, 428. Flexor digitorum profundus, 429. Flexor digitorum superficialis, 430. Flexor pollicis brevis, 431. Flexor digitorum brevis, 432. Flexor digitorum communis, 433. Flexor pollicis longus, 434. Flexor digitorum profundus, 435. Flexor digitorum superficialis, 436. Flexor pollicis brevis, 437. Flexor digitorum brevis, 438. Flexor digitorum communis, 439. Flexor pollicis longus, 440. Flexor digitorum profundus, 441. Flexor digitorum superficialis, 442. Flexor pollicis brevis, 443. Flexor digitorum brevis, 444. Flexor digitorum communis, 445. Flexor pollicis longus, 446. Flexor digitorum profundus, 447. Flexor digitorum superficialis, 448. Flexor pollicis brevis, 449. Flexor digitorum brevis, 450. Flexor digitorum communis, 451. Flexor pollicis longus, 452. Flexor digitorum profundus, 453. Flexor digitorum superficialis, 454. Flexor pollicis brevis, 455. Flexor digitorum brevis, 456. Flexor digitorum communis, 457. Flexor pollicis longus, 458. Flexor digitorum profundus, 459. Flexor digitorum superficialis, 460. Flexor pollicis brevis, 461. Flexor digitorum brevis, 462. Flexor digitorum communis, 463. Flexor pollicis longus, 464. Flexor digitorum profundus, 465. Flexor digitorum superficialis, 466. Flexor pollicis brevis, 467. Flexor digitorum brevis, 468. Flexor digitorum communis, 469. Flexor pollicis longus, 470. Flexor digitorum profundus, 471. Flexor digitorum superficialis, 472. Flexor pollicis brevis, 473. Flexor digitorum brevis, 474. Flexor digitorum communis, 475. Flexor pollicis longus, 476. Flexor digitorum profundus, 477. Flexor digitorum superficialis, 478. Flexor pollicis brevis, 479. Flexor digitorum brevis, 480. Flexor digitorum communis, 481. Flexor pollicis longus, 482. Flexor digitorum profundus, 483. Flexor digitorum superficialis, 484. Flexor pollicis brevis, 485. Flexor digitorum brevis, 486. Flexor digitorum communis, 487. Flexor pollicis longus, 488. Flexor digitorum profundus, 489. Flexor digitorum superficialis, 490. Flexor pollicis brevis, 491. Flexor digitorum brevis, 492. Flexor digitorum communis, 493. Flexor pollicis longus, 494. Flexor digitorum profundus, 495. Flexor digitorum superficialis, 496. Flexor pollicis brevis, 497. Flexor digitorum brevis, 498. Flexor digitorum communis, 499. Flexor pollicis longus, 500. Flexor digitorum profundus, 501. Flexor digitorum superficialis, 502. Flexor pollicis brevis, 503. Flexor digitorum brevis, 504. Flexor digitorum communis, 505. Flexor pollicis longus, 506. Flexor digitorum profundus, 507. Flexor digitorum superficialis, 508. Flexor pollicis brevis, 509. Flexor digitorum brevis, 510. Flexor digitorum communis, 511. Flexor pollicis longus, 512. Flexor digitorum profundus, 513. Flexor digitorum superficialis, 514. Flexor pollicis brevis, 515. Flexor digitorum brevis, 516. Flexor digitorum communis, 517. Flexor pollicis longus, 518. Flexor digitorum profundus, 519. Flexor digitorum superficialis, 520. Flexor pollicis brevis, 521. Flexor digitorum brevis, 522. Flexor digitorum communis, 523. Flexor pollicis longus, 524. Flexor digitorum profundus, 525. Flexor digitorum superficialis, 526. Flexor pollicis brevis, 527. Flexor digitorum brevis, 528. Flexor digitorum communis, 529. Flexor pollicis longus, 530. Flexor digitorum profundus, 531. Flexor digitorum superficialis, 532. Flexor pollicis brevis, 533. Flexor digitorum brevis, 534. Flexor digitorum communis, 535. Flexor pollicis longus, 536. Flexor digitorum profundus, 537. Flexor digitorum superficialis, 538. Flexor pollicis brevis, 539. Flexor digitorum brevis, 540. Flexor digitorum communis, 541. Flexor pollicis longus, 542. Flexor digitorum profundus, 543. Flexor digitorum superficialis, 544. Flexor pollicis brevis, 545. Flexor digitorum brevis, 546. Flexor digitorum communis, 547. Flexor pollicis longus, 548. Flexor digitorum profundus, 549. Flexor digitorum superficialis, 550. Flexor pollicis brevis, 551. Flexor digitorum brevis, 552. Flexor digitorum communis, 553. Flexor pollicis longus, 554. Flexor digitorum profundus, 555. Flexor digitorum superficialis, 556. Flexor pollicis brevis, 557. Flexor digitorum brevis, 558. Flexor digitorum communis, 559. Flexor pollicis longus, 560. Flexor digitorum profundus, 561. Flexor digitorum superficialis, 562. Flexor pollicis brevis, 563. Flexor digitorum brevis, 564. Flexor digitorum communis, 565. Flexor pollicis longus, 566. Flexor digitorum profundus, 567. Flexor digitorum superficialis, 568. Flexor pollicis brevis, 569. Flexor digitorum brevis, 570. Flexor digitorum communis, 571. Flexor pollicis longus, 572. Flexor digitorum profundus, 573. Flexor digitorum superficialis, 574. Flexor pollicis brevis, 575. Flexor digitorum brevis, 576. Flexor digitorum communis, 577. Flexor pollicis longus, 578. Flexor digitorum profundus, 579. Flexor digitorum superficialis, 580. Flexor pollicis brevis, 581. Flexor digitorum brevis, 582. Flexor digitorum communis, 583. Flexor pollicis longus, 584. Flexor digitorum profundus, 585. Flexor digitorum superficialis, 586. Flexor pollicis brevis, 587. Flexor digitorum brevis, 588. Flexor digitorum communis, 589. Flexor pollicis longus, 590. Flexor digitorum profundus, 591. Flexor digitorum superficialis, 592. Flexor pollicis brevis, 593. Flexor digitorum brevis, 594. Flexor digitorum communis, 595. Flexor pollicis longus, 596. Flexor digitorum profundus, 597. Flexor digitorum superficialis, 598. Flexor pollicis brevis, 599. Flexor digitorum brevis, 600. Flexor digitorum communis, 601. Flexor pollicis longus, 602. Flexor digitorum profundus, 603. Flexor digitorum superficialis, 604. Flexor pollicis brevis, 605. Flexor digitorum brevis, 606. Flexor digitorum communis, 607. Flexor pollicis longus, 608. Flexor digitorum profundus, 609. Flexor digitorum superficialis, 610. Flexor pollicis brevis, 611. Flexor digitorum brevis, 612. Flexor digitorum communis, 613. Flexor pollicis longus, 614. Flexor digitorum profundus, 615. Flexor digitorum superficialis, 616. Flexor pollicis brevis, 617. Flexor digitorum brevis, 618. Flexor digitorum communis, 619. Flexor pollicis longus, 620. Flexor digitorum profundus, 621. Flexor digitorum superficialis, 622. Flexor pollicis brevis, 623. Flexor digitorum brevis, 624. Flexor digitorum communis, 625. Flexor pollicis longus, 626. Flexor digitorum profundus, 627. Flexor digitorum superficialis, 628. Flexor pollicis brevis, 629. Flexor digitorum brevis, 630. Flexor digitorum communis, 631. Flexor pollicis longus, 632. Flexor digitorum profundus, 633. Flexor digitorum superficialis, 634. Flexor pollicis brevis, 635. Flexor digitorum brevis, 636. Flexor digitorum communis, 637. Flexor pollicis longus, 638. Flexor digitorum profundus, 639. Flexor digitorum superficialis, 640. Flexor pollicis brevis, 641. Flexor digitorum brevis, 642. Flexor digitorum communis, 643. Flexor pollicis longus, 644. Flexor digitorum profundus, 645. Flexor digitorum superficialis, 646. Flexor pollicis brevis, 647. Flexor digitorum brevis, 648. Flexor digitorum communis, 649. Flexor pollicis longus, 650. Flexor digitorum profundus, 651. Flexor digitorum superficialis, 652. Flexor pollicis brevis, 653. Flexor digitorum brevis, 654. Flexor digitorum communis, 655. Flexor pollicis longus, 656. Flexor digitorum profundus, 657. Flexor digitorum superficialis, 658. Flexor pollicis brevis, 659. Flexor digitorum brevis, 660. Flexor digitorum communis, 661. Flexor pollicis longus, 662. Flexor digitorum profundus, 663. Flexor digitorum superficialis, 664. Flexor pollicis brevis, 665. Flexor digitorum brevis, 666. Flexor digitorum communis, 667. Flexor pollicis longus, 668. Flexor digitorum profundus, 669. Flexor digitorum superficialis, 670. Flexor pollicis brevis, 671. Flexor digitorum brevis, 672. Flexor digitorum communis, 673. Flexor pollicis longus, 674. Flexor digitorum profundus, 675. Flexor digitorum superficialis, 676. Flexor pollicis brevis, 677. Flexor digitorum brevis, 678. Flexor digitorum communis, 679. Flexor pollicis longus, 680. Flexor digitorum profundus, 681. Flexor digitorum superficialis, 682. Flexor pollicis brevis, 683. Flexor digitorum brevis, 684. Flexor digitorum communis, 685. Flexor pollicis longus, 686. Flexor digitorum profundus, 687. Flexor digitorum superficialis, 688. Flexor pollicis brevis, 689. Flexor digitorum brevis, 690. Flexor digitorum communis, 691. Flexor pollicis longus, 692. Flexor digitorum profundus, 693. Flexor digitorum superficialis, 694. Flexor pollicis brevis, 695. Flexor digitorum brevis, 696. Flexor digitorum communis, 697. Flexor pollicis longus, 698. Flexor digitorum profundus, 699. Flexor digitorum superficialis, 700. Flexor pollicis brevis, 701. Flexor digitorum brevis, 702. Flexor digitorum communis, 703. Flexor pollicis longus, 704. Flexor digitorum profundus, 705. Flexor digitorum superficialis, 706. Flexor pollicis brevis, 707. Flexor digitorum brevis, 708. Flexor digitorum communis, 709. Flexor pollicis longus, 710. Flexor digitorum profundus, 711. Flexor digitorum superficialis, 712. Flexor pollicis brevis, 713. Flexor digitorum brevis, 714. Flexor digitorum communis, 715. Flexor pollicis longus, 716. Flexor digitorum profundus, 717. Flexor digitorum superficialis, 7

情動を測定／Measure Emotional State

- Heartbeat & Blood Pressure (心拍数、血圧)
- Pulse Wave (脈波)
- GSR(galvanic skin response, 皮膚電気反応)
- Eye movement (眼球運動)

「IoTニュースセレクト」
「意人との相性チェックに」、ロームが指輪型脈波センサーを開発
2016年7月7日

ロームは、大きさや形状サイズの小さな「脈波センサ」を「CEATEC JAPAN 2016」(2016年10月1日~3日、幕張メッセ)に出展した。ループ状の形状のほか、ワーム輪や指輪型などアバースペース分野で注目されるものもある。製品ブースでは、スマート腕時計や意匠などの相性チェックに用いたデモンストレーションを実験している。

この製品ビームは、LED光を輪に沿って、照射する。反射光は高感度センサで受け取れて、モニタに流量の変化を表示する。LED光には複数色光があり、反射する光の強度を測定するため、センサユニットを回転する。回転角や時間から、手首に慣性センサユニットを取り付けることでタッチパネルへの描画に表現力を持たせる(筆のように振る舞わせる)

COGCAM: Contact-free Measurement of Cognitive Stress During Computer Tasks with a Digital Camera
Daniel McDuff, Javier Hernandez Rivera, Sarah Gontarek, Rosalind Picard, CHI2016

カメラベースで心拍、呼吸関連のデータを収集し、ストレスと最も合致する指標を得る。その結果、心拍そのもの、呼吸そのもの、と比べて心拍の変動自体がストレスと最も合致することがわかった

人間計測手法／Measuring Human

意志から行動までの「どの経路を測るか」で5つの段階
Five layers, from our initial will to our perception.

- 脳活動計測／Measure brain activity.
- 神経・筋活動計測／Measure nerve activity.
- 自律神経系計測／Measure autonomic nerve related phenomenon.
- 運動計測／Measure motion.
- 心理物理実験／Ask the user (psychophysics)

行動計測／Measuring Motion

- Motion Capture System
 - 光学式／Optical
 - 機械式／Mechanical
 - 磁気式／Magnetic
 - ビデオ式／Image Processing*
- 一長一短／Pros and Cons
 - 遮蔽問題／Occlusion
 - ワークスペース／Workspace
 - 金属の影響／Effect of Metal

*KINECT等の詳細は後の回で

Simpler

- Gaming controllers can be used as a measuring device.
 - 重心動描計測→Wii Balance Board
 - 運動計測→Wii Remote
 - 全身運動など: KINECT, Leap Motionなどの台頭
- 簡単なものは自作可能
 - 加速度センサ、ジャイロセンサ

Sensors became ubiquitous

- For example, simple "touch-panel" is a type of gesture interface, which is very easily available today.
- Many researches on Human-Computer Interaction focuses on how to use simple sensor and guess the intention of the user, by machine learning.

Expressy: Using a Wrist-worn Inertial Measurement Unit to Add Expressiveness to Touch-based Interactions
Gerard Wilkinson, Ahmed Kharrufa, Jonathan Hook, Bradley Purglove, Gavin Wood, Hendrik Haeuser, Nils, CHI2016

手首に慣性センサユニットを取り付けることでタッチパネルへの描画に表現力を持たせる(筆のように振る舞わせる)

SkinTrack: Using the Body as an Electrical Waveguide for Continuous Finger Tracking on the Skin, CHI2016
Yang Zhang, Junhan Zhou, Gierad Laput, Chris Harrison

指から80MHz電場放出、リストバンド複数個で受け止め、位相差検出で指の場所を検出

One-Dimensional Handwriting: Inputting Letters and Words on Smart Glasses
Chun Yu, Ke Sun, Mingyuan Zhong, Xinchang Li, Peijun Zhao, Yuanchun Shi, CHI2016
Tsinghua University

メガネのツリについた1Dタッチセンサを使っていかに文字入力を行うか、アルファベットそれぞれの書き方から、長短のパターンを生成する

SkullConduct: Biometric User Identification on Eyewear Computers Using Bone Conduction Through the Skull, CHI2016
Stefan Schneegass, Youssef Oualil, Andreas Bulling

後頭部から入力して前頭部で出力する骨伝導の特性によって個人認証ができる。10人の被験者の場合、正しいユーザのアセプト率97%、誤ったユーザの誤認率6.7%

Today's Summary

Measurement of Human perception is necessary for interactive system design.

- 脳活動計測／Measure brain activity.
- 神経・筋活動計測／Measure nerve activity.
- 自律神経系計測／Measure autonomic nerve related phenomenon.
- 運動計測／Measure motion.
- 心理物理実験／Ask the user (psychophysics)

They can be used both as a evaluation tool, and part of an interactive system

小テスト／Mini Test 次回開始までに提出
<https://goo.gl/forms/85xfExX2mLheNncR2>

以下の全てに100字以内程度で解答せよ／Answer all questions within 50 words

1. EEGについて説明せよ Explain EEG
2. MEGについて説明せよ Explain MEG
3. MRIについて説明せよ Explain MRI
4. PETについて説明せよ Explain PET
5. NIRSについて説明せよ Explain NIRS
6. 有髓神経と無髓神経の違いについて述べよ Describe difference between myelinated and unmyelinated nerves.
7. 交感神経の活動で生じる現象を3つ挙げよ Quote three phenomena related SNS(Sympathetic nervous system) activity.
- 8.

Handouts on the web(再掲)

<http://kaji-lab.jp/ja/index.php?people/kaji/interactive>

-現在は2017年版がおかれています。徐々に変えていきます。
-梶本研→メンバー→梶本→講義→インタラクティブシステム特論
-Temporary, 2017 version. Will be replaced progressively.

-こちらのpdfには動画のリンク先(Youtube等)が埋め込まれているので、紙資料よりも便利。紙資料は配布せず、講義の1時間前までにアップロードします。必要なら事前にダウンロードしてください

From next time, lecture handouts will be online 1 hour before the lecture. Print it if necessary.