

16-848 Reference List for April 6, 2022

We started by looking at the monkey experiments from Sam Clanton's thesis from 2011. You can find his dissertation here: <https://www.ri.cmu.edu/publications/brain-computer-interface-control-of-an-anthropomorphic-robotic-arm/>

You can find videos of the monkey experiments here:
<https://motorlab.pitt.edu/multimedia.php>

We then turned to the following paper from Andy Schwartz's group that shows results from a long series of experiments with a single human subject with a cortical implant.

Wodlinger, B., J. E. Downey, E. C. Tyler-Kabara, A. B. Schwartz, M. L. Boninger, and J. L. Collinger. "Ten-dimensional anthropomorphic arm control in a human brain-machine interface: difficulties, solutions, and limitations." *Journal of neural engineering* 12, no. 1 (2014): 016011.
<https://iopscience.iop.org/article/10.1088/1741-2560/12/1/016011>

The supplementary videos that I showed today are all available from the publication web page.

We talked about how a lot of follow on work focuses on shared autonomy. This nice paper by Katharina Muelling is one example:

Muelling, Katharina, Arun Venkatraman, Jean-Sebastien Valois, John E. Downey, Jeffrey Weiss, Shervin Javdani, Martial Hebert, Andrew B. Schwartz, Jennifer L. Collinger, and J. Andrew Bagnell. "Autonomy infused teleoperation with application to brain computer interface controlled manipulation." *Autonomous Robots* 41, no. 6 (2017): 1401-1422.
<https://link.springer.com/article/10.1007/s10514-017-9622-4>
https://www.youtube.com/watch?v=adUCJh_ySrU

The following paper is a survey article containing interesting research related to BCI developments, some of them very recent.

Chandrasekaran, Santosh, Matthew Fifer, Stephan Bickel, Luke Osborn, Jose Herrero, Breanne Christie, Junqian Xu et al. "Historical perspectives, challenges, and future directions of implantable brain-computer interfaces for sensorimotor applications." *Bioelectronic medicine* 7, no. 1 (2021): 1-11.
<https://link.springer.com/article/10.1186/s42234-021-00076-6>

We spoke about alternative techniques, including SEEG (minimally invasive) and EEG (noninvasive). Here is an example of robot control with an EEG interface.

Kuhner, Daniel, Lukas Dominique Josef Fiederer, Johannes Aldinger, Felix Burget, Martin Völker, Robin Tibor Schirrmester, Chau Do et al. "A service assistant combining autonomous robotics, flexible goal formulation, and deep-learning-based brain–computer interfacing." *Robotics and Autonomous Systems* 116 (2019): 98-113.

<https://www.sciencedirect.com/science/article/pii/S0921889018302227>

<http://www2.informatik.uni-freiburg.de/~kuhnerd/neurobots/>