# Can artificial neural networks be deployed on FPGAs for prosthesis control?

**With FPGAs, custom hardware can be designed for artificial neural networks. This may lead to performance improvements for artificial neural networks, thereby allowing for more advanced prosthesis control.**

For an amputee, a comfortable and easily controllable robotic prosthesis may significantly improve life quality. One of the proposed inputs for controlling robotic prostheses is by surface electromyography. In other words, the prosthesis can be controlled by measuring the electrical potential in muscles from the surface of the skin. A neural network can then be trained to infer movement patterns from these signals. An issue with neural networks is their large complexity, making them difficult to adopt on smaller microcontrollers, typically desired on prostheses that run on battery. This puts a limit on the scale and speed of the neural networks that can be deployed. A good prosthesis controller should not only correctly determine the intended movement, but also do it within a short time frame. For this reason, the alternative approach of using FPGAs was attempted. An FPGA is in essence re-configurable hardware, where instead of programming software into hardware, the hardware itself is programmed. This allows task specific hardware to be built which can do many calculations at once. In short, the main advantage would be allowing for multiple calculations to be performed in parallel as opposed to in a sequence, thus gaining a speedup. A workflow was proposed and followed in which a Convolutional Neural Network was constructed and trained on a computer. It was then, through several steps, translated into a corresponding hardware design, and deployed to an FPGA. The resulting implementation was fast enough to allow for multiple inferences within the desired timing constraint. This, in turn, meant that majority voting could be used to improve results. There still remain issues, notably in accuracy and power consumption. Overall, this project successfully demonstrated the possibility of using FPGAs as controllers. In the future, this may open up for possibilities of using more dedicated hardware for neural networks, with FPGAs acting as design prototypes.