Design of a Low-Cost, Low Inertia, Backdrivable Upper-Body Humanoid

Choi, Jilly (School: duPont Manual High School)

General purpose humanoid robots have long been envisioned for a plethora of applications such as disaster relief, industrial automation, agriculture, or elderly assistance. A humanoid form for a robot allows for optimal utility and mobility in a world where the environments and tools are designed around humans. However, in the current field of robotics, conventional robot actuator design struggles with three key limitations. A lack of backdrivability in dynamic tasks (undefined and quickly changing forces and trajectories) (Wensing, 2017), a lack of humanoids that are low cost & highly back-drivable, and a prohibitively high cost of research on humanoids(Kim et al., 2015). Thus, this research sought to tackle these problems in the design of a low-cost, low inertia, high impact mitigation, humanoid upper body. The design implemented 3D printed Quasi-Direct Actuators designed on Autodesk Fusion360, with high torque BLDC motors inspired by MIT's proprioceptive actuator on the MIT Cheetah. In addition, a PID controller with IMF dampening was employed with off the shelf electronics culminating in a cost of ~1000 dollars. This was <1% of the cost of current humanoids that can range from 50k - millions of dollars to buy or research. The designed humanoid was able to achieve its research goals and achieved its benchmarks for functionality, back-drivability and cost, and developments in this research has the novel potential to allow for the widespread accessibility of humanoid research due to its low cost, and advance the frontiers of humanoid research, especially in human-robot interaction.

Awards Won:

Second Award of $2,000

Serving Society Through Science: Second Award of $500