Quix: A Powered, Lower-Body Exoskeleton to Improve the Mobility of Individuals with Paralysis

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***Abstract*—Quix is IHMC's latest iteration of powered, lower-body exoskeletons. Similar to previous devices like the Mina v2 exoskeleton [1], Quix was designed to enable individuals with paralysis to transfer out of their wheelchair, stand up, and walk around. IHMC aims to continue driving the state-of-the-art of exoskeleton technology towards a personal mobility device that allows for safe and simple execution of activities of daily living. Quix is preparing for competition at both the Cybathlon in Zurich, Switzerland and the 2020 Paralympics in Tokyo, Japan as part of Toyota Mobility Foundation's Mobility Unlimited Challenge.**

***Index Terms*—exoskeleton, assistive devices, wearable robotics**

Quix is a powered exoskeleton that IHMC is developing to provide increased mobility and independence to people with paralysis. The device will allow users to stand up and walk through a variety of environments, including up and down stairs and ramps, and across both flat and bumpy terrain.

Powered actuation at the hip (both flexion/extension and adduction/abduction), knee (flexion/extension), and ankle (plantarflexion/dorsiflexion) provide smooth and natural walking motions. These eight actuators enable the device to exhibit a wide variety of movements, utilizing a combination of actuation in both the sagittal and frontal planes. Each actuator weighs about 2.5 kg and can achieve a peak torque of 200 Nm and peak speed of 7 rad/s. The exoskeleton is powered by two 6S lithium polymer batteries that supply a maximum operating time of approximately 1 hour of heavy usage. These batteries are housed in the backpack and can be hot-swapped to allow for extended run times.

Each actuator houses its own required electronics, including a motor driver and logic board. The actuators in each leg are daisy-chained to each other by the power and data lines that originate in the backpack. The software control algorithms are dependent on commands from the pilot and feedback from the exoskeleton's sensor suite. An inertial measurement unit (IMU) provides orientation of the exoskeleton, which can be used to help balance the device. Pressure-sensing footpads provide center-of-pressure feedback which is a key parameter for various walking controllers. A set of push buttons and LCD screen on the crutch wirelessly transmit commands, allowing the user to select among different behaviors such as sit, stand, and different walking speeds.

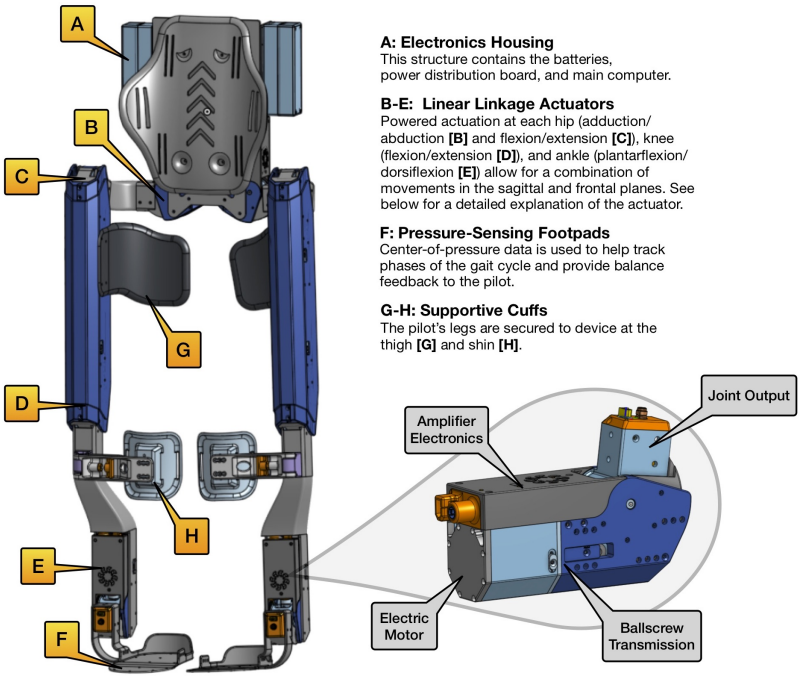

Fig. 1. This figure highlights some key components of the Quix exoskeleton. The CAD model of the exo is shown on the left, with a zoomed-in view of one of the eight powered actuators shown in the bottom-right.

References

[1] Robert Griffin, Tyson Cobb, Travis Craig, Mark Daniel, Nick van Dijk, Jeremy Gines, Koen Kramer, Shriya Shah, Olger Siebinga, Jesper Smith, et al. Stepping forward with exoskeletons: Team ihmc's design and approach in the 2016 cybathlon. *IEEE Robotics & Automation Magazine*, 24(4):66–74, 2017.