Simulation of BEAR Proprioceptive Actuator using Motorwizard

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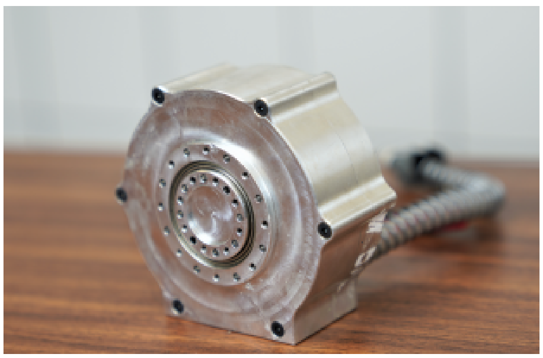

Fig. 1: BEAR: Back-drivable Electromechanical Actuator for Robotics

***Abstract*—In this white-paper, we present the simulation of the Back-derivable Electro-mechanical Actuator for Robotics (BEAR). BEAR is a proprioceptive motor module designed for legged robots. Through EMWorks' Motor wizard, we simulate the torque and the distribution of the magnetic flux throughout the motor.**

I. Introduction

Traditional robotic actuators are designed to be as rigid as possible in order to enable accurate position control. However, such actuators are not ideal for robots operating in environments that are rich in collisions and uncertainties. In recent years more progress has been made toward the development of actuators that are able to mitigate such collisions and uncertainties. There are multiple proposed solutions to this, including series elastic actuators [1] and quasi-direct drive actuators [2]. The BEAR actuator shown in Fig. 1, is a proprioceptive actuator that uses a high torque BLDC with a low gear reduction. Such a design reduces the reflected inertia and increases the back-drivability.

In this paper, we present the simulation results of the BEAR actuator using EMWorks' Motorwizard [3].

II. Design and Setup

As shown in Fig. 2, the bear motor consists of a high torque BLDC motor followed by a gear reduction phase of 1:6. PMSM motor CAD geometry is shown in Fig.3. The PMSM has an outer rotor configuration with surface mounted-magnets, where 42 magnets are used with a curved profile. The stator consists of 36 slots with 3-phase windings in the delta configuration.

Fig. 2: BEAR actuator exploded view

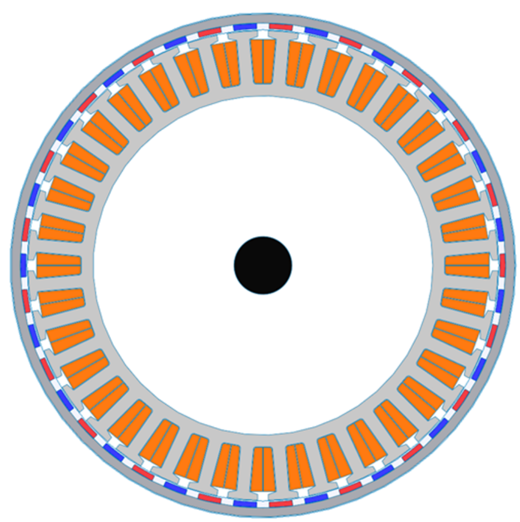

Fig. 3: CAD model for the BEAR motor architecture

III. Results

In this Motorwizard study we simulate the PMSM using a 3-phase sinusoidal current drive with a 60A rms current as shown

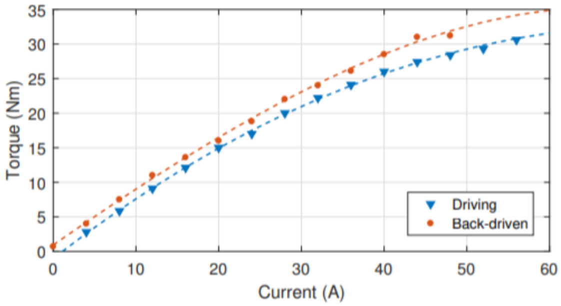

Fig. 4: Actual BEAR motor torque curve as shown in [2]

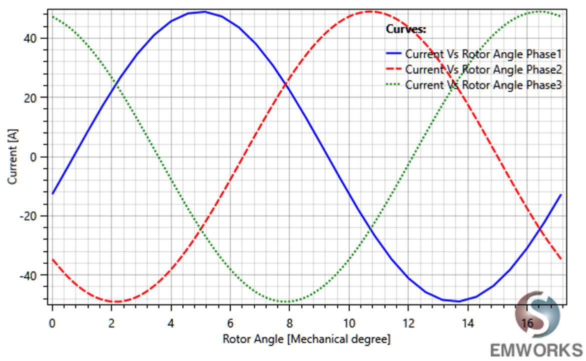

Fig. 5: Simulated current 3-phase current 60A rms current

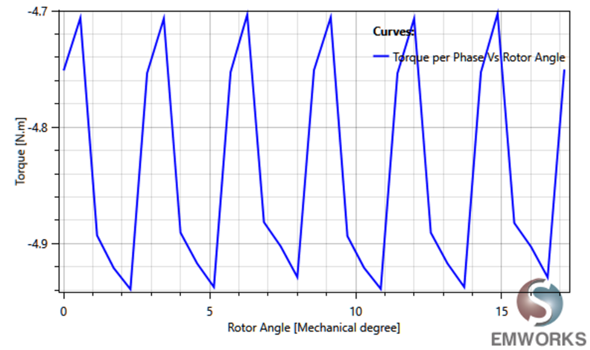

Fig. 6: Torque ripple with respect to motor angle

in 5. We also show the corresponding motor torque ripple shown in 6. We also use motorwizard to study the magnetic flux density of the BEAR actuator PMSM for an RMS current value of 60Amps as shown in 7

IV. Conclusion

In this white paper we present the results of simulating the BEAR actuator developed in RoMeLa lab at UCLA using EMWorks Motor wizard. We simulated the motor under a 3-phase current with a 60A rms current. We show the results of the torque ripple as well as the magnetic flux density under the specified conditions.

Acknowledgment

We would like to express our gratitude to the EMWorks for providing a license for EMS software for academic research purposes.

References

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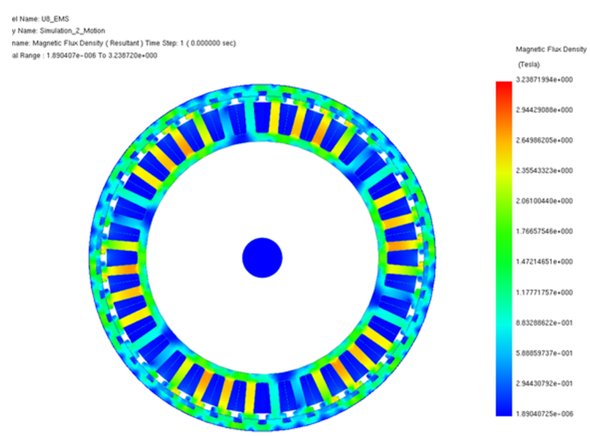

Fig. 7: Magnetic Flux Density