Electric Motor Dynamometer

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Introduction

Problem Statement

The objective of this capstone project was to develop a user-controlled system capable of deriving the key desired motor metrics: rpm, torque, and power under varying conditions. Originally, this was assigned to be a chassis dynamometer to test electric motorcycle metrics, but due to customer and time constraints, the system was downsized.

Overview of Constraints

The system must provide a controlled, constant resistance to the device under test while collecting and displaying precise, accurate data on a user-friendly interface. The implementation shall also follow all applicable NEC codes and regulations.

Design

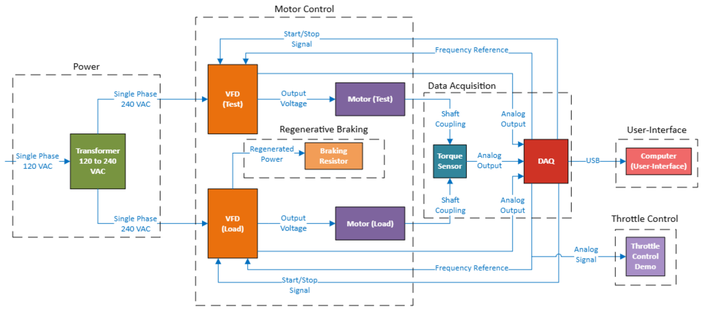

Fig. 1 System Block Diagram

- Power: A 1kVA transformer was used to step up the single phase 120 VAC, from the wall, to 240 VAC. The VFDs were then derated and utilized to be phase converters.
- Motor Control: A $^1/_3$ HP and a $^1/_2$ HP induction motor are each controlled by separate Yaskawa 1000 series VFDs.
- Regenerative Braking: Any regenerated power, during braking, is dissipated through a 400-watt braking resistor.
- Data Acquisition: A rotary torque sensor and the VFDs were used to extract raw data signals, and the NI USB-6215 then took in and converted these into readable values.
- User-Interface: LabVIEW was utilized to appropriately display all data and control the system.
- Throttle Control: A Nema 17 stepper motor, driven by a A4988 drive and Arduino, controls a 3d printed clamp to display throttle position reference to motor speed.

The Team

From Left to Right: Andrew, Aaron, Jonathan, Ethan, Dylan, Branson

Fig. 2 System Layout

Experimentation

Capabilities:

- The DAQ is able to read and display rpm, torque, and power accurately and precisely, to the thousandths, with little to no noise.
- The system is able to be moved and run on 120 VAC due to the transformer and the VFD's phase conversion capabilities.
- Any user can fully operate the system from his/her laptop with the constructed LabVIEW code.
- All data, upon testing completion, can be saved and later analyzed in an Excel file.

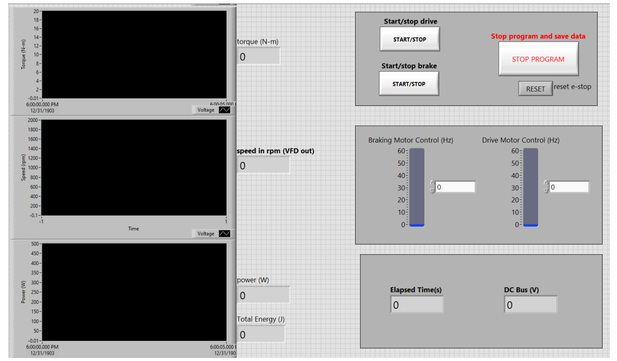

Fig. 3 User-Interface Screen

The system utilizes LabVIEW and Excel to display and save all recorded data from each test.

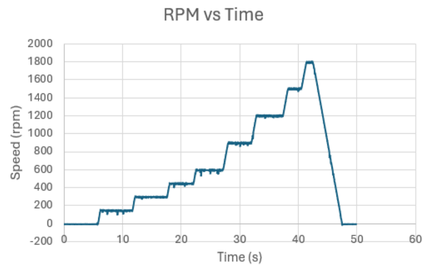

Fig. 4 RPM Graph (Excel)

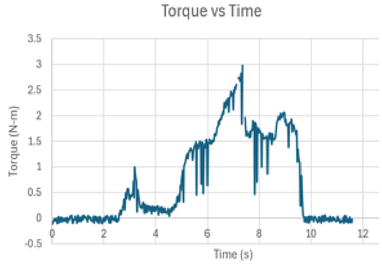

Fig. 5 Torque Graph (Excel)

Conclusion

The team has successfully constructed and proven the capabilities of the electric motor dynamometer. As a result, this design is now capable of being expanded and integrated to fit the desires of the electrical motorcycle chassis dynamometer by future teams.

Final Budget	
Subsystem	Cost
Braking / Motor Control	$448.00
DAQ	$875.59
Throttle Control	$67.95
User-Interface	$7.69
Sensor	$506.89
Miscellaneous	$290.28
Total Cost	$2,196.40

We would like to specially thank Professor Micah Rentschler for his constant support and advice throughout our design. We also would like to thank the College of Engineering for their guidance and support.