Compact Dynamic Motor Test Bench Integrated in Mobile Steering Test Bench

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**Motivation**

- Current test bench designs are bulky with complex algorithms.
- Inflexible and complex test systems increase development time.
- Flexible and fast execution of motor performance test.
- Reduce test time due to ECU software revisions.
- Compact and rugged automation of test execution.
- Reduce development time caused by bulky inflexible test system.

**Aim**

The aim of this thesis was to develop a compact test bench for steering electric motor drive under various working points and load conditions along with automation of the test to get flexibility. Over the duration of the thesis, the various possibilities of developing a test bench that can achieve the test standards for the steering power packs under various working points and load conditions using a compact architecture was researched. The key test cases for the power pack were identified, and a flexible application software was designed with the aim of using the same test bench to functionally verify and validate different power pack designs and software versions without modifying the test bench software and the hardware setup.

**Scope**

- Selection of load and load controller.
- Analysis of load performance to match system requirements.
- Design of control system and system identification.
- Flexible Software Application Design.
- Integration of prototype.
- Integration tests and analysis of tests.

**System Requirements**

- OUT specifications
- Motor torque in Speed curve
- Rack size constraints
- Electrical integration / Control mechanism
- Load control, RPM control
- Cost effectiveness

**Load Comparison**

- Magnetic Particle Brake
- Eddy Current Brake
- Permanent Magnet Brake
- Hysteresis Brake
- Motor Torque vs Speed Characteristics

**Software Test Requirements**

- Constant torque case: The torque is kept constant for a certain duration to analyze the power outputs. This test is important to analyze the motor efficiency.
- Test sequence case: This test involves the execution of a user defined sequence. This test plays an important role in analyzing the temperature behavior of the motor.

**System Block Diagram**

- Prototype Development

**Prototype**

- Controller response observations:
  - The rise time of 1 to 2 seconds
  - The controller gains are constant up to 1000 RPM
  - Brake response time slower than motor acceleration time

- Brake response observations:
  - The rise time slower for higher RPM
  - Max torque for duty cycle not constant for different RPM
  - Brake response inconsistent
  - Motor torque drop time inconsistent: 20 ~ 120 seconds

**Application Software**

- Additional power supply to reduce voltage fluctuations, improve repeatability.
- Additional torque sensor for brake torque measurements.
- Current measurement circuit enhancement.

**Scope of Enhancement**

- Inclusion of additional Tests
- Option to import MATLAB models for PID simulations.
- Additional offline data analysis functionalities.
- Programmatically modify latency if possible.