DEVELOPMENT OF INDEPENDENTLY CONTROLLED FOUR WHEEL DRIVE SYSTEM FOR AUTONOMOUS ELECTRIC VEHICLE [UREP21-062-2-022]

18 March 2020
Outline

1. Goals and objectives
2. Achievements and outcomes
3. Post Projects Plans
Goals and objectives

The aim of this project is to develop a four-wheel electric vehicle drive system and demonstrate its prerational superiority over the conventional two-wheel vehicle drive.

In order to design and implement a 4x4 electric vehicle the following objectives are envisaged:

1. Modelling and simulating the motor used.
2. Design of an embedded system based on Pulse Width Modulation Technique.
3. Inverter power circuit, gate drivers, current and voltage sensors design and implementation.
4. Develop interactive software using Labview to perform on-line control of motor drive system.
5. Closed-loop motor control to enable 4x4 functionality.
System Design

Design Components

- **Gate Drives**
- **Inverter**
  - To convert DC battery voltage to AC voltage to operate the motor.
- **Gate Driver**
  - Step-up the voltage from the microcontroller to the inverter switches.
- **Voltage Sensor**
  - To sensor voltage.
- **Current Sensor**
  - To sense current.
- **Dock Station**
  - To provide simplified connections from the microcontrollers to the gate Drives.
System Design (Contd.)

Inverter Design

Gate Drive Design
System Design (Contd.)

Voltage and Current Sensors Design

Voltage Sensor Design

Current Sensor Design
System Design (Contd.)

Inverter board Design
System Design (Contd.)

Dock Station PCB Design

Dock Station PCB Design
Complete Block Diagram of 4x4 EV
Complete Block Diagram of 4x4 EV
Achievements and outcomes

1. System Design

This block diagram explains the design hardware setup and how the selected components are interfaced together.
Achievements and outcomes

The figures below show the setup of the four motors. As can be seen below, the four motors have been set on a testbench. Each motor is connected to an inverter and a microcontroller.
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Achievements and outcomes

Semi-Autonomous Operation is achieved using Lab view interface software. The full control is achieved using the Texas Instrument interface card. The developed software is shown in the below figures.
Achievements and outcomes

Individual BLDC Motor / Drive Control

- Enable
- Battery Level (in %) 10

- Speed Adjustment 1
  - Direction 1: Forward
  - Break 1: Break
  - Speed in RPM (M1): 0

- Speed Adjustment 2
  - Direction 2: Reverse
  - Break 2: Break
  - Speed in RPM (M2): 0

- Speed Adjustment 3
  - Direction 3: Forward
  - Break 3: Break
  - Speed in RPM (M3): 0

- Speed Adjustment 4
  - Direction 4: Reverse
  - Break 4: Break
  - Speed in RPM (M4): 0

Stop
Achievements and outcomes
Achievements and outcomes

One research paper is written and submitted to an International Journal named as Journal of Urban Technology, Taylor &Francis:

Aya Ali Amer, Nehaja Narayan Joglekar, Ajad Howeldar, Jassem Mohammed, Mohammed Al-Mahfooz, Atif Iqbal, Mohammed Al-Hitmi, Syed Rahman
“Design and Development of A 4x4 Electric Vehicle Drive System”, Journal of Urban Technology,
Post Projects Plans

Several additional features can be augmented in the design to enable additional functionalities of the system. In the future the vehicle can be improved to work in fully autonomous control mode by adding these features:

1. A wireless transmitter and receiver set for driver control in full autonomous mode.
2. A camera or radar for path tracking for obstacle avoidance in autonomous mode.
3. A GPS position system to assist in position tracking for in autonomous mode.