Modern Electric, Hybrid Electric, and Fuel Cell Vehicles

Fundamentals, Theory, and Design

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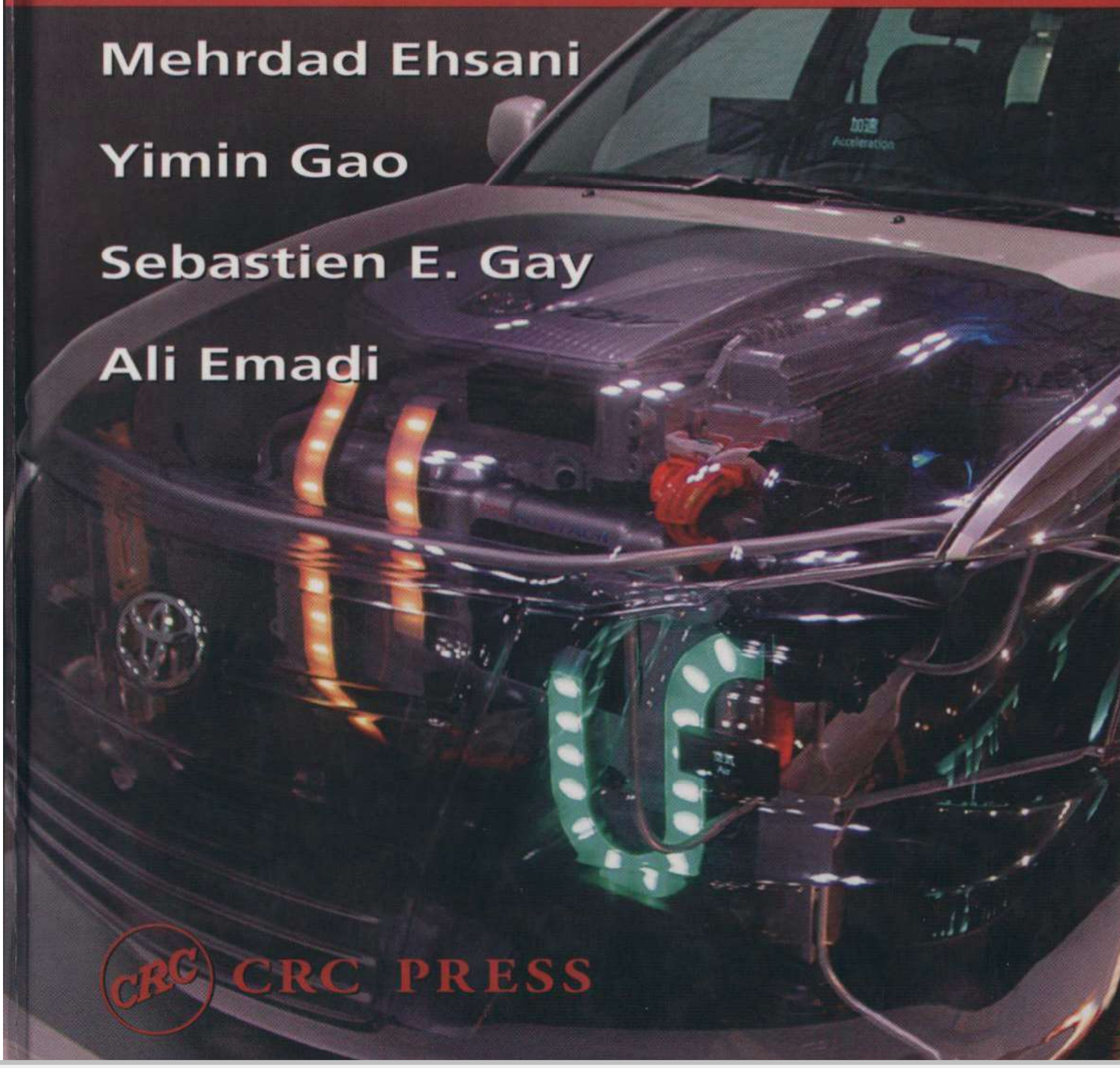

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Parallel Hybrid Electric Drive Train Design

CONTENTS

Unlike the series hybrid drive train, the parallel hybrid drive train has features that allow both the engine and traction motor to supply their mechanical power in parallel directly to the driven wheels. The major advantages of parallel configuration over a series configuration are (1) generator is not required, (2) the traction motor is smaller, and (3) multi-conversion of the power from the engine to the driven wheels is not necessary. Hence, the overall efficiency can be higher.[5] However, the control of the parallel hybrid drive train is more complex than that of a series hybrid drive train, due to the mechanical coupling between the engine and the driven wheels.

There are several possibilities for configurations in a parallel hybrid drive train, as mentioned in Chapter 5. But the design methodology for one particular configuration may be not applicable to other configurations and the design result for a particular configuration may be applicable for only a given operation environment and mission requirement. This chapter will focus on the design methodology of parallel drive trains with torque coupling, which operate on the electrically peaking principle; that is, the engine supplies its power to meet the base load (operating at a given constant speed on flat and mild grade roads, or at the average of the load of a stop-and-go driving pattern) and the electrical traction supplies the power to meet the peaking load requirement. Other options, such as a mild hybrid drive train, are discussed in Chapter 9.

The base load is much lower than the peaking load in normal urban and highway driving, as mentioned in Chapter 5. This suggests that the engine power rating is lower than the electrical traction power rating. Due to the better torque–speed characteristics of the traction motor compared to the engine, the single-gear transmission for the traction motor might be the proper option. Thus, this chapter will focus on the design of the drive train as shown in Figure 8.1.

The design objectives are:

1. To satisfy the performance requirements (gradeability, acceleration, and maximum cruising speed)
2. To achieve high overall efficiency
3. To maintain the battery state-of-charge (SOC) at reasonable levels in the whole drive cycle without charging from outside the vehicle
4. To recover the brake energy.

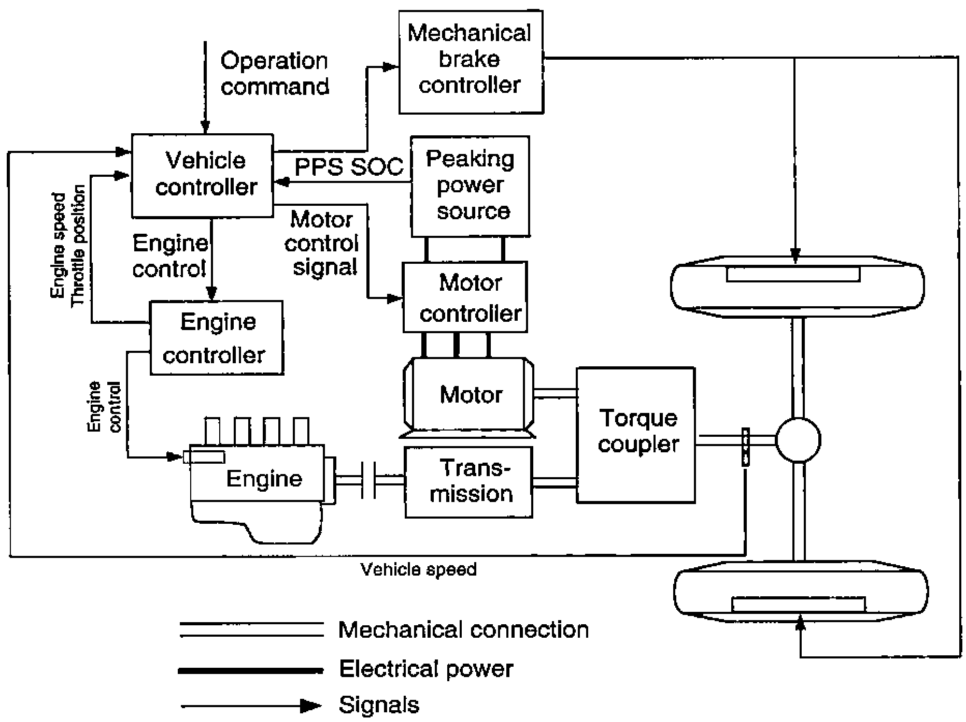

FIGURE 8.1
Configuration of the parallel torque-coupling hybrid drive train

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