Assisted Direct Start

Customer: Ms. Eileen Davidson, Ford Motor Company

Motivation
The United States Department of the Treasury estimate that traffic congestion consumed an extra 1.9 billion gallons of fuel in 2011, which is approximately 5 percent of all of the gasoline consumed in the U.S. Other studies show that drivers encounter an average of 10 to 15 red lights and stop signs on a typical 20 mile commute, which can add 5 to 15 minutes of idle time and wasted gas. By eliminating engine idle when the vehicle is stopped, the average car’s fuel economy will improve by about 3.5%.

While hybrid technology can be used to mitigate this problem, it is expensive, putting it out of reach for many consumers. In order to meet the challenge of creating an affordable system that eliminates idle fuel waste, the Assisted Direct Start System was developed. This technology can be applied to a conventional gasoline or diesel engine at a very low cost, as it requires only a few additional hardware components to be added to the base vehicle. In addition to the improved fuel economy benefits of Assisted Direct Start, exhaust emissions are reduced by approximately 4%, making this a truly green technology.

Assisted Direct Start Description
The Assisted Direct Start system (hereafter ADS) automatically shuts down the engine when the vehicle is stopped, instead of idling the engine, in order to improve fuel economy and greenhouse gas emissions. The engine is automatically restarted when the driver releases the brake and engages the gas pedal.

The starting and stopping of the engine must happen in a seamless manner, without inhibiting vehicle performance. Thus, after the engine has stopped, it must be able to be restarted immediately when the driver demands it.

Of course, customer comfort is also important, so the ADS system must be aware of other needs of the customer, including the climate control settings. The customer desired cabin temperature must be maintained during ADS operation. If the customer has other electrical demands, like moving the window up and down, or operating the windshield wipers, those systems must also continue to work without any noticeable degradation in performance. The system must be aware of the state of the battery in order to insure all electrical systems can adequately perform their function.

The engine system itself has limitations as to when ADS can be executed. For example, when the engine is cold, quick restarts may not be possible, so the ADS function may not be available until the engine warms up.

When the vehicle is in low speed operation for an extended period of time (like parking lot maneuvers), the customer may become annoyed at the continual starting and stopping of the engine. There are also times when the vehicle acceleration performance after engine stop may be
compromised (for example, when the vehicle is loaded or when towing a trailer), making the engine restart hesitation time more noticeable. Therefore, the customer should be provided a means to inhibit the ADS function.

Subsystems involved in the ADS system:

1) Engine Management Subsystem: monitors the driver inputs, including brake pedal, accelerator pedal, and PRNDL position. It also provides engine state information, actuates the engine starting system, and provides fuel cut function for engine stop.

2) Battery Management Subsystem: monitors the state of the battery, including battery voltage, current and temperature. Provides state of battery health and charge to the ADS supervisory subsystem.

3) Driver Interface Subsystem: provides feedback to the customer on the state of the vehicle and ADS. Also allows the customer to activate or deactivate the ADS system.

4) Climate Control Subsystem: allows driver to set vehicle temperature for automatic cabin temperature control. It also allows the customer to manually control the A/C or heating system.

5) Vehicle Electrical Subsystem: actuates and provides the status of the bulk of the electrical systems in the vehicle, including windows, windshield wipers, seat position, etc.

6) ADS Supervisory Subsystem: interacts with all of the other subsystems, calculates the demand on the electrical charging system, and commands the starting and stopping of the engine. Can enable or disable individual vehicle electrical and climate functions.

Scenarios

**Scenario One**: Fully working system as described above. Demonstrate the priority of functions in the vehicle, assuming that driver comfort is the most important, while continuing to meet the overall constraints of the system.

**Scenario Two**: Fully working system as described. Demonstrate the priority of functions in the vehicle, assuming that vehicle fuel economy is the most important, while continuing to meet the overall constraints of the system.

**Scenario Three**: Fully working system as described above. The frequency of ADS events is a known customer irritant, and while the customer has the ability to disable the system, he may choose not to, or he may forget he has that option. Implement a “customer annoyance avoidance”

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system by monitoring the frequency of ADS events. Allow ADS to re-engage when conditions indicate the frequency will be at an acceptable level.

**Scenario Four:** Fully working system as described above. The brake pedal sensor has been diagnosed as failed. How can partial system function be maintained?