Project proposal template
Graduate School studentships
March 2015

Project title	Vibration-free engine start-up and shutdown through adaptive integrated starter generator input shaping	
First Supervisor	Professor	M. Necip Sahinkaya
Second Supervisor	Yahya Zweiri	
School	Mechanical and Automotive Engineering	
Other member of supervisory team (no more than three KU supervisors in total)	Robert Rayner	
Specific requirements beyond 2:1 degree		

Project summary

(max 4,000 characters)

Problem Statement

Vibration during engine start-up and shutdown is a well-known, current engine limitation. Complaints from users of vehicles equipped with start-stop systems have been reported correlating engine start-up and shutdown to compromised passenger comfort.

Traditionally, internal combustion engines start using electric starter motors that are active only during start-up. More advanced approaches include *mild hybrid* solutions where the traditional starter motor is replaced with an integrated starter generator (ISG).

The requirement for modern engines start and stop frequently has rendered methods for improving engine vibration characteristics particularly important. Notable examples of work addressing the subject include the i-StARS system by Valeo and the Integrated Starter Alternator Damper (ISAD) system by Continental.

Although these solutions have proved valuable, considerable physical modifications to the base engine required for their function constitute a productive and financial limitation. For ease of and financial competitiveness of implementation, a novel method is required able to reduce vibration in the absence of physical modifications to the engine.

PhD Deliverables

The proposed research study shall address engine start-up and shutdown vibration through adaptive, online shaping of ISG signal inputs. In the first instance, offline measurements of engine vibration will be used to develop a first ISG input signal shaping model taking crankshaft angular speed and acceleration data through fast Fourier transformation. Once this knowledge of start-up and shut-down vibration is established, a custom observer algorithm will be developed to mitigate vibration by tuning the input shaping in real-time.

The effects of real time ISG input signal shaping on start-up and shutdown vibration will be quantified and validated through *in silico* and real engine testing. The effect of changes in vehicle and environmental parameters on the solution's efficiency shall also be addressed.

Key PhD stages:

- Understand the causes of engine vibration during start-up and shutdown
- Enhance the understanding of vibration through computer simulations
- Develop a method of shaping ISG input signals to reduce engine vibrations during engine start-up and shutdown
- Design and develop an adaptive observer algorithm for online ISG input shaping modulation

Collaboration

The research project will be carried out in collaboration with **Jaguar Land Rover.**