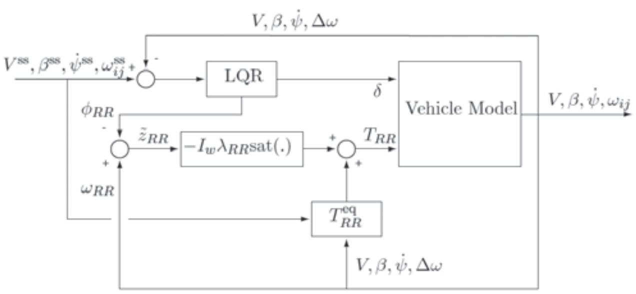
Centre for Engineering Dynamics

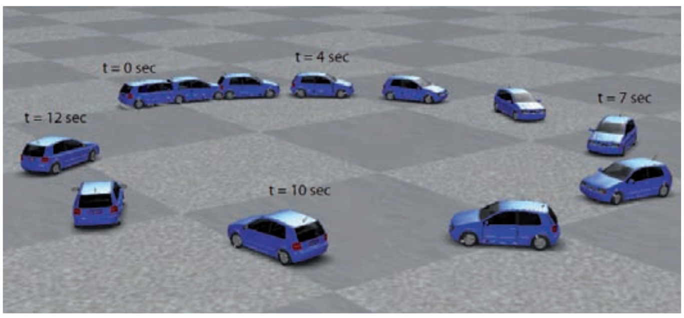
Engineering Dynamics is a broad spectrum of research activity. This centre is particularly concerned with Vehicle Dynamics, Structural Dynamics, Motion Analysis and Robust Systems.

Current Activities

Vehicle Dynamics

Led by Dr Efstathios Velenis. Our research objective is the encapsulation of expert driver knowledge on vehicle limit handling within a rigorous mathematical framework and the development of passenger vehicle driver assist systems with "expert driving skills". The research activities include the collection of data during the execution of limit driving techniques by expert race drivers, reproduction of these techniques in simulation and identification of their optimality properties, and the design of control algorithms to stabilise the vehicle during cornering with the tyres operating close to their maximum force capacity. The architecture of a "drifting" controller and the vehicle's trajectory during stabilisation are shown below.





Structural Dynamics

Led by Dr Cristinel Mares. Our research objective is the development of models and identification methods for complex and large scale systems, with emphasis on uncertainty and variability analysis. Current projects include helicopter rotor dynamics analysis (test facility shown below), vibration suppression for wind turbines, and development of robust damage detection methods using vibration data and wavelets analysis for structural dynamics applications.

Dynamics and motion analysis

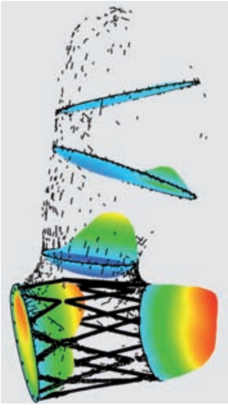
Led by Professor Ibrahim Esat.

Currently there are 10 researchers and 5 visitors working mainly in following three areas

1. Musculoskeletal modelling and human body motion, including: anatomically described joint kinematics and dynamics; joint characterisations using various invariants; muscle tremors. Development of musculoskeletal devices. Development of in-house musculoskeletal modelling software.
2. Motion and vibration control, including: active, semi active, and self-regulating control devices applied to suspension systems and engine vibration absorption; windmill shafting system analysis; cam and cam driven system modelling (including 3D globoidal cams), mechanism synthesis and development of in-house multibody vibration modelling software.
3. Biologically inspired algorithms applied to engineering problems and motion control, including: neural network design by the use of Voronoi polygons; Neural network encoding schemes; Quantum inspired algorithms, GA, PSO; Algorithms applied to a variety of engineering problems such as the use (in real-time) of GA in optimal control problems.

Robust Systems

Led by Dr Mark Atherton. Our research objective is to make engineering systems and devices less sensitive to parameter variability, disturbance or unwanted perturbations. Activities include: Optimising the design of vascular stents for desired blood flow characteristics (see figure).



Also, the design of *Piezoelectric bimorphs* for specified audio-haptic frequency response behaviour against geometric and material variability. *Anti-noise for dental drilling* focusing on the adaptive tracking of unwanted noise for improving patient comfort. Finally, the *robustness of complex networks* – the influence of redundancy, distribution of functionality and self-organisation for improving the performance of communication networks.

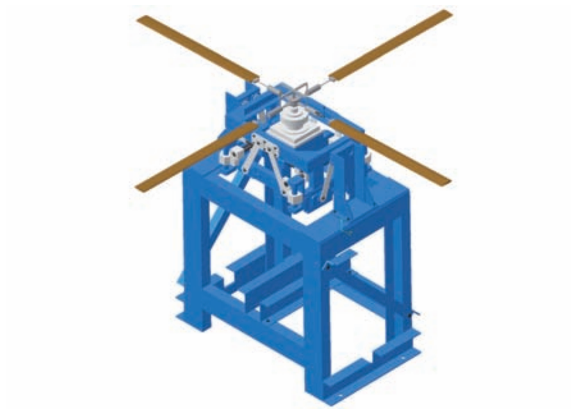
Facilities

Vibration actuation and measurement

Vibration equipment includes a Polytec CLV laser Doppler vibrometer with Clio audio signal generator and processor.

Helicopter Rotor

A fully instrumented scale model of a helicopter rotor enables the study of rotor dynamics and aeroelastic response. The rig is capable of enforcing motion at the hub in 3 translations and 2 rotations and can allow the hub to be free-floating. A 6 component balance at the hub base allows the measurement of forces and moments.



Test Vehicle

Brunel's test vehicle is instrumented with a data-logging and sensor suite to correlate the dynamic response of the vehicle to the driver's inputs during limit handling. The instrumentation includes a twin-antenna GPS receiver providing vehicle speed and sideslip angle, an Inertial Measurement Unit (3 axis accelerations and 3 axis rotation rates), a CAN-bus interface to collect engine RPM, throttle position and 4 wheel speeds signals, steering angle and brake pressure sensors.

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