The Centre for Power Transmission and Motion Control

UNIVERSITY OF BATH

The Centre for PTMC: analytical and experimental research into next-generation machine systems.
Dr Jos Darling, Dr Andy Hillis, Dr Nigel Johnston, Dr Patrick Keogh,
Dr Roger Ngwompo, Prof Andrew Plummer, Dr Necip Sahinkaya, Dr Pejman Iravani

PhD Project Vacancies 2012

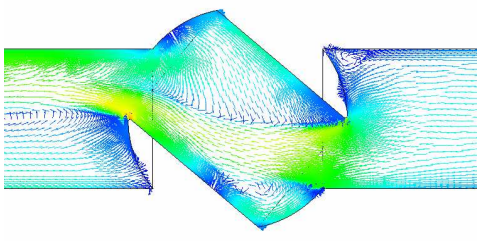
Fully-funded studentships are available on a competitive basis. Studentships include all tuition fees for UK/EU citizens and a tax free maintenance allowance (stipend) of at least £13 590 per year. University and Faculty Graduate School studentships may be awarded for other projects on a competitive basis.

1. Vibration-based damage detection
All structures and components are susceptible to damage. Modern lightweight structures such as aircraft, bridges and wind turbines are particularly susceptible. The ability to detect the presence of damage early and track its progression in such structures will improve their safety, reliability and operability. This project will investigate the application of novel structural health monitoring techniques based upon measurements of normal operating vibrations. (Dr A J Hillis)

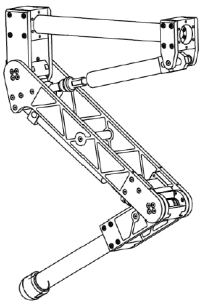
2. Novel active seal design and control for high precision and high bandwidth motion control
In fluid power systems, seals are typically passive elements that limit the leakage of fluid. Friction forces are usually overcome by the hydraulic actuation capability. However, there are particular advantages to be gained by designing and integrating active seal elements into motion control systems. These include the precise control of the actuation force over sub-micron displacements together with high bandwidth control of the actuation force. It is envisaged that piezoelectric actuators will be integrated into active seal designs, which will also interface with material and tribological investigations. (Prof P S Keogh, Dr D N Johnston, Dr C R Bowen)

3. High force all-electric dynamic testing
Dynamic materials testing machines have traditionally used hydraulic actuation. However direct-drive electromagnetic actuation is now being used in lower force ranges (up to 10kN) as a result of the increased force density and reduced cost of high performance brushless motors. This project will investigate the feasibility of motor driven screw drives for dynamic testing at forces up to 25kN, considering fundamental limitations, screw wear and life, and controller design. If successful, the force range of all-electric dynamic testing machines will be significantly increased. *Industrial support: Instron.* (Prof A R Plummer).

4. Intelligent powered prosthetic knee
State-of-the-art prosthetic knees have microprocessor-controlled stiffness and damping characteristics to provide relatively relaxed and natural level walking. However, amputees find activities which benefit from significant power transmission through the knee, such as stair climbing, problematic. Fully powered knees have been developed to tackle this, but these have short battery life, and are unacceptably noisy. This project will investigate a hybrid concept, in which the knee can operate passively during level walking, but can be powered at other times. Practical issues such as weight and noise will be assessed.
Industrial support: Blatchford. (Prof A R Plummer).

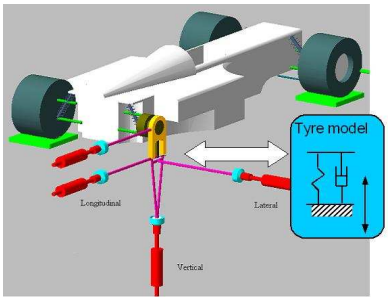


5. Modelling dynamic characteristics of aircraft refuelling systems
Simulation models will be developed for fuel flow during aircraft refuel, with detailed modelling of the pumps, valves, fuel hoses and pipes. The aims will be to predict surge pressures, and to investigate and propose methods for reducing surge pressure.
(Dr D N Johnston).



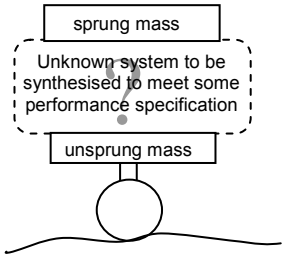
6. Agile robot locomotion
The majority of the Earth's land mass is inaccessible to wheeled vehicles. Legged locomotion is a potential solution, allowing mobile machines to traverse rough terrain. Running robots are legged machines with a dynamic capability, i.e. with sensing, actuation and control systems which enable operation outside the constraints of static balance, and are thus more robust and versatile than walking robots. Hydraulic actuation is required in order to deliver sufficient power to many independently controlled actuators, whilst minimising weight and size. The design of practical hydraulic running robots will be considered in this project, focussing particularly on energy efficiency and control. (Prof A R Plummer, Dr P Iravani, Dr M N Sahinkaya)

7. Robotics: control and behaviour generation
Controlling humanoid robots is a complex task given their many degrees of freedom and multiple sensor inputs. Probabilistic optimisation of dynamics will be proposed as a method for action planning/selection (such as walking, moving arms, reaching for objects, etc). The investigation will make use of a NAO humanoid robot. The robot is fabricated of light materials, thus its joints and links are flexible, posing new modelling and control problems. (Dr P. Iravani, Dr M.N. Sahinkaya)



8. Model-in-the-Loop Testing
Physical testing is used extensively to characterise mechanical systems. However, in many cases, mathematical models are now available which adequately describe the behaviour of part of the test specimen. Thus test systems can be built which split the specimen into a physical part and a virtual part. *Model-in-the-loop* (MiL) testing, or *hybrid simulation*, is used to describe this concept. Focussing on automotive and motor sport testing, this project tackles the issue of optimising realism in the presence of non-ideal actuators and sensors. (Prof A R Plummer, Dr MN Sahinkaya)

9. Synthesis of Dynamic Systems Using Inverse Methods and Optimisation Techniques Given a system to be designed such as a suspension system, and some specifications (e.g. in terms of frequency response), the objective of the project is to propose and develop a methodology combining inverse methods and optimisation techniques for the synthesis of the unknown part of the system so as to meet the required performance. (Dr R Ngwompo)



Engineering Doctorate (EngD) Opportunities

EngD's are 4 year doctorates in which the student spends 75% of their time in a collaborating company. Fully funded studentships are available for UK applicants. See www.bristol.ac.uk/engineering/systemscentre

High Accuracy Aero Engine Fuel System Modelling Technology (with Aero Engine Controls)
This project is to study new modelling processes to enhance the design and development of aero engine fuel systems. Current modelling techniques are inadequate to ensure "right first time" design, leading to high cost, long lead times, and additional weight. This is largely due to difficulties with very accurate dynamic modelling of very complex fluid systems. This project will employ CFD and system modelling techniques to better understand both individual component contributions to fluid flow, and complex system interactions. These models will then be fully validated on fuel system test rigs. (Dr N Johnston)

Modelling and Control of High Frequency, High Amplitude, Fuel Flow Oscillations in Aero Engine Control Systems (with Aero Engine Controls)
Future aero engines will employ a range of active fuel control systems in order to drive down harmful emissions and reduce specific fuel consumption. These systems will require the ability to generate high frequency fuel flow oscillations at the injector nozzles. To enable their design, new mathematical analysis, modelling and simulation methods need to be developed and integrated with state-of-the-art knowledge of the application domain. These methods will be engine tested on a future demonstrator large gas turbine developing world leading low emissions combustion technology. (Dr N Johnston)

For more information, please contact any PTMC academic, or Centre Director Prof Andrew Plummer (A.R.Plummer@bath.ac.uk, x6140, 8E2.2)

http://www.bath.ac.uk/ptmc/