Project proposal template
Graduate School studentships
March 2015

Project title	Investigation and selection of potential future strategies/active suppression of skin friction
First Supervisor	Professor — Jian Wang
Second Supervisor	Dr Sing Lo
School	Aerospace and Aircraft Engineering
Other member of supervisory team (no more than three KU supervisors in total)	Professor Tao Zhang, Professor Jinsong Leng (Visiting professor at Kingston, in China)
Specific requirements beyond 2:1 degree	1st degree or 2:1 plus MSc

Project summary

(max 4,000 characters)

Aerodynamic efficiency and flow control of future aircraft and their component will provide enormous impact and contribution to air prolusion from CO_2 and NO_x, and success of future aviation. Further the passive methodology investigated in our FP7 project "Synthesis of Advanced top Nanocoatings with improved Aerodynamic and De-icing behaviour—SANAD", investigation of feasibility of active suppression of skin friction is proposed.

Shark skin has been studied for many years. The tiny scales covering the skin of shark are shaped like small riblets which aligned with the flow direction. The mechanism of shark skin drag reduction is fairly understood, the small riblets impede/prevent the cross-stream translation of the stream-wise vortices and morphing characteristics of shark skin under different pressure and velocity provide optimised small riblets. From our previous researches on wavy surface and forward facing steps, the "features" should be smaller than certain size to achieve the positive effects. Further researches has demonstrated that hydrophobic or super-hydrophobic "mucus" secreted by shark further reduce drag. Wind tunnel experiments demonstrated the hydrophobic properties will show effects on low speed airflow as well.

All of abovementioned natural things in the animal world seem beautiful dreams in human fabricated world, especially in human aviation. However, with advent of nanotechnology, those dreams could become true. Research developments shed the light on our dreams. The research outcomes include

- Research development in BAE Systems, (http://www.baesystems.com/article/BAES_175799) "Aircraft set to become more human as engineers develop smart skins which can detect injury"
- Multiple-shape memory cycle of Nafion electrospun nanofiber membranes and shape-memory polymers coated with nanopaper done by Professor Jinsong Leng (visiting professor at Kingston) and his group.

Combining those developments and technologies, smart sharkskin becomes feasible. The proposed research is aimed at numeric modelling to characterize the effects of tiny changes of smart sharkskin under different flow speed and pressure. The objectives of this proposed research are as followed:

- Critical literature review to further understand mechanism of drag reduction of shark skin, development of numeric modelling of turbulent drag and effect of hydrophobic/super-hydrophobic on turbulent drag
- Development and/or enhancement of high fidelity numeric model to quantitatively modelling turbulent drag
- Applying high fidelity numeric model to provide examples on the effects of tiny changes of smart sharkskin under different flow speed and pressure to guide the further development of smart shark skin by Professor Leng's team.

Supervisor team: Professor Jian Wang, Dr Sing Lo, Professor Tao Zhang, Professor Jinsong Leng (visiting professor at Kingston and the Director of the Centre for Smart Materials and Structures (CSMS) at School of Astronautics of Harbin Institute of Technology, China)