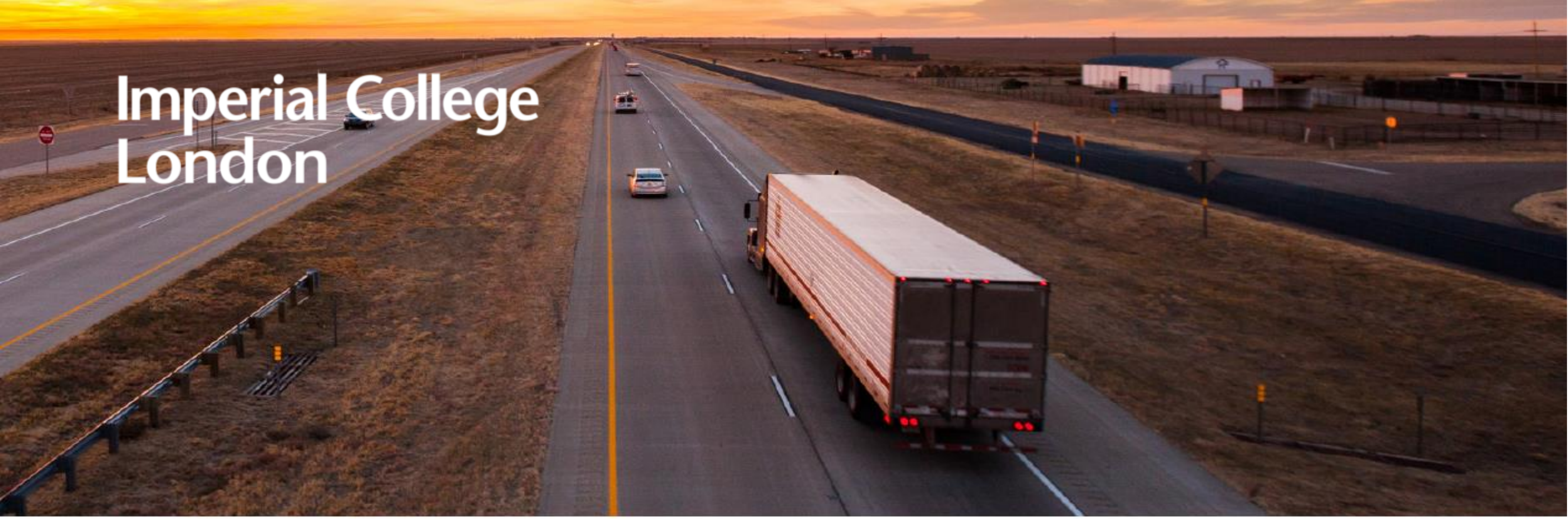

SmartFlap

9% lower fuel costs for trucks from enhanced drag reduction

Summary

The SmartFlap technology provides possibly the best yet solution to reducing drag caused by the turbulent wake at the back of a truck. It uses actively controlled flaps of similar size those of currently available systems, which operate at a slow speed over a narrow range of movement, delivering fuel savings of up to 9%. The demonstrated drag reduction and potentially low cost of the system make it a cost effective investment for truck operators. Also, the size of the flaps and ease of installation ensure that they will be robust and unobstrusive for loading operations as well as on the road.

Background

The design of many road vehicles is aerodynamically inefficient, in particular large road vehicles have a blunt rear end which generates a wake that can lead to dissipation of up to 25% of the total energy produced by the engine.

Improvement of the aerodynamic efficiency is key for environmental, economic and practical reasons. In 2017, road transportation produced 7bn tonnes of CO_2 by using 3tn litres of fuel at a cost of $3-6tn. Aerodynamic efficiency is also important for electric vehicles to increase the range.

SmartFlap is a crucial technology which significantly improves the aerodynamic efficiency yet requires only a small geometric modification, equivalent to the spoilers already present on many vehicles.

Technology

Building on over 5 years of intensive research into the behaviour of turbulent wakes on the bluff body shape of trucks, engineers at Imperial College London have optimised a system which accounts for the effects of yaw angle flow caused by either cross winds or vehicle manoeuvring, e.g. cornering and overtaking. Resulting from a deep understanding of the flow fields created around the truck in these conditions, the team has developed an adaptive flap system that modifies in real-time the flow around the truck.

Figure 1 illustrates the effect of yaw angle flow on the truck and the benefits of adapting the flap deflection under such conditions.

Benefits

- Fuel savings for a standard truck drive cycle of 9%.
- Low cost system to ensure pay-back in investment.
- Unobstructive, robust flaps which allow normal loading and unloading in docking bays.
- Suitable for retro-fitting and new equipment.
- Can be compliant with design and performance regulatory requirements.
- Experimentally tested and clear understanding of the net energy savings.

Applications

- Truck trailers, rear and side loading.
- Automotive rear spoilers
- Coaching industry.

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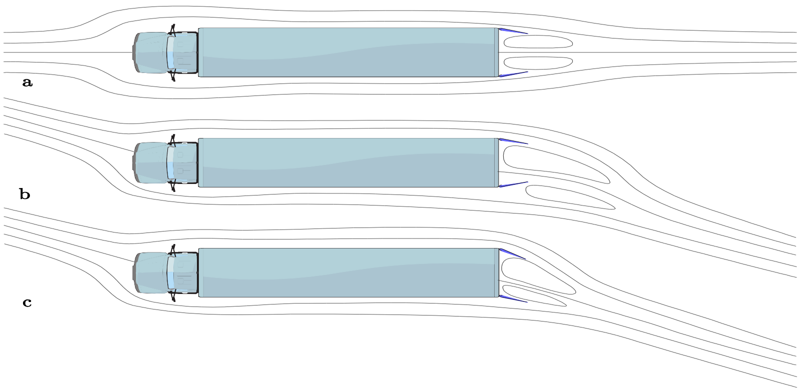
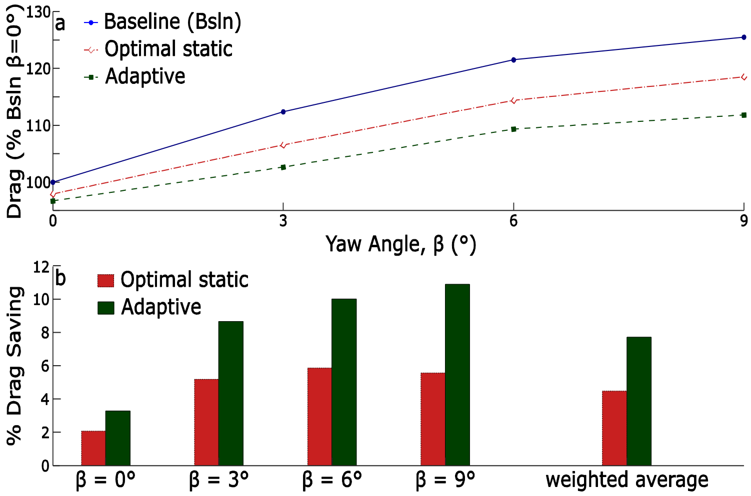


Figure 1(a) shows the optimal symmetric position of the flaps if there were no cross-wind and the truck is travelling in a straight line. However, in windy conditions the air flow is at a yaw angle to the truck, the flaps react to control the flow field at the rear of the truck adapting from Figure 1(b) to Figure 1(c), and reaching the new optimal asymmetric position for cross-wind.

Results

A typical wind speed distribution is available from meteorological data obtained at Heathrow airport, enabling us to evaluate typical yaw angles β. These were used to run a series of wind tunnel tests to simulate probable real-world conditions. Figure 2(a) presents the drag of the wind tunnel model as a percentage of the drag of a baseline (no-flaps) in no-wind conditions (β=0°). No-flap, static flap with optimal positioning and adaptive flap configurations were tested. As observed, in all cases drag increases with yaw angle and the drag saving using adaptive positioning is significantly larger than using static flaps. The drag reduction of the two strategies at each yaw angle (β) with respect to the no-flap baseline is presented in Figure 2(b), along with the average of drag saving weighted with the typical probabilities of each yaw angle.



In practice the flaps have a small range of displacement of 0-25° and take 1-12 seconds transit time depending on the amount of displacement and response required. The system could use simple low power actuators which would have negligible power requirements compared with the energy saving created by the drag reduction.

Technology Readiness

Technology readiness level (TRL) of this technology is 3-4

Intellectual property information

Drag reduction method: International Publication number WO2017/072530. It is also published as GB2544044 and EP3368397.