THE HONG KONG POLYTECHNIC UNIVERSITY 香港理工大學
KTEO Knowledge Transfer and Entrepreneurship Office 知識轉移及創業處
Issue | Aug 2021

Technology Frontier

News Bite on PolyU's Innovation

Smart All-electric Antilock Braking System

Safer, quieter, more responsive and eco-friendly

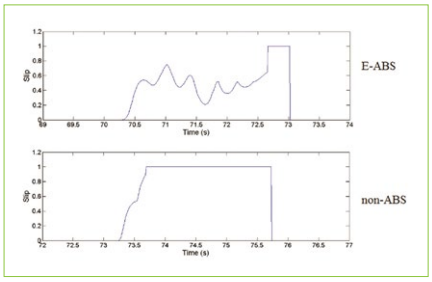
Antilock Braking System (ABS) stops the wheels from skidding when a car is braked hard on a slippery road, enhancing control and safety. But conventional ABS uses complex hydraulic systems for movement transfer which slows down braking response. The brake fluid in such systems also poses many problems and is not environmentally friendly. Researchers from the Department of Electrical Engineering thus invented a Smart All-electric ABS, substantially reducing braking time and distance while being eco-friendly and quiet.

Prof. Eric Ka-wai Cheng posing before the single-wheel ABS test bench

When you drive on a slippery surface and brake hard, the wheels may stop turning and skid on the road surface. The locked wheels mean that you can neither steer the car nor stop it effectively. When skidding is detected, the Antilock Braking System (ABS) automatically releases and reapplies the brakes quickly and repeatedly so that the wheels keep turning and get a better grip on the road for better control and braking effect. However, conventional ABS uses hydraulic or electrohydraulic brakes. The use of hydraulic fluid has been a pain point leading to countless issues. Such systems are also deemed not suitable for electric vehicles (EVs). In light of this, Prof. Eric Ka-wai Cheng from the Department of Electrical Engineering led a research team to develop Smart All-electric ABS, boasting not only faster and more dynamic braking response, but also shorter braking time and distance, eco-friendliness and quiet operation, thereby greatly enhancing motorists' safety and experience.

Conventional hydraulic or hybrid ABS

In conventional hydraulic or electrohydraulic ABS, movement and forces are transferred by the pressure of brake fluid. When a brake pedal is stepped on, the fluid becomes pressurised and activates the brake to stop the wheels from turning. However, such systems have a few disadvantages. First off, they are complicated and involve the transfer of forces via a number of components. That means the system is slower in response. Secondly, the hydraulic system depends on the pressure of the hydraulic fluid, which is affected by various factors, such as temperature.



Braking performance: E-ABS provides a better slip control when compared with non-ABS

The electromechanical brake (EMB) of the Smart All-electric ABS

Prof. Cheng explained, "Oftentimes, you have to step harder on the brake in cold weather. The brake fluid also leaks easily and can be contaminated by moisture. In both cases, braking ability is retarded, and the braking system responds slower than usual, which could be dangerous. That's why car owners need to check and replace brake fluid regularly, and that adds to the maintenance cost. The moisture in brake fluid also rusts the metal component in the hydraulic system, making it less durable." Finally, the brake fluid contains organic solvents and is highly flammable. Generally speaking, it needs to be replaced every two years and could be hazardous to the environment if not disposed of properly.

Smart All-electric ABS

The ABS developed by Prof. Cheng and his team uses all-electric electromechanical brakes with no hydraulic parts. That means there is no longer any brake fluid in the system, which could be good news. Prof. Cheng said, "Not using a hydraulic system to transfer the movements, the all-electric ABS is much simpler and direct in design. All parts are electronic in nature and signals are passed directly from the control unit to the brake, so that it responds 10 times faster than conventional hydraulic ABS, greatly shortening the braking distance and time. Of course, that also means better user safety."

Without brake fluid, the all-electric ABS is more eco-friendly and the components are also more durable as metal parts are less likely to rust.

And there is another major advantage related to riding comfort. "As EVs are gaining much popularity, people are getting used to a quiet ride as electric motors are much quieter than gasoline or diesel engines. That makes the hydraulic brakes and pedal vibrations all the more annoying when it's so quiet inside the car," said Prof. Cheng.

Perfect for EVs

Apart from engine cars and rail-bound vehicles, the Smart All-electric ABS is also intrinsically compatible with EVs. In EVs with hybrid ABS, the brake-by-wire system senses how far a driver steps on the brake pedal and determines how much braking force is needed. The control unit then calculates how much force can be achieved by regenerative braking (using the turning wheels as generator to charge the battery) and how much braking force is needed from hydraulic pressure. Then an electric pump is triggered to generate that pressure to stop the car. Prof. Cheng explained, "The need for an electric pump to generate hydraulic pressure slows down the response and the hydraulic system takes up more space. On the contrary, our all-electric ABS can be integrated into EV's central control unit more readily, and freeing more space."

In March 2021, Smart All-electric ABS won a silver medal at the Special Edition 2021 Inventions Geneva Evaluation Days - Virtual Event, an online version of the prestigious International Exhibition of Inventions of Geneva.