Innate behavior determines how we steer our car

January 2 2015

When maneuvering a steering wheel, both children and adults demonstrate a jerkiness that researchers have previously been unable to explain. A new discovery shows that the jerkiness is due to an innate behavior humans have when reaching for a target with their hand. Credit: Henrik Sandsjouml

Researchers at Chalmers University of Technology have solved a 70 year old mystery in traffic research: an until now inexplicable jerkiness when we steer a vehicle. The discovery may lead to safety systems in cars that can correct dangerous steering movements before they occur.

The ability to predict what a driver is going to do in the near future and to be able to prepare the car's system for this sounds a little bit like science fiction, and it would naturally be a dream come true for the safety departments at car manufacturers. The dream is now one step closer to becoming reality.

"With the driver model I have developed, it is possible to predict what drivers are going to do with the steering wheel before they do it. It is possible to predict how far the driver is going to turn the wheel, right when the person starts a wheel-turning movement. It's like looking into the future," says Chalmers researcher Ola Benderius.

As a result of the recently published discovery, several applications for car support systems can be developed to make our cars safer. Smarter anti-skid systems and systems for fatigued drivers are two examples of potential usage areas.

"Imagine a fatigued driver on the verge of running off the road. He or she suddenly wakes up and reflexively initiates a very large corrective manoeuvre, a potential misjudgement that can lead to something very dangerous. Since we are now able to predict how far the driver is going to turn the wheel, the vehicle's support systems can identify potential misjudgements and intervene, which means a serious accident, such as the car travelling into approaching traffic, can be avoided," says Ola Benderius.

What is the mystery that Ola Benderius has solved? As early as 1947, the well-known British researcher Arnold Tustin (1899-1994) produced the first model for how a person steers towards a target. He identified a continuous and linear control behaviour. When a car is driven, this corresponds to the driver gently and continuously following the road with the steering wheel. This behaviour is known as tracking within control theory, and it has been the prevailing theory for car driving ever

since. However, when comparing the linear model with actual measured data, some deviations become apparent, namely jerkiness in the steering signal.

Tustin saw these deviations from the continuous prediction as well, but the mystery has remained unsolved until now. Ola Benderius and his colleague Gustav Markkula got the idea while they were attending a lecture on neurocognition at Sahlgrenska University Hospital. The lecture addressed the behavioural theory of reaching, which concerns the basic human behaviour when we reach for something.

When studying how we humans move our hand from Point A to pick up something from Point B, the speed of the movement has a direct relationship with the distance - the longer the distance, the quicker the movement. The interesting effect of this is that the time for the movement is the same regardless of the distance.

"We immediately recognised this pattern from our measured steer signals," says Ola Benderius. "It was a bit of a eureka moment. Was it possible that this basic human behaviour also controlled how we steer a car?"

With the idea in mind, Ola Benderius extracted over 1,000 hours of car and truck driving from real driving data, which resulted in 1.3 million steer corrections. It turned out that 95 per cent of these correspond with the reaching theory. Ola Benderius and Gustav Markkula had discovered that steering is not linear when the driver follows the road, but rather that the driver turns the wheel according to the special reaching pattern.

"We were able to use the theory to explain what researchers had been trying to solve for a long time. This was the answer to the previously inexplicable jerkiness in the control signal. Rather than looking upon steering as continuously following the road, steering corrections seem to

be applied in a very predetermined manner," says Ola Benderius. "The control behaviour has also proven to be very natural; I saw this in an earlier study where I examined driving behaviour in 12 year olds and their parents."

With this new knowledge, he was able to develop a mathematical model that can explain many observed steering behaviours, which means that the driver response to different situations can be predicted before it occurs. Ola Benderius believes the discovery will have an impact on an entire research field.

"This might completely change how we regard human control of vehicles, crafts and vessels. I hope and believe that many researchers will utilise the findings and start to think in new ways. Control behaviour has traditionally been studied on the basis of control theory and technical systems. If it is instead studied on the basis of neuroscience with focus on the human, an entire new world opens up. This could push the research field in an entirely different direction," says Ola Benderius.

More information: The study and mathematical model are part of Ola Benderius' doctoral thesis that was recently published: "Modelling driver steering and neuromuscular behaviour": publications.lib.chalmers.se/publication/205699

Provided by Chalmers University of Technology