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Self-Adjusting Mirror for Tractor-Trailer Cornering Safety

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Abstract:- During a sharp turning of a long tractor-trailer, the two fixed side-view mirrors on either side of the cockpit would lose their usefulness because the field of vision provided by them would be irrelevant. One of them would show the front part of the trailer's body while the other showing a view that is far away from the trailer. This might cause unfortunate events ranging from falling into a drain and damage the vehicle to life-threatening accidents. The various existing solutions to this problem are either too costly, not convenient or lack of flexibility.

The new technique proposed in this paper is to design an electric self-adjusting side-view mirror that changes angle automatically as the driver turns the steering wheel during cornering so that the critical point of the trailer's rear wheel is locked onto no matter how much the tractor is turning. It uses the commanding current from the power steering control module to drive a direct-current reversible motor to rotate the side-view mirror an angle proportional to the rotation of the steering wheel.

Key words: Tractor-trailer; side-view mirror; cornering safety

1. PROBLEM OF TRACTOR-TRAILER SIDE-VIEW MIRROR

While making a sharp left-turning, the driver of a very long tractor-trailer must pull to the right side as much as possible just before the junction (*b*), and then cut in from the right (*c*) to ensure sufficient space for the last left wheel of the trailer to pass the critical point which may be a curb-stone, a drain or a parked vehicle.

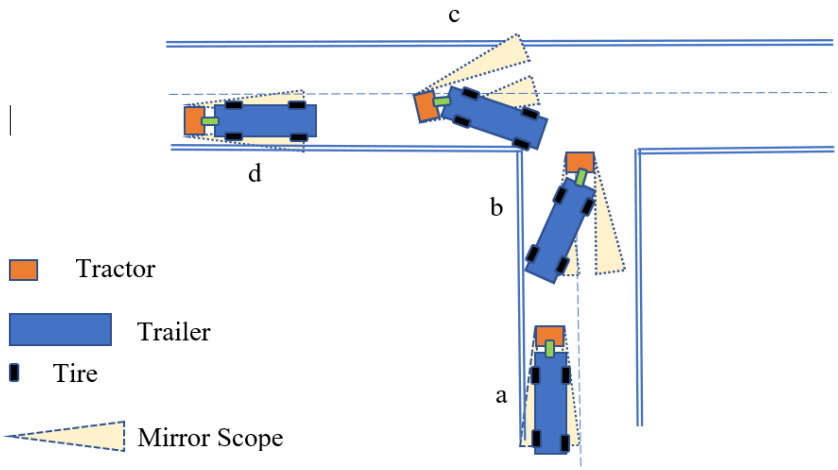

Figure 1: Tractor-Trailer Turning a Corner

A common problem faced by the driver is the field of vision provided by the side mirrors do not cover the required area during sharp turning. The is because the side-view mirrors are permanently fixed to the side of the tractor's driving cockpit beside the wind screen. This is alright during straight ahead driving as shown in position *a* and *d* in *Figure 1*. However, during a sharp left-turning as depicted in position *b* and *c*, the left mirror gives a view of the middle or front part of the trailer while the right mirror provides a totally irrelevant view.

This problem existed for decades but drivers of these long tractor-trailer today still face the problem.

2. PRESENT SOLUTIONS

Since this simple problem existed for decades, one can expect a solution, at least a partial one, to be already in place for it. There are, indeed, a few and are discussed below.

2.1 Driver Assistant

Employ a human to assist the driver particularly during sharp left-turning. This person have to look out the window to watch the critical point for the driver. This solution introduces high extra cost because the assistant is idle most of the time and it is dangerous for him to put his head outside the window. Not useful when doing right-turning (assuming driver side is on the right).

2.2 Multiple Mirrors

This is the adopted solution in most cases [2,3]. There are several variations as briefly described below.

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2.2.1 Fixed Double-Angle Mirrors

An additional mirror, usually a smaller one, is fixed to the side mirror at a wider angle as shown in *Figure 2*, so that, during a sharp left-turning, Reflection 2 can cover the critical point [2].

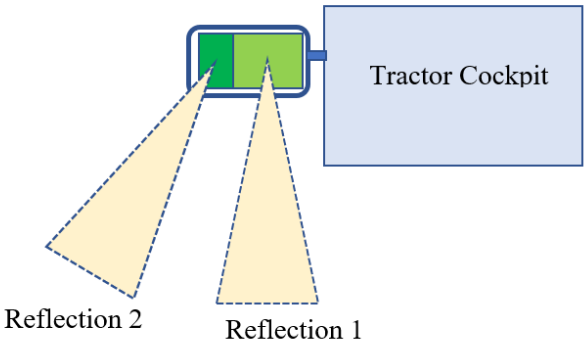

Figure 2: Fixed double-angle mirror

2.2.2 Fixed Second-Angle Mirror

This is actually similar to the first type described above. By separating the two mirrors as shown in *Figure 3*, the driver has a larger field of vision [3]. Most importantly, it reduces the confusion the driver might have as to which mirror to look at while turning.

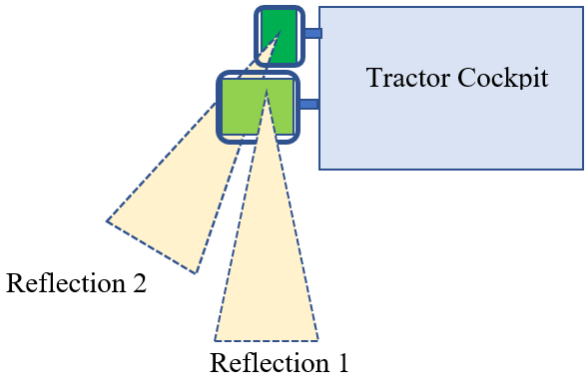

Figure 3: Fixed second mirror

2.2.3 Extendable/Retractable Mirror

When needed, the electrically controlled side mirror can be extended to provide a different vision scope shown in *Figure 4* as Reflection 2. It can be retracted for a normal scope of vision by simply pressing a button. The problem is, when turning a corner, the long tractor-trailer driver should have both hands on the steering wheel at all time and not busying himself pressing buttons.

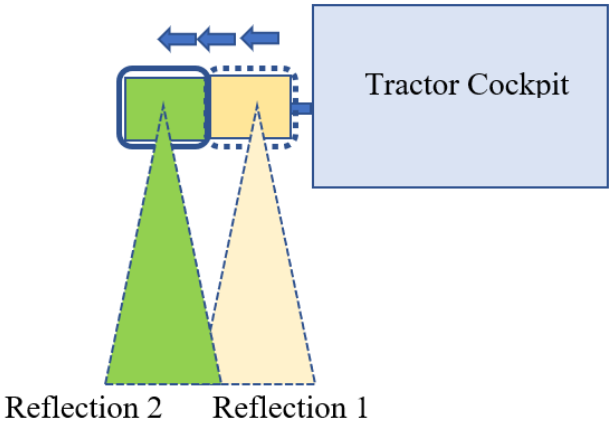

Figure 4: Extendable/Retractable Mirrors

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2.2.4 Adding Convex Mirror

A small convex mirror can be added to the existing side-view mirror, as shown in *Figure 5*, to provide a wider scope of vision that include the critical point. However, the small size of the convex mirror is difficult for the driver to comfortably use for this purpose.

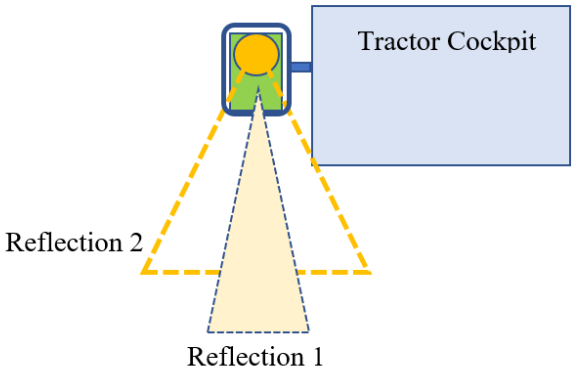

Figure 5: Adding Convex Mirror

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3. PROPOSED SOLUTION

Imagine that if the driver of the long tractor-trailer has an extra very long hand which he can use to adjust the left side-view mirror to cover the critical point while the other two normal hands turn the steering wheel during cornering, then this simple problem is solved easily. But we know that ni driver has a third very long hand. However, if we can make the side-view mirror adjust itself continuously to cover the critical point as the driver make the turning, and then back to its original position once the cornering is done, this is even better than giving the driver a third hand. This is achieved through the use of Electric Self-Adjusting Side-View Mirror.

4. ELECTRIC POWER STEERING

In the first generation of power steering called Hydraulic Power Steering (HPS), an engine accessory belt is used to drive a hydraulic pump providing pressurized fluid that operates a piston in the power steering gear to assist the driver in steering the vehicle with less effort [6]. Years later, there emerged systems that incorporated electronic control known as Electric-Hydraulic Power Steering (EHPS) or Electric Power-Assisted Steering (EPAS). Such systems use an electric motor to drive a high-efficiency hydraulic pump which speed is regulated by an electric controller to vary pump pressure and flow thus providing steering effort tailored for different driving situations. For instance, during highway cruising when steering assistance is not needed, the pump is run at very low speed or even completely shut off for energy saving. On the other hand, when the speed of the vehicle decreases especially during parking maneuver, the electric motor provides essential directional control to give more assistant to the driver [4].

Electric Power Steering (EPS), as its name implies, completely eliminates the hydraulic fluid pump portion and uses an electric motor directly attached to the steering rack via a gear mechanism. Sensor measurements of vehicle speed, steering direction, wheel torque, angular position and turning rate are used to compute steering dynamics and driver effort by an on-board microprocessor [4]. Besides better steering control, compact in size and light in weight, EPS also provides fuel savings and higher capability for integration which is the subject of this paper.

5. BASIC CONSTRUCTION AND OPERATION OF ELECTRIC POWER STEERING

Figure 6 shows the basic construction of an EPS. The steering sensor (SS) which is actually consists of two sensors in one, the torque sensor and the rotation sensor, determine the magnitude and direction of the turning of the steering wheel and feed the information to the Power Steering Control Module (PSCM). The microprocessor in the PSCM uses this voltage signals together with the signal that indicates vehicle speed sent from the Engine Control Module (ECM) to calculate how much power assist to the steering wheel is required before sending a command signal to the Power Unit (PU). Upon receiving the command, the PU supplies the EPS motor with the right amount of current in the appropriate direction. Increasing the current increases the power assist while reversing the current flow reverses the motor's spin direction. A feedback signal from the EPS motor to the PSCM is required in order to protect both units from thermal damage due to control overload [5,6].

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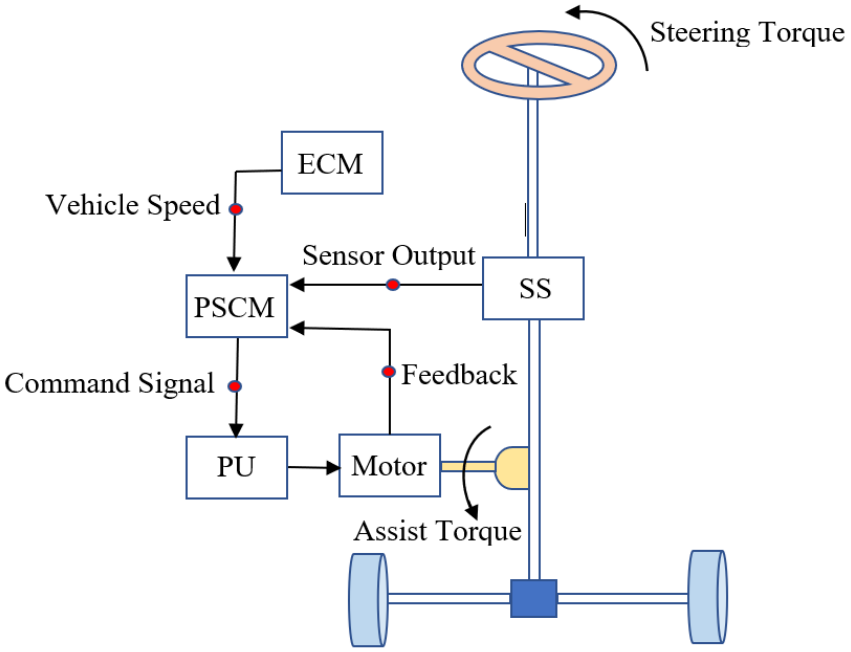

Figure 6: Basic construction of an EPS

6. INTERFACE BETWEEN THE ELECTRIC POWER STEERING AND THE PROPOSED ELECTRIC SELF-ADJUSTING SIDE-VIEW MIRROR.

Figure 7 shows the Electric Self-Adjusted Side-View Mirror and the EPS module. The ESA-SVM is attached to a dc servomotor fixed permanently at the two locations where SVM are normally fixed for long tractor-trailers, i,e, upper left and right corners, one each, of the wind screen. The command signal from the PSCM to the PU, after been appropriately conditioned by the signal conditioner SC, can be used to drive the servomotor to rotate the ESA-SVM clockwise or counter-clockwise so that the scope of vision from the mirror's reflection is fixed on the critical point no matter how much the steering wheel is turned as depicted in Figure 8.

A switch can be added to the circuit to return the ESA-SVM to initial position and cut off power supply to the servomotor when the tractor is not pulling the long trailer.

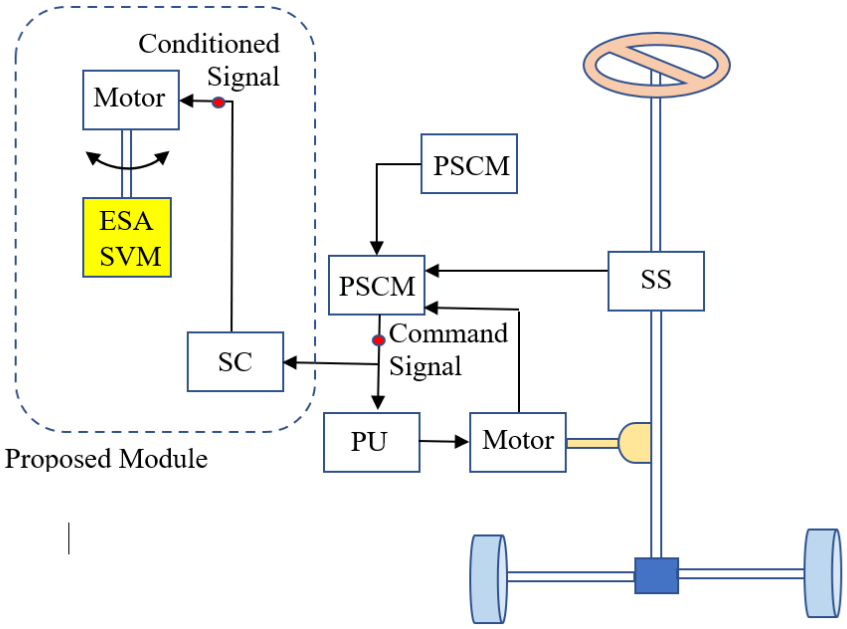

Figure 7: EPA-ESA Side-View Mirror Interface

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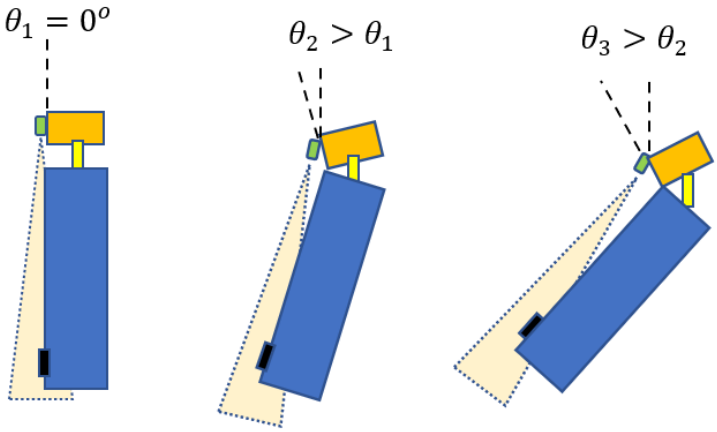

Figure 8: Fixed scope of reflection as the long tractor-trailer turns

7. ALTERNATIVE SOLUTION

We may put a sensor that measure the alignment of the tractor and the trailer, which is the angle in Figure 9, and convert that angle measurement to electrical signal and use it to command the servomotor to achieve the same purpose. However, this requires the installation of an extra piece of hardware, namely the angular sensor, at or near a heavy moving part, and the conversion and calibration of one unit (angular) to another unit (electrical). Extra part translate to extra cost and the conversion usually introduces error. In addition, the angular sensor needs regular calibration dur to the constant vibration of the travelling vehicle. Thus, this method is not desirable compared to the proposed method.

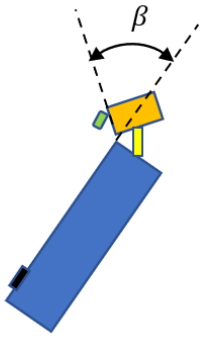

Figure 9: Alignment angle between tractor and trailer

8. CONCLUSION

By using the proposed Electric Self-Adjusted Side-View Mirror which can rotate itself automatically so that the scope of reflection is fixed on the critical point, the long-standing problem of inappropriate coverage of side-view mirror's reflection for long tractor-trailer during sharp turning is easily solved.

This method is simple, utilizing only minimal hardware interfacing with existing Electric Power Steering system and can be enabled/disabled with the press of a button.

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