Control Method of Power Seat Motor for Comfort of Automobile Driver

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***Abstract*—Automobile seats must provide comfort to drivers and passengers while driving. Drivers should feel comfortable with the seat that has the smooth motion. This can be acquired through the control of seat motor. In this paper, a control method profiling start and stop current is proposed. The soft-start current profile is achieved by increasing the voltage to the motor. With the soft-start current profile, the slow-start motion is possible. The experimental test shows that the proposed control method reduced the reflection sound pressure by 14.3% and the shock acceleration by 85.7%, respectively.**

Keywords-control; power seat; automobile; soft-start; soft-stop; current profile.

I. INTRODUCTION

The seat of an automobile must support the comfort to the driver and passenger while driving. The control method of the seat position is changed from manual type to power type, which means using the motor to increase the comfort of the driver as proposed by Lahiry [1] and Kovener [2]. Lahiry and Kovener used the motor to move the seat from one position to the other position. The seat using the motor is called power seat and that is classified as two-way or four-way power seat according to a number of control direction. By using the motor, several problems, such as vibration, noise, and overcurrent, appear. Researches for the evaluation of these problems are conducted. Cho [3] visualized the automotive power seat slide motor noise, Han [4] suggested the method for automatic measurement of noise and vibration for power seat DC motor in the vehicle, and Seo [5] evaluated the vibration and sound quality according to battery voltage change while moving a power seat in an automobile forward or backward. Those researches suggested the method for measurement and analysis of the noise and vibration generated by the power seat DC motor, which is controlled by step voltage to move the seat. In this study, the method for suppression of the noise and vibration is proposed. The driver should feel comfortable with the seat that has smooth motion, which can be achieved through the proposed method.

In Section II, configuration of the power seat is presented. Then, the control method of the motor for generation of the current profile, such as soft-start and soft-stop, is proposed in Section III. DC motor driver having the proposed control function is developed and experimental test is conducted with the DC motor and the power seat in Section IV.

II. CONFIGURATION OF POWER SEAT

The power seat is classified as two-way power seat or four-way power seat according to the number of control direction. The power seat consists of seat body, motor, motor driver, and actuating mechanism. The motor used in the power seat is classified as recline motor conducting the rotating function of seat back, tilt motor conducting the tilting function of seat base, slide motor conducting the moving function of seat base horizontally, and height motor conducting the moving function of seat base vertically according to function as shown in Figure 1. The DC motor, having properties such as high starting torque, good output efficiency for input current, and easy rotating control, is used for the power seat. The motor driver adopts the electric driving type using the electric switching device.

III. CONTROL METHOD

The driver should feel comfortable with the seat that has smooth motion, which can be acquired through DC motor control having soft-start and soft-stop current profile as shown in Figure 2. In this figure, current profile by proposed control method is smooth compared to current profile due to step input voltage. By the adoption of soft-start and soft-stop current profile to DC motor control, the power seat can be moved smoothly.

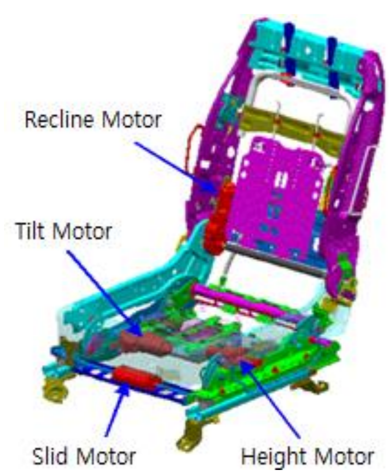

Figure 1. Configuratin of power seat having recline motor, tilt motor, slide motor, and height motor.

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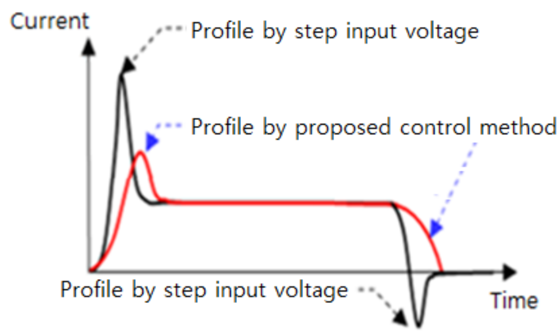

Figure 2. DC motor control method having soft-start and soft-stop current profile.

The soft-start current profile can be achieved by increasing the voltage applied to the DC motor as shown in Figure 3. The shape of the soft-start current profile can be controlled according to increasing time (Ti), which is changed according to the friction force of guide rail in the power seat. The control block diagram of DC motor driver, which is using the electric switching device, is shown in Figure 4. The gate signal is generated by controller according to current flowing to the DC motor. The soft-start current profile is controlled by the gate signal. The increasing time (Ti) for soft-start and decreasing time (Td) for soft-stop can be controlled in the microprocessor.

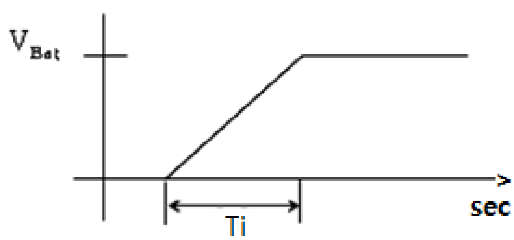

Figure 3. Applying voltage to DC motor for the generation of the soft-start current profile.

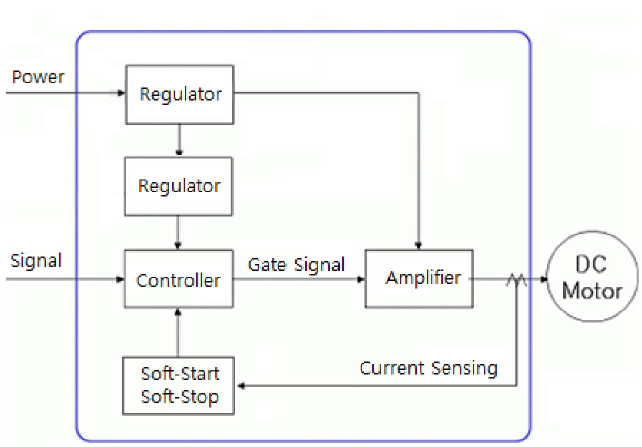

Figure 4. Control block diagram of DC motor driver.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

DC motor driver having functions shown in Figure 4 is developed as shown in Figure 5. The developed motor driver circuit consisted of control circuit for control of motor by microprocessor and power circuit for generating the current. Figure 6 shows the experimental setup for the performance test of developed DC motor driver. In this setup, power supply, current probe, and digital oscilloscope are used to measure the driving voltage, current, soft-start time, and soft-stop time.

Figure 7 (a) shows the measured motor current profile without control of voltage to DC motor in case of motor start. The seat has the sudden-start motion through the current profile shown in Figure 7 (a). The driver may feel discomfort from the sudden-start motion of the seat. Figure 7 (b) shows the measured motor current profile with control of voltage to DC motor in case of motor start. The soft-start time is measured as 0.226sec, and this time can be controlled in the microprocessor. The seat has the slow-start motion through the current profile shown in Figure 7 (b). The driver may feel comfort from the slow-start motion of the seat. Figure 8 shows the measured motor control signal and current profile generated by the developed motor driver in case of soft-start and soft-stop.

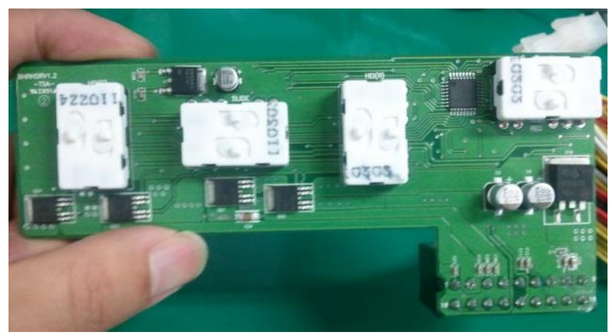

Figure 5. Developed DC motor driver having the functions of soft-start and soft-stop.

Figure 6. Experimental setup for the performance test of developed DC motor driver.

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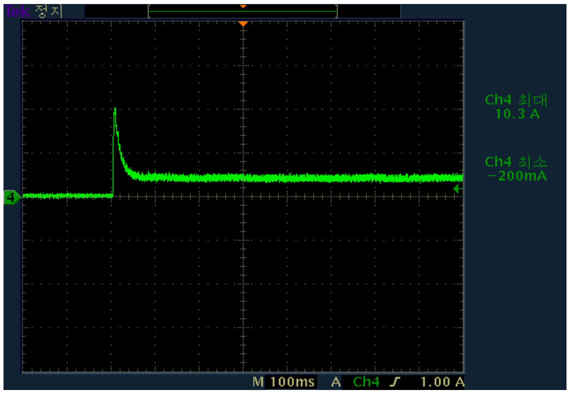
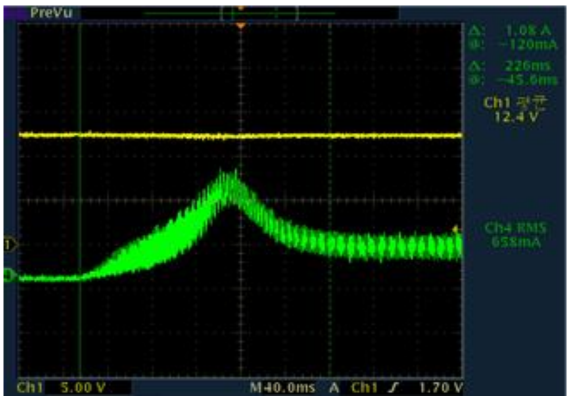


(a)



(b)

Figure 7. Measured motor current profile (a) without control of voltage and (b) with control of voltage to DC motor.

Figure 8. Measured motor control signal and current profile generated by control of voltage to DC motor with the developed motor driver.

Table I lists the performance of the developed motor driver. The soft-start and stop-time can be controlled from 0.02sec to 2sec. This time duration is determined according to properties such as friction force between guide rail of seat.

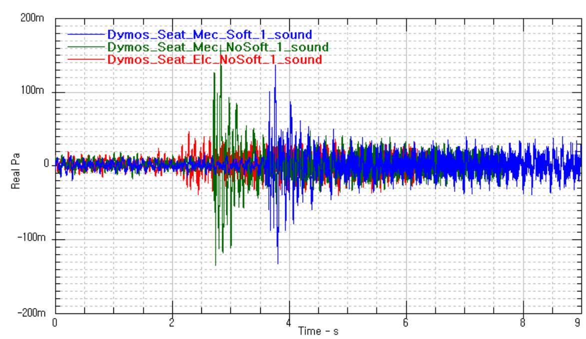
Figure 9 shows the experimental setup for the performance test of seat motion by applying the proposed control method in the dead sound chamber. Pressure meter is used to measure the reflection sound pressure and the accelerometer is used to measure the shock acceleration.

Figure 10 shows the measured reflection sound pressure and shock acceleration according to the absence and presence of soft-start and soft-stop control method.

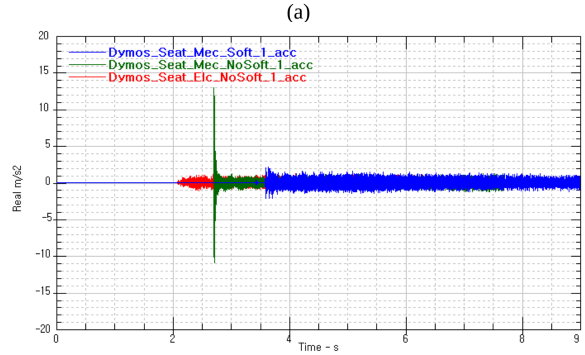
TABLE I. PERFORMANCE OF DEVELOPED DC MOTOR DRIVER

Parameter	Value	Unit
Driving voltage	6-24	V
Driving current	20	A
Soft start time	0.02-2	sec
Soft stop time	0.02-2	sec

Figure 9. Experimental setup for the performance test of seat motion by applying the proposed control method in the dead sound chamber.



(a)



(b)

Figure 10. Measured (a) reflection sound pressure and (b) shock acceleration.

In Figure 10 (a), the reflection sound pressure of non-controlled motor is 160mPa and the reflection sound pressure of controlled motor is 140mPa. In Figure 10 (b), the shock acceleration of non-controlled motor is 14m/sec^2 and the shock acceleration of controlled motor is 2m/sec^2. From the verification test, the reflection sound pressure is reduced by 14.3% and the shock acceleration is reduced by 85.7% by applying the proposed control method.

V. CONCLUSIONS

In this paper, the control method of the motor for the generation of current profile, such as soft-start and soft-stop, is proposed. The soft-start and soft-stop current profiles are achieved through the voltage control applied to the DC motor. DC motor driver is developed, and experimental test using the developed motor driver is conducted to verify the proposed control method. From the verification test, the reflection sound pressure is reduced by 14.3% and the shock acceleration is reduced by 85.7% by applying the proposed control method. From the study, we expect that the driver can experience comfort upon applying the proposed control method.

In the future, we will evaluate the comfort level of drivers, when the control method is applied to an automobile.

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