

Operability Enhancement of Steering Wheel Switch for Audio Remote Control

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ABSTRACT

A steering wheel switch for audio remote control with a new shape has been developed with the aim of enhancing operability of the switches and addressing issues related to advancing functions of the on-board equipment in the new model CIVIC. The switch operation time and the magnitude of the effect on steering while driving were measured, and a comparison made with the former switch confirmed the operability of the new model switch. The effect on steering while driving was reduced, and the operating load of the new model switch is lower than that of the former switch.

1. Introduction

The functions of equipment installed on-board automobiles have been increasing rapidly in recent years, resulting in an increase in the number of switches that control operations. The question of how to make the kinds of switches that control these functions easier to operate has recently been a common issue in the development of automotive on-board equipment.

The new model CIVIC has introduced a new multi-information display (MID) that allows the driver to select display information from a variety of different kinds of information so as to make use of multiple functions. In order to operate the MID, a steering wheel switch for audio remote control was developed that included the previous audio remote control function with information display switching. The operability of the switch that makes it possible to operate it without looking was sought to enhance the operability of this operating switch during driving by focusing in particular on the human tactile capability and conveying the different operations to the driver by distinguishable shapes. This paper reports on the design concept and operability evaluation of the new switch.

2. Design Concept

In the course of this development, three aims were pursued in order to achieve momentary cognition and intuitive operation, which are the concept for Honda

interfaces: (1) Heightened operability during driving (allows for momentary operation of the switch and has little impact on driving); (2) keeps misoperation of audio devices down to a minimum; and (3) allows switch operation without confusion, even by users of previous systems.

2.1. Basic Structure and Target Requirements

The operating switch for the audio remote control has conventionally featured with three functions on the steering wheel: (1) volume adjustment, (2) changing channel/track, and (3) audio source switching. In order to help prevent confusion for users of previous systems, it was necessary to provide the new CIVIC with the same equipment. The ordinary switch configuration would allocate these three functions to three switches on the middle part of the steering wheel (Fig. 1(a)). The points to be considered when designing these switches are that they have little impact on driving operations with a shorter operation time and that misoperation of the switches is limited, while maintaining a similar form with conventional equipment.

It is important to place these switches at locations on the steering wheel where the fingers can reach them easily in order to shorten the operation time. When placing the switches, if they are located too close, then they will impinge on the steering wheel grip. This will not only have an impact on steering operation, it will also introduce the likelihood that the driver will press a switch inadvertently while steering. In this case, it becomes necessary to install a guard near the switch or use some other such means to help

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keep the switch from being pressed mistakenly.

Clustering the individual switches together in one location can also be effective in shortening the operation time. However, this also introduces the likelihood that adjacent switches could be pressed at the same time, so it necessitates measures to prevent mistaken switch operation. The individual switches are ordinarily placed apart from each other, or separator ribs are placed between or near the switches to help keep them from being pressed mistakenly.

These methods of trying to help prevent misoperation will to some extent interfere with the range of switch operation from searching for the switch to pressing it, thus inviting some reduction in operability. Consequently, these measures to shorten the operation time and measures to help prevent misoperation are ordinarily in a trade-off relationship. The new model switch achieves a shorter operation time than previous switches while having a shape that also acts to help prevent misoperation.

Figure 1 shows enlarged images of the former and new model switches. The new model switch is placed so as to

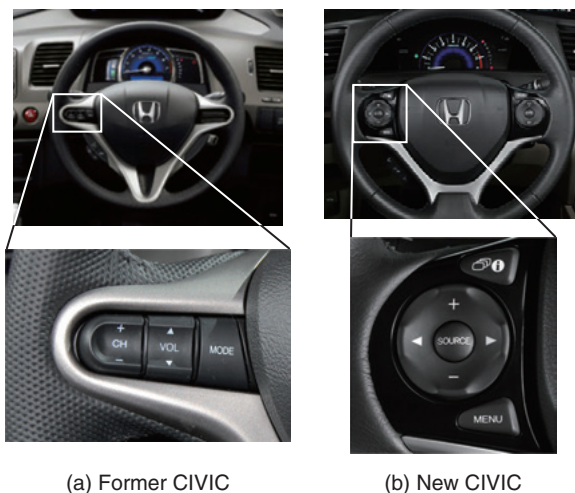


Fig. 1 Images of steering switch

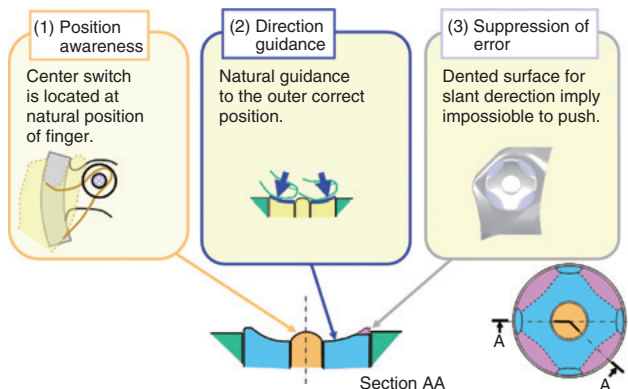


Fig. 2 Ergonomic design of new switch

be naturally at the center of the thumb's location when the steering wheel is held horizontally (in a neutral position), and the switch is given a spherical shape. This makes the center of the whole switch (the home position) clearly identifiable even without looking (Fig. 2(1)).

Of the switches at top and bottom and on the left and right sides, the top and bottom are for volume and the left and right are for channel/track selection. This layout makes it possible to readily determine the function by changing the movement of operation from the center to top-and-bottom or left-and-right. Moving from the center toward the periphery, the switch surface rises up higher. When the switch is pressed, therefore, the load naturally tends to be directed toward the periphery so that operability is enhanced while the likelihood of misoperation from pressing the center of the switch is limited (Fig. 2(2)).

It is a feature of the switch that the protrusion of the surface in the four directions and the depression in diagonal directions make it possible to distinguish momentarily by the tactile sense of the thumb placed on the switch in which directions the switch can be pressed and which directions it cannot (Fig. 2(3)). The way the switch shape is devised also made it possible to reduce the overall size of the switch and minimize impact on the steering grip shape.

3. Operation Time Measurement Method using Driving Simulator

In order to perform accurate measurements of the switch operation time that indicate operability performance, switch operation testing on a driving simulator that models the driving environment was utilized as the main performance measurement method.

Figure 3 shows the driving simulator used for these tests. It has a driver's seat installed indoors with a screen that shows a 180° field of view of driving scenes. It provides the test subject with simulated reaction force from the steering wheel and brakes.

Measurement of switch operation time while driving was done by the so-called dual-task technique⁽¹⁾ because driving tasks and switch operation tasks are constantly performed in an overlapping manner. Measurement by the dual-task technique takes the secondary task (in this case, the driving operation) to be an interference load with respect



Fig. 3 Image of driving simulator

to the main task (the switch operation), so that the balance of loads becomes important. If the two are not in balance, then the secondary task ceases to function as an interference task with respect to the main task, with the result that measurement cannot be considered dual-task technique measurement. Driving in a driving simulator generally tends to be taken as imposing a somewhat lighter driving load compared to actual driving because the driver receives a smaller amount of information. In dual-task designs with tasks involving essentially small operation loads, such as the operation of steering wheel switches, overcoming this kind of characteristic of the driving simulator becomes an issue. For the present research, the driving environment was configured to increase the driving load on the driving simulator so as to approximate the load of actual driving more closely by even a small margin. Specifically, the simulation was configured with the task of following a vehicle to the front, and the driver is given instructions such as to maintain a fixed distance from the vehicle in front.

While driving over the set course, the driver is given voice instructions once every six seconds to perform a random selection from five different tasks (raising volume, lowering volume, selecting next channel/track, selecting previous channel/track, switching sound source). The operation is initiated on hearing a buzzer that is sounded one second after the voice instruction, so that the time taken in hearing the voice instructions will not be included in the operation time. The time up until the designated switch was pressed was measured as the operation time. Single test subjects performed approximately 45 switch operations, the average of which was taken as the operation time.

4. Test Results for Former and Developed Steering Switches

In order to confirm the operation time reduction effect of the developed switch, a comparison of operation time for the same task between the former and developed switches was made. Figure 4 shows the measurement results. Wilcoxon signed-rank test⁽²⁾ results show that operation time was shortened approximately 0.15 sec, with 5% significance.

As concerns the influence on driving while operating the switch, the mean rate of variation in steering angle after operating the switch was taken as an index for the smoothness of steering operation and former and developed switches were compared. Figure 5 shows the comparison result of former and developed switches in terms of the mean rate of variation in steering angle while operating the switches. It is considered that, following the former switch operation, the drivers repeatedly perform sudden, minute steering corrections in brief periods of time to compensate for their departure from the intended running trajectory. In the case of the developed switch, on the other hand, the value goes down, indicating smoother steering operations are conducted.

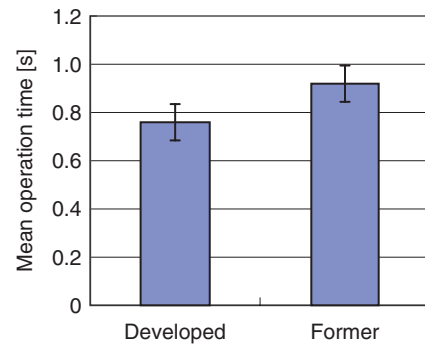


Fig. 4 Measurement result of mean operation time

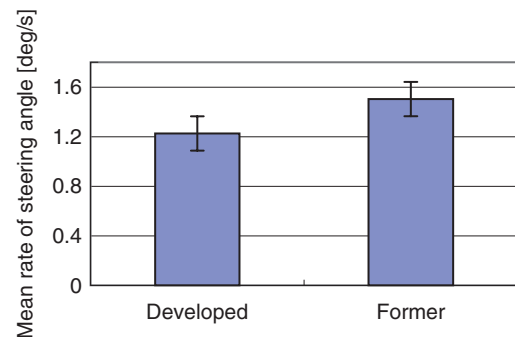


Fig. 5 Example of variation of steering angle

5. Conclusion

A switch shape that enables momentary cognition using the tactile sense of the thumb and switch operation directions that achieve intuitive operation with a high functional distinguishability were used in enhancing the operability of steering wheel remote switches by designing a steering wheel switch with a new structure capable of shortening the operation time. This was confirmed to produce a reduction in the operation time by comparison with the former switch.

There are various different perspectives on the enhancement of automotive Human Machine Interface (HMI). In addition to operability while driving, there are the issues of ease of comprehending the switch when operating it for the first time, the layout that enables operation without confusion among multiple functions, and marking methods that indicate function content in an easily readable manner. Comprehensive enhancement of all these is necessary. The author hopes to proceed with HMI development by using human characteristics effectively in devising combinations of methods at multiple levels to reduce cognition and operation load and resolving these issues in an HMI that can be understood more intuitively and operated more instantaneously.

References

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