

# Characteristics of Touch Panel Operation with Non-Dominant Hand in Car Driving Context

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**Abstract.** The aim of this study is to examine the differences of operability between dominant hand and non-dominant hand in car driving context, especially in operating of touch screen of car navigation system. For the operation of touch screen of car navigation system during car driving, the primary task is of course car driving, and the secondary task is the operation of the touch screen for a car navigation system. In this study, we drove 2 kinds of experiments; the 1st experiment was to investigate the basic usage for touch screen, and the 2nd experiment was to examine the characteristics under dual tasks; the primary and the secondary tasks. As a result, in case of single task, we could find significant differences between with dominant hand and with non-dominant hand. On the other hand, in case of dual task, we could not find significant differences so much, but only when the secondary task was not so complicated we could find statistical difference between dominant hand and non-dominant hand.

**Keywords:** car navigation system, dominant hand, non-dominant hand, operability, haptic, tactile, car driving context.

## 1 Introduction

Touch screen operation can be roughly divided into 2 kinds; those are tactile and haptic. In touch screen operation context, the word “tactile” indicates to touch the screen, and “haptic” indicates to trace the screen slipping the finger on it. Tactile can be divided into further 2 kinds, tap and double tap. On the other hand, haptic can be divided into further 5 kinds, drag, flick, pinch, pinch in and pinch out (Table 1). Especially “haptic” is new operation concept for recent years when smartphone, tablet PC, and etc. have been so common. That’s because until then operations like haptic had not been existed yet for switch or button operation. Since haptic enables more intuitive operation, tools or devices with this type of operation has been increasingly widespread. For example using iPad, we can turn a page or scroll a screen as if we turn a page of a book.

By the way, in car driving context, there are some situations in which we operate a car navigation system. Though we cannot operate the motor company original car navigation system during driving by locking mechanism, Japan Automobile Research

Institute predict that in next generation smartphone and tablet PC will be used as an alternatives of current car navigation system. And actually some drivers do even right now in spite of illegal in Japan. The functions of smartphone and tablet PC, as a car navigation system, help to decrease drivers' unsafe behavior. That's because by them drivers cannot lose their way, and can eliminate the anxiety at the location where they do not know well. At the same time, it is pointed out that those could be one cause for the accidents/incidents because the touch screen operation during driving leads to the inattentive driving.

**Table 1.** Characteristics of touch screen operation [1]

Tactile		
T1	Tap	Tapping with fingers
T2	Double Tap	Tapping twice with fingers
Haptic		
H1	Drag	Slide with fingers
H2	Flick	Flick the screen with finger
H3	Pinch	Press with two fingers
H4	Pinch in	Reduction with two fingers
H5	Pinch out	Expansion with two fingers

A car navigation system is usually located at the middle of the dashboard; that means, in Japan, drivers operate it with left hand. Dominant hand of almost 90% of Japanese is right. That means most of Japanese drivers have to operate touch screen with non-dominant hand. Here, one simple question occurs. I wonder if there are no issues on safety. Because the operation with non-dominant hand might prevent the attention for car driving, more than with dominant hand. When using dominant hand, drivers could operate in skill-based behavior. But when using non-dominant hand, drivers cannot move their hand automatically as they want.

The aim of this study is to examine the differences of operability between dominant hand and non-dominant hand in car driving context, especially in operating of touch screen of car navigation system. For the operation of touch screen of car navigation system during car driving, the primary task is of course car driving, and the secondary task is the operation of the touch screen for a car navigation system. In this study, we drove 2 kinds of experiments; the 1st experiment was to investigate the basic usage for touch screen, and the 2nd experiment was to examine the characteristics under dual tasks; the primary and the secondary tasks.

## 2 Experiment

### 2.1 Experiment I

**Summary.** The task for the 1st experiment was set; that is to find the final destination using car navigation system. This task consists of 3 sub-tasks, and includes letters input (tap), scaling (double tap, pinch in and pinch out). The 1st sub-task was to input the place name of the final destination shown as figure 1. The 2nd sub-task was scaling using double tap. The default screen showed the whole Japan at first. Next, a subject expands the scale of the map until the subject has been able to find the building of the final destination, with a method of double tap (figure 2). The 3rd sub-task was also scaling but using a method of pinch-in and pinch-out. The procedure was the same as the 2nd sub-task; the default screen showed the whole Japan at first. Next, a subject expands the scale of the map until the subject have be able to find the building of the final destination, with a method of pinch-in and pinch-out (figure 3).

In each sub-task, required time and ratings of the questionnaires related to their operability were acquired as evaluation indexes. Each participant did each sub-task with each hand. This experiment was carried using iPad-mini (7.9" tablet PC). 20 male students who are between 18 yrs. and 24 yrs. (mean=21.8 yrs., SD=1.5 yrs.) were cooperated as participants. Dominant hand of all the participants was right. To check their dominant hand, all the participants took Chapman-Test [2].



Fig. 1. Input the place name (Tap)



Fig. 2. Double Tap



Fig. 3. Pinch In/Out

**Result and Discussion.** Figure 4 shows the result of required time for each sub-task, with each hand. For sub-task 1, significant differences were found between each hand ( $p < 0.05$ ). This result shows that to input characters needs more dexterity than double tap or pinch-in/out. In other words, for double tap and pinch-in/out, there are no significant differences for task efficiency (required time) between dominant hand and non-dominant hand.

In every figure, light gray shows the result of dominant hand, dark gray shows the result of non-dominant hand.

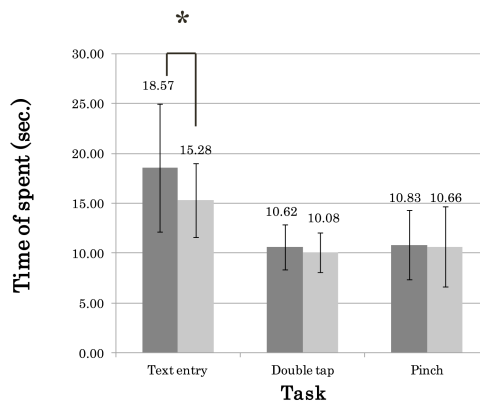
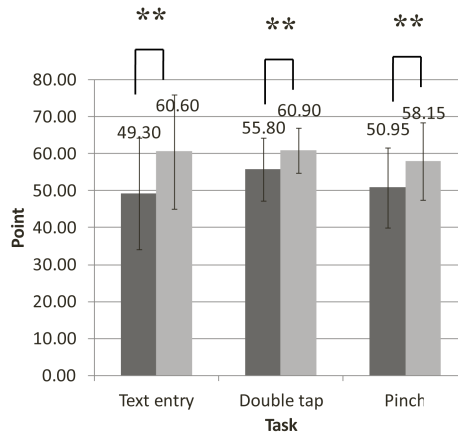


Fig. 4. Result of Required Time (light: dominant hand, dark: non-dominant hand)

Figure 5 shows the result of questionnaires for operability. The points shown in figure 5 mean the sum of the points of each question. That means; if the points show higher, it means more comfortable to operate. In each sub-task, we could find the significant differences between dominant hand and non-dominant hand ( $p < 0.01$ ). It's matter of course, when we operate touch screen with non-dominant hand, we would not feel comfort operability.



**Fig. 5.** Result (Points) of Questionnaire (light: dominant hand, dark: non-dominant hand)

## 2.2 Experiment II

**Summary.** We set the task introduced in Experiment I, as a secondary task. In addition, we have set a lane-keep task using driving simulator as a primary task. We used a racing-simulator game named Gran Turismo 4 of Sony Play Station 2 as the driving simulator. Each participant was demanded to keep 80kmh and to keep the lane of the oval course.



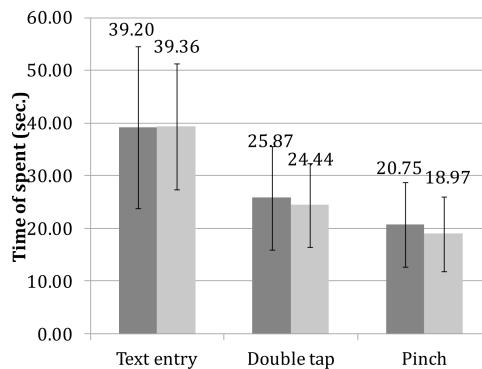
**Fig. 6.** Experiment II

42" liquid display was set in front of the participant. The distance between them was 200 cm. A participant sat on a driving seat with gas and brake pedal, and also the instrument panel and steering were set in front of the participant. Next to the steering, iPad as a car navigation was set on both side. Depending on the experiment condition, a participant had used either of the iPad. And next to iPad, a stimulus light was set. These are shown as figure 6. 20 male students who are between 21 yrs. and 24 yrs. (mean=21.95 yrs., SD=1.43 yrs.) were cooperated as participants. Dominant hand of all the participants was right. To check their dominant hand, all the participants took

Chapman-Test. All the participants are smartphone users, and have a driving license and drive a car with right hand drive.

We acquired the number of the errors (derailing), and the response time for the stimulus light as evaluation indexes for the primary task, and also acquired required time and ratings of questionnaires related to their operability as indexes for each secondary task. These are basically the same as of experiment I.

**Result and Discussion.** Figure 7 shows the result of required time for each sub-task, with each hand. There are no significant differences between dominant hand and non-dominant hand. By only the kinds of tasks, required time was changed. Input characters needs more time than double tap and pinch, and pinch needs less time than other tasks. These show, in dual task, there are not significant influences to operate touch screen with either one; dominant hand or non-dominant hand. It could be said that the difficulty of the secondary task gave some influence to the drivers.

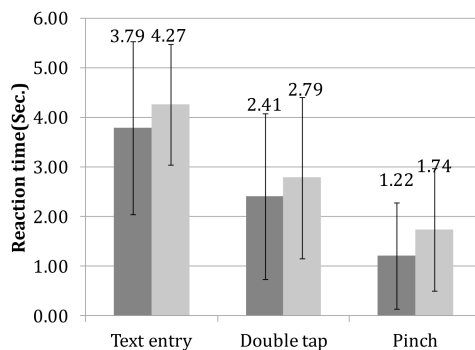


**Fig. 7.** Result of Required Time (light: dominant hand, dark: non-dominant hand)

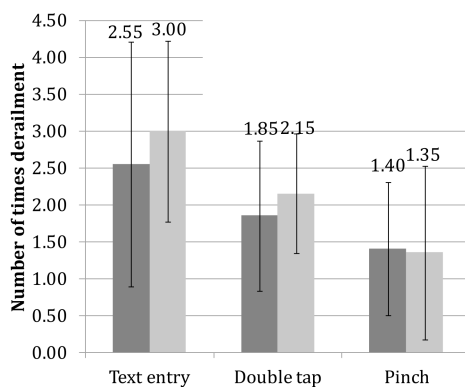
Figure 8 shows the result of response time for stimulus light. Figure 9 shows the number of derailing. It could be said that both results show almost the same result as the result of required time. So we can have almost the same discussion as the above.

But on response time, we could find the significant difference in case of pinch-in/out as a secondary task. It is quite interesting that there is a significant difference when a driver's workload is less than other secondary tasks. This could be said; there are some influences of dominant hand, when the secondary task is quite simple. In other words, the effect of the dominant hand is reduced when the secondary task become more complicated to some degree.

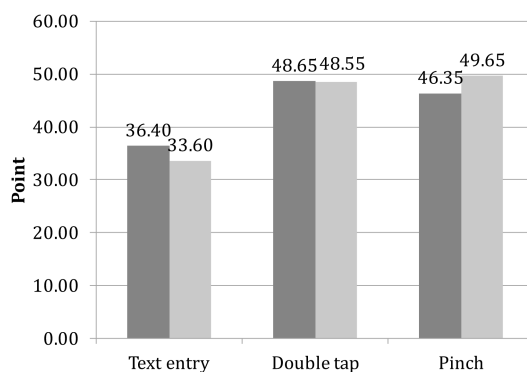
Figure 10 shows the result of questionnaires for operability. The points shown in figure 10 mean the sum of the points of each question. That means; if the points show higher, it means more comfortable to operate. It could be said that also this result showed almost the same result as the result of required time. There are no significant relation between dominant hand and non-dominant hand, and the degrees of operability are depended on the complexity of the task. So we can have almost the same discussion as the above.



**Fig. 8.** Reaction Time for Stimulus Light (light: dominant hand, dark: non-dominant hand)



**Fig. 9.** Number of Times of Derailing (light: dominant hand, dark: non-dominant hand)



**Fig. 10.** Result (Points) of Questionnaire (light: dominant hand, dark: non-dominant hand)

### 3 Conclusion

The aim of this study is to examine the differences of operability between dominant hand and non-dominant hand in car driving context, especially in operating of touch screen of car navigation system. For the operation of touch screen of car navigation system during car driving, the primary task is of course car driving, and the secondary task is the operation of the touch screen for a car navigation system. In this study, we drove 2 kinds of experiments; the 1st experiment was to investigate the basic usage for touch screen (under only single task), and the 2nd experiment was to examine the characteristics under dual tasks; the primary and the secondary tasks.

As a result, in case of single task, we could find significant differences between the hands, dominant hand and non-dominant hand. Participants felt less operability when he operated with non-dominant hand. Required time for double tap was more than pinch-in/out, this could be said that pinch-in/out is more simple task than double tap.

On the other hand, in case of dual task, we could not find significant differences so much. Only when the secondary task was not so complicated we could find statistical difference between dominant hand and non-dominant hand. In other words, the influence of dominant hand is reduced when the secondary task become more complicated.

### References

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