

Evaluation of a Functional Film Attached on Top of a Tablet PC

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Abstract. This paper presents usability evaluation of a functional film named PenFit attached on top of a tablet PC. We compared a tablet PC with PenFit and that without PenFit from the viewpoint of the ease of writing. We considered several measures to evaluate the ease of writing. We propose “how people can write letters neatly (neatness)”, “how people can write quickly (speed)” and “how people can write without fatigue (fatigue)” as the measures to evaluate the ease of writing. As a result, it is suggested that the functional film provides the ease of writing.

Keywords: pen interface, functional film, ease of writing, electromyogram.

1 Introduction

A Tablet PC is gradually getting common. The price-down is promoting its wider use in many scenes. However, the surface of LCD integrated tablets has been very hard so that a pen is slippery, people feel hard reaction from the surface, and they feel tired after writing. Although a tablet PC is promising for school children, this strange feeling of writing is not favored by them.

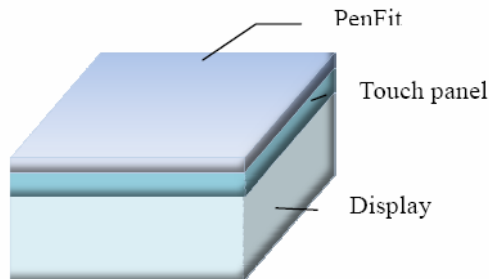


Fig. 1. PenFit on top of writing surface

A functional film is proposed to enhance the ease of writing and provide smooth feeling of writing on a tablet PC. We select the product named PenFit, which has the largest sale, to evaluate whether it realizes the aimed effect.

2 Evaluation Measures

We considered several measures to evaluate the ease of writing. We asked people to write on a tablet PC with PenFit and that without PenFit (naked tablet PC) and evaluated the ease of writing according to these measures.

We propose “how people can write letters neatly (neatness)”, “how people can write quickly (speed)” and “how people can write without fatigue (fatigue)” as the measures to evaluate the ease of writing.

Moreover, for pen interfaces, such as menu selection, pen tap, dragging, and so on, pen operability is also important. On top of that, writing pressure is available from a pen so that we also measure it.

We should measure these factors for people who are familiar with a tablet PC and people who have no experience of using it.

2.1 Neatness

The measure “neatness” is still broad so that we decompose it into 6 factors as follows:

- Control: being able to control a pen just as we want.
- Smoothness: feeling smooth when we write.
- Continuation: being able to move a pen as we write.
- Feedback: feeling proper reaction from the surface.
- Naturalness: feeling natural as if writing on a paper
- Tiredness: feeling tired (distinguished from physical fatigue).

We let subjects to write text at three writing conditions, i.e., “Write it slowly”, “Write it as usual”, and “Write it as fast as possible” on a tablet PC with PenFit and on a naked tablet PC. We don’t tell the subject of using PenFit or not. After the experiment, we let them evaluate the ease of writing.

2.2 Speed

We measure writing speed when the above subjects write text at three writing conditions of “slowly”, “as usual”, and “as fast as possible” on a tablet PC with PenFit and without it.

2.3 Fatigue

We measure the fatigue of the subjects when they use a tablet PC with PenFit and without it. The subjects write text for 60 minutes including 5 minutes break after 30 minutes. We measure electromyogram after 10, 20, 30,45,55 and,65 minutes from the start.

2.4 Pressure

We measure the pressure of a pen to writing surface when the subjects write a tablet PC with PenFit or not.

2.5 Operation

We perform an experiment on pen operations on Windows GUI with a pen using PenFit or not. The operations are “Double tap”, “Pen hold “and “Drag & Drop”.

- Double tap: attaching a pen to the same screen position twice quickly.
- Hold: fixing a pen at the same screen position for some predefined period.
- Drag & Drop: choose an object by putting down a pen, moving (dragging) the pen, and lifting the pen off at a destination.

We count how many times subjects succeed to make each operation.

3 Result

3.1 Neatness

We asked subjects to express their subjective evaluation on control, smoothness, continuation, feedback, naturalness and tiredness into 6 ranks (0 as worst to 5 as best). Fig. 2 to Fig. 4 shows the average at 3 kinds of writing speed.

We performed t-test on the questionnaire result for the 6 measures. Table 1 shows either of writing on PenFit or without it is superior to the other significantly. The mark “-” denotes no significant difference between the two.

Generally speaking, PenFit provides better control, continuation, and feedback but posed drawback in tiredness. This is probably because people feel friction when they write on PenFit while they can run a pen almost without friction on a naked tablet PC. We should recognize that the hard surface of LCD-integrated tablet is different from

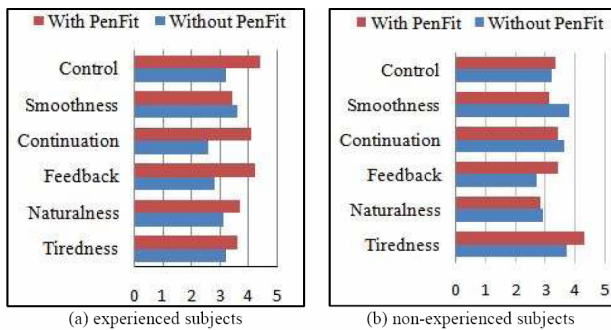


Fig. 2. Neatness when writing slowly

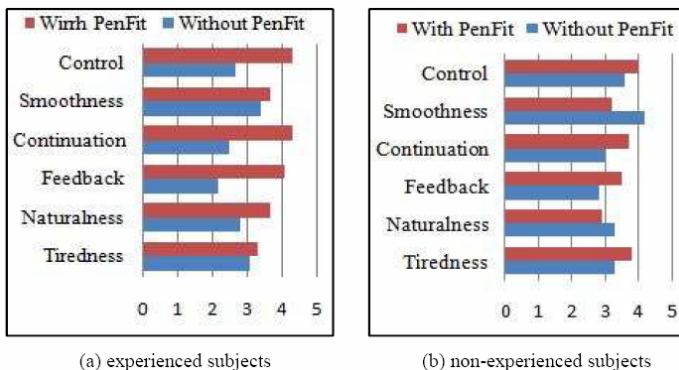


Fig. 3. Neatness when writing as usual

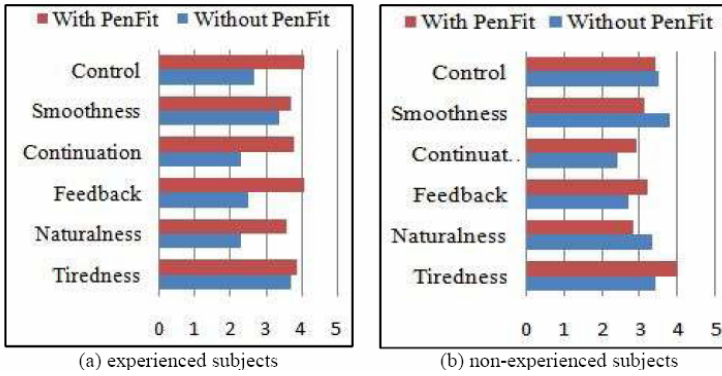


Fig. 4. Neatness when writing as fast as possible

Table 1. Superiority of writing on PenFit or without it

(a) experienced subjects						
measure.	Control.	Smoothness.	Continuation.	Feedback.	Naturalness.	Tiredness.
writing speed.						
slowly.	-	-	-	PenFit	-	Without PenFit
as usual.	PenFit	-	-	-		Without PenFit
as fast as possible	PenFit	-	-	-		Without PenFit
(b) non-experienced subjects						
measure.	Control.	Smoothness.	Continuation.	Feedback.	Naturalness.	Tiredness.
writing speed.						
slowly.	-	-	-	PenFit	-	Without PenFit
as usual.	PenFit	-	-	-		Without PenFit
as fast as possible	PenFit	-	-	-		Without PenFit

real paper and a new writing condition. There remains comparison between PenFit and real paper. If PenFit provides equivalent evaluation in other measures as real paper, we consider the PenFit’s superiority in control, continuation and feedback is important, although it has the drawback in tiredness in comparison to a naked tablet PC.

3.2 Speed

We measured writing speed when the subjects wrote text at three writing speeds on a tablet PC with PenFit and without it. Fig. 5 shows the time spent for writing a certain

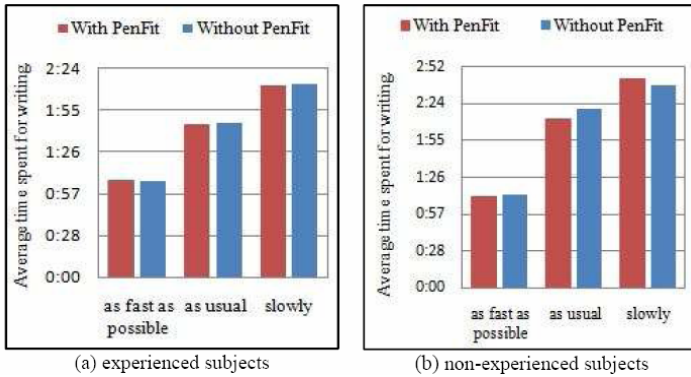


Fig. 5. Average time spent for writing

amount of text (100 characters). Significant difference was observed between experienced and non-experienced subjects and among the three writing speeds but not between writing on PenFit and without it.

3.3 Fatigue

We measured electromyogram of 8 experienced subjects and 8 non-experienced subjects at 10 minute later and 60 minute later after starting writing.

As for the fatigue measure, t-test did not show significant difference between writing on PenFit or not regardless of experience.

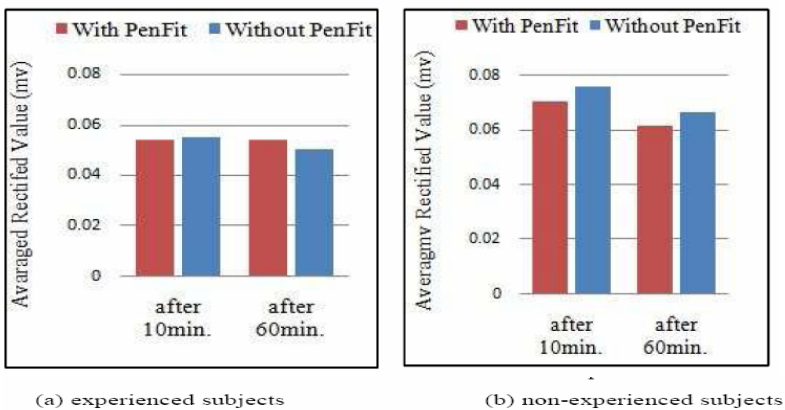


Fig. 6. Averaged Rectified Value

3.4 Pressure

We measured the pressure of a pen to writing surface from 8 experienced subjects and 8 non-experienced subjects when they wrote a tablet PC with PenFit or not. Table 3 shows the average score of the pressure. Pressure score has a 0 ~255 grade.

Table 2. Pressure of a pen to writing surface

(a) experienced subjects.

	<i>PenFit</i>	<i>Without PenFit</i>
<i>experience1</i>	198.02	197.75
<i>experience2</i>	197.24	187.67
<i>experience3</i>	157.49	155.14
<i>experience4</i>	152.55	177.44
<i>experience5</i>	162.20	174.13
<i>experience6</i>	140.43	154.97
<i>experience7</i>	182.96	201.89
<i>experience8</i>	201.54	177.25
<i>Average</i>	174.05	178.28

(b) non-experienced subjects.

	<i>PenFit</i>	<i>Without PenFit</i>
<i>no-experience1</i>	163.73	170.67
<i>no-experience 2</i>	145.76	160.67
<i>no-experience 3</i>	118.20	129.84
<i>no-experience 4</i>	191.15	188.82
<i>no-experience 5</i>	115.20	106.79
<i>no-experience 6</i>	170.38	170.37
<i>no-experience 7</i>	205.57	211.25
<i>no-experience 8</i>	178.29	183.64
<i>Average</i>	161.04	165.26

T-test did not show significant difference between writing on PenFit or not regardless of experience.

3.5 Operation

We performed an experiment on pen operations on Windows GUI with a pen using PenFit or not. We measured success rate of 8 experienced subjects and 8 non-experienced subjects to make each operation. Table 3 shows the rate.

As for the operation of “Double tap”, “Hold”, the average success rates of PenFit are better than without PenFit regardless of experience. However, t-test did not show significant difference between writing on PenFit or not regardless of experience.

As for “Drag & Drop”, the success rates is about 100% regardless of experience.

Table 3. Averaged of success rate of each operation

(a) experienced subjects.

	PenFit	Without PenFit
Double tap	90%	89%
Hold	100%	90%
Drag & Drop	98%	98%

(b) non-experienced subjects.

	PenFit	Without PenFit
Double tap	94%	83%
Hold	97%	91%
Drag & Drop	100%	98%

4 Conclusion

This paper has presented to what extent a functional film named PenFit solves problems of writing on a tablet PC and enhance ease of writing. We have proposed neatness, speed and fatigue as the measures to evaluate the ease of writing. As for the neatness, we have decomposed it into control, smoothness, continuation, feedback, naturalness and tiredness.

Experiments have suggested that PenFit provides better control, continuation, and feedback. As for the tiredness, however, it posed drawback to a naked tablet PC. This is probably because PenFit provide friction. There remains comparison between PenFit and real paper.

As for pen operations, PenFit provides superiority in “Hold” and ”Double tap” while no significant difference in “Drag&Drop” in comparison to a naked tablet PC. Moderate friction provides by PenFit makes careful operations easy and provides better control of a pen.

On the other hand, PenFit provides no significant difference from a naked tablet PC in writing speed, fatigue and pressure.

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