Evaluation Approach for Web Form Usability

Tomomi Nomura and Yasue Mitsukura

Keio University
3-14-1 Hiyoshi, Kohoku-ku, Yokohama, Kanagawa 223-8522, Japan
Phone / FAX: +81-45-566-1718
E-mail: nomura@mitsu.sd.keio.ac.jp, mitsukura@sd.keio.ac.jp

Abstract
In this study, we propose an evaluation approach for web form usability. With the popularization of online activities, a web form is used as a means of intermediation between a company and users. It is a crucial problem to provide a user-friendly web form. Therefore, our aim is to investigate users’ feelings and behavior during the completion of a web form in different ways: a questionnaire, an electroencephalogram (EEG), and eye tracking. Moreover, we quantify and visualize the evaluation results in order to easily understand a large amount of information at a glance. As a result, we were able to extract valuable information for web form usability from several angles. Thus, we have developed an overall evaluation approach in order to clearly comprehend web form usability.

1. Introduction
In recent years, online application procedures have quickly spread with the growth of the Internet. In Japan, approximately 80% of people access the Internet [1]. Therefore, companies have become interested in user-friendly web forms, which have a great influence on company management. For instance, creating a web form with high user satisfaction can bring about an increase in users and greater understanding of users’ needs.

Conventional usability evaluations reflect on the opinions of experts or general users [2]. In addition, eye tracking has become prevalent in usability studies. Eye tracking is a tool for measuring eye movement while a user is looking at a stimulus [3]. These methods provide experts’ and users’ subjective opinions or their unconscious behavior. However, they have a disadvantage that we cannot know users’ latent feelings. In this study, we add an EEG to the above usability evaluation methods, which is the electronic activity measured on the scalp. Recently, EEG-based evaluation methods have received attention because an EEG can reflect the true inner emotions [4]. Therefore, we apply three approaches to the evaluation of web form usability: a questionnaire, EEG measurement, and eye tracking.

By using a variety of data obtained in these three different ways, we quantify and visualize users’ feelings and behavior. This is because those who are involved in creating web forms do not fully know how to handle evaluation results. No matter how many evaluation results a company can acquire, the amount of complex information is too large to properly grasp. This issue could trigger the creation of an inappropriate web form. Hence, it is necessary to present evaluation results that are clearly understandable to everyone. To achieve such a purpose, we visualize the information. Visualization helps users to manage and understand large amounts of information [5]. Visible evaluation results lead to a clear understanding of the web form features and to the extraction of key information required to create a satisfactory web form.

In this study, we evaluate web form usability by using a questionnaire, EEG measurement, and eye tracking. Furthermore, we present easy-to-understand evaluation results at a glance through visualization. Thus, we develop evaluation methods to comprehend web form usability.

2. Experimental Procedure
In order to investigate users’ feelings and behavior during the completion of a web form, we experiment with the use of two biological signals (see Fig. 1).

One is a simple band-type electroencephalograph. In contrast to conventional EEG systems, we can wear the device with ease and with no restriction of the head. Moreover, the only measurement point is the Fp1 point defined by the international 10-20 system (see Fig. 2). This point is located on the left frontal cortex. It is considered that the Fp1 point is closely related to changes in human emotions [6]. Therefore, this simple device is suitable for investigating how a user feels when completing a web form under the same conditions as in everyday use.

The other is an on-screen eye tracker (Tobii T60XL), which reveals what part of a web form the user is looking at. Since this system is contactless, the user feels like he or she is working on a personal computer as usual.

By using the two devices, which make it possible to carry out measurements without burdening users, we conduct experiments. The subjects are four females and two males in their 20s, who are accustomed to operating a personal
Each subject completed ten web forms from Japanese companies (see Table 1), during which EEG measurement and eye tracking were performed. Once they completed a web form, they evaluated it according to five grades (1: hard to complete - 5: easy to complete). Moreover, they commented on the negative aspects of the form. Sufficient rest was allowed after completing each web form.

3. Proposed Method
3.1 Quantification and visualization of users’ feelings and their behavior
We quantified each subject’s feelings and behavior while completing each web form. In this study, three indicators are investigated: psychological, electroencephalographic, and behavioral indicators.

3.1.1 Psychological indicators
The psychological indicators are based on the subject’s five-grade evaluation and negative comments. For each web form, we classify fields that the subject found unpleasant to complete into seven groups: (a) general information (name, date of birth, and gender) and contact information (address and phone number), (b) occupation, (c) housing and family information, (d) bank information, (e) agreement, (f) password and driver’s license number, and (g) specific requests. These groupings are common to all ten web forms.

3.1.2 Electroencephalographic indicators
To obtain electroencephalographic indicators, we started to analyze EEG data. Each acquired EEG was converted to a frequency domain spectrum every second by a fast Fourier transform. We dealt with the amplitude spectra at 4-22 Hz. Next, we applied this process to detection systems for diverse emotional states, which were demonstrated in our previous study [7]. In this study, we extracted each subject’s level of aversion (0%: low - 100%: high) during each second while he or she completed a web form. This is because we need to determine exactly which fields subjects find unpleasant to complete in order to reveal the features of easy-to-understand web forms. The average aversion level in each web form per subject. The average level is divided into five grades (1: 100-81%, 2: 80-61%, 3: 60-41%, 4: 40-21%, 5: 20-0%). Moreover, we extracted fields in a web form that had more than 80% aversion levels. These detected fields are categorized into seven groups in the same way as the psychological indicators.

3.1.3 Behavioral indicators
By using eye-tracking videos, we focus on four behavior patterns as behavioral indicators: (h) the duration of discomfort, (i) the number of characters entered, (j) the number of incorrect entries and blank entries, and (k) the number of scrollings. The duration of discomfort is defined as the total time spent on fields negatively evaluated by a subject and fields where the subject gazed at the same point for more than 5s. In order to facilitate data analysis, (h), (i), and (k) are normalized as follows.

\[
(h) \frac{\text{duration of discomfort (s)}}{\text{total measurement time (s)}}
\]

\[
(i) \frac{\text{number of characters entered (byte)}}{\text{number of maximum characters entered among the ten web forms (byte)}}
\]

\[
(k) \frac{\text{number of scrollings (time)}}{\text{total length of the web form (cm)}}
\]

In this study, we consider that subjects have more difficulty completing a web form with increasing values of (h), (i), and (k).

Finally, we visualized all the indicators in five colors. In addition, we put cross marks in boxes representing psychological indicators if there were fields arousing aversion as indicated by the subjects. Similar visualization was

---

Table 1: Details of web forms

| Web form number | Name of corporate body                  | Purpose of web form         |
|-----------------|----------------------------------------|-----------------------------|
| 1               | Sumitomo Mitsui Banking Corporation    | Credit-card application     |
| 2               | JCB Co., Ltd.                          | Credit-card application     |
| 3               | All Nippon Airways Co., Ltd.           | Member registration         |
| 4               | IKEA                                   | Member registration         |
| 5               | Lifenet Insurance Company              | Document request            |
| 6               | Mashi Beauty Lab Co., Ltd.             | Member registration         |
| 7               | Nissen Co., Ltd.                       | Member registration         |
| 8               | SBH Securities Co., Ltd.               | Opening of an account       |
| 9               | Keio University                        | Document request            |
| 10              | Toppan Forms Co., Ltd.                 | Job application             |
applied to boxes representing electroencephalographic indicators when there were fields with an aversion level of more than 80% as detected by the EEG.

3.2 Quantification and visualization of web form features

We also quantified each web form feature. We considered the text size and the contrast between the background color and the text color. Actually, a web form contains several different text sizes and colors. In this study, we focus on the text size and contrast in terms of the (l) labels, (m) notes, (n) sample entry, (o) asterisks, and (p) frame border for the entry field.

In regard to the quantification of the contrast between two colors, we use the following formulae based on RGB model suggested by the World Wide Web Consortium (W3C).

\[
\text{Color brightness} = \frac{\{(R1-R2)*299\} + \{(G1-G2)*587\} + \{(B1-B2)*114\}}{1000}
\]

\[
\text{Color difference} = (\text{MAX}(R1,R2)-\text{MIN}(R1,R2)) + (\text{MAX}(G1,G2)-\text{MIN}(G1,G2)) + (\text{MAX}(B1,B2)-\text{MIN}(B1,B2))
\]

Here, “R”, “G”, and “B” mean red, green, and blue, and “1” and “2” indicate the background color and text color, respectively. The three colors have integer values from 0 to 256. According to W3C, two colors provide good color visibility if the color brightness difference is more than 125 and the color difference is more than 500 [8].

Furthermore, we display the above results as circles with different colors and sizes.

4. Results and Discussion

To begin with, we quantified and visualized each subject’s feelings and behavior for each web form in three ways (see Fig. 3). We were able to see diverse results immediately from the proportion of each color. For example, the second form by Subject F was hard to complete because it had a large dark area. On the other hand, Subject B appeared to have completed the ninth web form easily because every indicator was light.

In addition, there were different evaluations between the psychological indicators and the electroencephalographic indicators, such as for the first form completed by Subject C, which shows that the subject found the web form hard to complete whereas the EEG detected a low level of aversion. In order to investigate the cause of such a result, we took into account the behavioral indicators. Contrary to the low aversion level obtained by the EEG, we confirmed that subjects tended to downgrade their evaluations of a web form when they had to enter a high number of characters on a keyboard or they had a high number of incorrect entries and blank entries. In this way, visualization allowed us to correctly understand and smoothly extract evaluation results.

Next, we discuss the web forms with cross marks in more detail. In the majority of web forms, the groups where the cross marks were put were different between psychological and electroencephalographic indicators. In particular, we looked at the fields having more than 80% aversion levels obtained by the EEG despite subjects considering these fields easy. We counted the number of fields in a web form generating aversion detected only by the EEG and calculated the average percentage of all subjects experiencing aversion per web form (see Table 2). The third web form had the most fields generating aversion. These results are considered in terms of the features of the web form, and we visualized the results in the term of the web form features (see Fig. 4).

We presumed that subjects felt less discomfort when the color brightness of the sample entry was more than 220, such as in the fourth, ninth, and tenth web forms. This is why these three forms generated lower percentages of aversion. In other words, subjects tended to be less frustrated while completing the web form. We concluded that a sample entry was needed in order to guide subjects who had never seen the web form before. Moreover, small text sizes were not always unfavorable, taking the sixth and seventh web forms as examples. Thus, we assumed that subjects were unconsciously frustrated by web form features. A desirable web form should have a high color brightness of more than 220, a high value of color difference,
Table 2: Subject-averaged percentage of the number of fields per web form generating aversion detected by EEG

| Web form number | Subject-averaged percentage of the number of fields per web form generating aversion detected by EEG [%] |
|-----------------|--------------------------------------------------------------------------------------------------|
| 1               | 13.92                                                                                            |
| 2               | 22.10                                                                                            |
| 3               | 30.67                                                                                            |
| 4               | 12.18                                                                                            |
| 5               | 14.04                                                                                            |
| 6               | 18.41                                                                                            |
| 7               | 15.94                                                                                            |
| 8               | 19.44                                                                                            |
| 9               | 12.96                                                                                            |
| 10              | 14.96                                                                                            |

Figure 4: Visualization of results in terms of web form features and large text.

5. Conclusions

In this study, we proposed an evaluation approach for web form usability involving a questionnaire, EEG measurement, and eye tracking. In addition, we quantified and visualized our results. This process allowed us to clearly understand the evaluation results and also to extract key information for creating a favorable web form. We confirmed that web form usability depended on the interaction of diverse evaluations such as users’ conscious and unconscious feelings, their behavior, and web form features. In the future work, we will consider more indicators and analyze the acquired information more comprehensively. Moreover, we would like to increase the robustness of our study and thus we develop effective evaluation methods for ensuring web form usability.

Appendix

Here we give the Uniform Resource Locators (URLs) of the ten web forms used in our experiments carried out on four days, 19th and 23rd April and 11th and 13th June 2013.

1. https://www.smbc-card.com/nyukai/online_nyukai/yuso_agreement.jsp

2. https://www.jcb.co.jp/online/service/ssl/entry?1228185+3950+100+110002110&ActionType=entrytop

3. https://cam.ana.co.jp/amcmember/amcentry/AMCEntryF

4. https://secure.family.ikea.jp/join.php

5. https://frm.lifenet-seimei.co.jp/catalog/

6. http://www.cosmekitchen-webstore.jp/Form/User/UserRegistRegulation.aspx

7. https://www.nissen.co.jp/src/cr/Kiyakujsp.jsp

8. https://m.sbisec.co.jp/eatiw011

9. https://w2.axol.jp/entry14/keio/step01

10. https://mypage.1011.i-web.jpn.com/toppan-f2014/

References

[1] Ministry of Internal Affairs and Communications: 2013 White Paper Information and Communications in Japan, Ministry of Internal Affairs and Communications, p. 51, 2013.

[2] L. Manzari and J. Trinidad-Christensen: User-centered design of a website for library and information science students: Heuristic evaluation and usability testing, Information Technology and Libraries, Vol. 25, No. 3, pp. 163-169, 2006.

[3] C. Ehmkie and S. Wilson: Identifying web usability problems from eye-tracking data, Proceedings of the 21st British HCI Group Annual Conference on People and Computers, Vol. 1, pp. 119-128, 2007.

[4] O. Sourina, Y. Liu and M.K. Nguyen: Real-time EEG-based emotion recognition for music therapy, Journal on Multimodal User Interfaces, Vol. 5, Nos. 1-2, pp. 27-35, 2012.

[5] D. Toker, C. Conati, B. Steichen and G. Carenini: Individual user characteristics and information visualization: Connecting the dots through eye tracking, Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 295-304, 2013.

[6] L. A. Schmidt and L.J. Trainor: Frontal brain electrical activity (EEG) distinguishes valence and intensity of musical emotions, Cognition and Emotion, Vol. 15, No. 4, pp. 487-500, 2001.

[7] H. Fukai, Y. Tomita and Y. Mitsukura: A design of the preference acquisition detection system using the EEG, International Journal of Intelligent Information Systems, Vol. 2, No. 1, pp. 19-25, 2013.

[8] World Wide Web Consortium: Techniques for Accessibility Evaluation and Repair Tools, W3C Working Draft, 2000.