The Evaluation of the Digital Gross Photography System Usability

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Abstract

Objective: Questionnaires designed to evaluate the DGPS usability was applied to improve the pathologists’ workflow. Background: The range of product application and cost of products rather than the product usability are primary concerns when purchasing products. This trend has become a problem in the medical environment. The technology-oriented medical devices rather than user-oriented may cause problems at work, for example, the disruption of the work environment and feeling of tiredness. Method: Questionnaires administered to pathologist after work were used to identify the effects of user height and foot size on the DGPS usability was analyzed. Results: The source of improvement in handling DGPS was obtained from the comprehensive analysis of the effects of user height, foot size and interface on the DGPS usability. Conclusion: From the evaluation of the DGPS usability, the source of improvement was obtained. However, it might be possible to evaluate the DGPS usability by attachment of electromyography (EMG) on pathologist.

Keywords: DGPS, Usability, Questionnaires, Medical Devices, Improvement

Introduction

The histopathologic examination is a test confirming diseases by observing clinical specimen received from surgical operation or endoscopy, with the naked eye and a microscope. In order to have more accurate examination and confirmation, DGPS (Digital Gross Photography System) is used when photographing clinical specimen. This device is manufactured and sold by a single company in Korea while Japanese and German companies are selling it overseas. In case of the existing devices, things like camera height and length measurer had to be manually adjusted for each clinical specimen. Such adjusting work might be considered as inconvenience by users. [1], [11], [17]

In 2010, a survey on satisfaction in domestic and foreign products was conducted for medical staffs using medical devices in domestic tertiary medical centers (university hospitals). The most representative items include low reliability (23%, lack of clinical data and usability evaluation) and lack of performance and functions (20%) and inconvenience of use (6%), and such causes for dissatisfaction were shown because the devices were released without going through proper usability evaluation. Also such products without usability evaluation are expected to have accidents caused by human factor. [9]

Recently in Korea, there have been attempts to improve reliability and human factor issue related to medical devices and system, accompanied by usability evaluation for products. In order to reduce errors caused by human factor and increase reliability of DGPS product, this study conducted a usability test for the device, and based on such evaluation values, the improvement measures in accordance with body factors of DGPG were drawn.

Related Work

According to the medical device-human error report by the U.S. Institute of Medicine, the causes of accidents caused by human error when using the relevant equipment include frequency, size of the device and complexity of system. It reports that such accidents occur with products whose design of the system does not recognize human factor with the exterior that is hard to be used by users. [2]

In order to reduce the accident cases caused by human factor, the ISO (International Organization for Standardization) continuously modifies/supplements regulations of suitability (usability) evaluation for medical device every year. The ISO standards define manufacturers’ processes of analysis on usability, regulations, design, verification and validation, related to safety of medical device. The usability process of ISO defines not only the process in which users use medical device and system, but also that every information related to overall products like shipping, storage and installation in the whole process from manufacturers to users should be provided. It is also suggested that it should consider not only users’ age,
weight, health and symptom, but also linguistic background, academic level and potential problem. Additionally, this standard focuses on frequently used functions of the relevant device and system. It is defined that such mainly used functions should be decided including users’ interaction with the medical device from its design, which should be recorded in usability process. If they are not considered in the design stage, it can aggravate users’ physical workload and also increase errors affecting safety-related functions. As shown above, ISO suggests usability to manufacturers, considering every safety matter from design to use, and many researchers conduct their studies on medical device based on such regulations. [4], [5]

Thus this study conducted a usability evaluation of DGPS used from dept. of pathology in university hospitals. Though DGPS is comprised of H/W and S/W, this study researched improvement measures by analyzing inconvenience for each body factor, focusing on its hardware.

**DGPS**

DGPS(Digital Gross Photog raphy System) is mainly used from large hospitals and dept. of pathology in university hospitals. The main users of this device are engineers in charge of histopathology in dept. of pathology, instead of doctors or nurses. When other departments(surgery and etc.) collect and send patients’ tissues to dept. of pathology, the engineers in charge of pathology take the first photograph of the original specimen. After photographing, basic work like washing, cutting to collect only clinical specimen and the 2nd photographing of specimen is performed in the order. Additional work can be done based on the judgment of pathologic specialists. DGPS is comprised of hardware for image storage, management, output and photography, and software for operating this hardware. [3]

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<tr>
<th>Item</th>
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<th>Function</th>
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<tr>
<td>Image storage &amp;</td>
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<td>Image output</td>
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<td>Image photograph y</td>
<td>Camera</td>
<td>Photographing tissue image</td>
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<tr>
<td>Software</td>
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3.1 Hardware

The H/W of DGPS is comprised of camera, monitor, lighting, palette, foot switch, drawer to keep mouse and keyboard, and additional equipment of the device. The Head Colon for photographing image is equipped with Cannon 60D DSLR. As a key equipment of the photographing device, the camera is interlocked with the computer inside of DGPS. The output equipment is installed with a 17 inch- touch monitor. Through this monitor, it is possible to check user interface for photographing clinical specimen by simply touching the screen with a finger.
the other one is to operate camera shooting. The lighting and acrylic palette are designed to control diffused reflection for the optimized photograph of clinical specimen. On the right side of DGPS, there is a storage space for additional equipment, which can be used to store cleaning equipment for the next shooting after photographing clinical specimen. Using the palette storage space on its left side, it can be easily put in/taken out in case when replacing palettes.[3]

3.2 Software

Figure 3 User interface screen of DGPS

The software is a means for users to operate hardware of DGPS. The user interface can be classified into checking pathologic image, searching and managing the photographed image. Checking pathologic image is a function to check clinical specimen in image form when photographing. When double-clicking on the image of specimen, it becomes enlarged and then editing functions such as comment, color and rotate change are running.

Figure 4 The form of ID user interface of DGPS

When photographing clinical specimen, certain unique pathology ID should be entered for each specimen before pressing the shooting button. This is essential because pathologic specialists enter such pathology ID when searching for specimen afterwards. The UI that gives pathology ID is provided in two forms. First, it is the form in which users enter pathology ID, using keyboard. Second, pathology ID is entered using only mouse just like Figure 3, in which a virtual keyboard is created to enter pathology ID when clicking on number and character. After photographing specimen is completed, users can search for the previous specimen image by entering pathology ID or by looking for the relevant pathology in dependent on year, month and date after clicking on the calendar.

DGPS Usability Method

This study focused on drawing the operator-centered improvement measures through usability evaluation of DGPS which is comprised of hardware and software. This article focused on drawing improvement measures and satisfaction related to users’ height and foot size for hardware.

DGPS Usability scenario

As DGPS is mainly used from dept. pathology in large hospitals, the research on usability was conducted through interview with an engineer in charge of pathology in Seoul National University Hospital. When a specimen is requested, in the usability scenario of the main device, it is moved to the pathologic engineer’s workroom to record. After photographing the initial condition of the specimen, the pathologic engineer washes it, cuts the part with disease and conducts the 2nd photographing. After the 2nd shooting, it is checked and judged by a pathologic specialist, and then it can be additionally photographed and lastly, saved in a specimen slide. This work takes around 20-30 minutes, which is performed about 100-150 times a day in university hospitals and general hospitals.[2] In the usability evaluation of this study, subjects operated DGPS in the order shown in Figure 5, and then filled out survey, in which collected evaluation values were analyzed. Before this usability evaluation, the test participants cognized strengths and weaknesses of DGPS and received sufficient education about the
device and system. The reason why such education was provided before the test is based on the following research contents. When Nielsen (1994) conducted usability evaluation for beginners, the participants without any preliminary education drew only 22% problems while participants received general education about the device and system drew 60% problems. According to this result, we can get more definite results when participants are aware of general knowledge of the product, for efficient usability evaluation.[15]

Evaluation of DGPS

In order to draw improvement measures of DGPS through usability evaluation, participants filled out survey evaluation after operating the device their own. In order for the evaluation of DGPS, the test focused on two elements, the first is the satisfaction in DGPS photograph work in dependent on height and the second is the foot switch improvement in accordance with foot size. [18]

The test on DGPS was conducted for beginners, not professionals. However, these participants basically took a course of HCI and human factors engineering from colleges, and also fully knew about basic operation method and test elements of DGPS before the test. In order to additionally analyze participants’ height and foot size before operating the device, their height and foot size were measured by Martin’s Anthropometer. Through average height and foot size of Size Korea and SPSS Clustering method, the height and foot size were classified into six height groups and five groups for foot size.[14][15]

5.1 Overall satisfaction relation

Though DGPS is comprised of much hardware like illumination plate, worktable, monitor, keyboard & mouse, storage space for equipment and drawer, we analyzed the survey to extract elements related to height and foot size. In the result of analyzing survey evaluation of lab and the manufacturer, the foot switch was the only element related to foot size so that this element was excluded from analysis.[10]

5.2 Satisfaction in accordance with height

We conducted a test and analysis on elements related to DGPS work, which is about the influence of elements like monitor, worktable and keyboard & mouse on height, one of the participants’ body factors.
Figure 7. Analysis results of each hardware related to height

Figure 7 is the result of variance analysis on each element with height classified in groups. In regard of keyboard & mouse, the group 4(170~175cm) said 'the most satisfied' with work, and the next one was the group 3(175~180cm). In regard of monitor height, the same groups were drawn in the same order as the worktable height also showed similar result. Based on this result, we found that overall users with 170-180cm height had high satisfaction in DGPS work. Since this number accords with the average height of Korean people in 20s, it is expected that there will be no changes of height for overall DGPS work.[8]

5.3 Satisfaction in accordance with foot size

In order to photograph specimen or move the head colon up and down, the foot switch should be adjusted. In case of the existing photography system, users have to operate the shooting button manually after adjusting the camera manually. In order to solve the problems like error caused by minute hand shaking and inconvenient adjustment, such work method was changed into foot method. However this test was carried out because such foot method is lack of reliability of whether there is any inconvenience in accordance with users’ foot or not.

Figure 8. Results of analyzing the foot switch in accordance with foot size

First, the participants’ foot size was classified into total five groups, comparing it with the average foot size of Size Korea. Figure 8 is the result of variance analysis on satisfaction in the foot switch in accordance with participants’ foot size. In the results of analysis, the group 3(265~275mm) had the least inconvenience in work while users with 285~290mm foot size showed low satisfaction. In other words, it was found that it would be better to secure a bit of extra space with the foot switch.[7][8]

Result

This test drew improvement measures of hardware elements through usability evaluation of DGPS. Among participants’ body factors, we focused on height and foot size, and also selected elements related to such body factors during whole operation. Though the survey evaluation focused on those two elements, other hardware parts were also evaluated. For improvement measures, the DGPS monitor is needed to be changed to be movable automatically by using a button just like the camera, that it would be better to secure extra space for the foot switch, and that the height of the worktable is needed to be adjustable. In addition, we had more measures of H/W including modification of the drawer length, more power to fasten lighting and location of lighting adjustor.

Conclusion

This study aimed to draw improvement measures through usability evaluation of DGPS. In the usability evaluation, participants participated in the test after fully knowing about how to use, strengths and weaknesses of DGPS, and then filled out the survey evaluation after operating the device. The analyzed evaluation values selected and analyzed hardware elements in accordance with height and foot size to draw improvement measures. Also additional matters for modification were researched through the survey evaluation of general H/W parts. This measures will be used as a basic data to improve the product. The following test will attach participants’ EMG on tops of survey evaluation of the device. Measuring muscle
fatigue of each element through EMG, the improvement measures of hardware will be drawn as conducting usability evaluation of UI.

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[8] Enforcement Regulations of the Medical Appliances Act