Suitable GUI Selection Using Analytic Hierarchy Process

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Abstract— **This paper proposes a method of selecting design strategies for user interfaces for various controllers based on an analytic hierarchy process. The goal of this model is to modify the graphical user interface of a remote controller to one that is the most suitable for each user. This paper proposes a new model with six evaluation criteria — Physiological, Knowledge, Psychology, Complicated System, Complicated Peripherals, and Habit. As alternatives, we decided our design strategy for the user interface — Vision assistance, Cognition assistance, Operation assistance, Memorizing. This proposed method was realized and evaluated by incorporating a processor assumed to be for AV remote controller use as practical applications. This paper verifies its effectiveness.**

Keywords - Analytic hierarchy process; design strategy; optimized user interface

I. INTRODUCTION

This paper proposes a method of selecting design strategies for user interfaces for various controllers based on an analytic hierarchy process. As practical applications, this paper discusses about an audio-visual (AV) remote controller.

An AV remote controller and its user interface have the problem of who is using the AV remote controller. There are many kinds of user in homes such as children and the elderly, as well as those with vision impaired and different levels of ability with AV equipment. When different people use the same AV remote controller, it cannot satisfy all their requirements.

When considering the many needs of users, system complexity, functions and additional equipment, the controller requires various interfaces, which are not practical to produce.

The authors have proposed some design strategy models on user interface of AV remotes [1, 2]. However, these targeted general users interface (UI) and have not discussed special alternatives for Graphical User Interface (GUI).This study proposes solving this problem by changing the GUI of a multi-wireless remote controller.

This paper describes a new model of AV remote controller GUI using an Analytic Hierarchy Process (AHP) [3]. It proposes a method in which the GUI evolves with each user. The method of selecting the GUI design strategy in accordance with a user's requirements is also described. Finally, a prototype AV remote controller was built for verification.

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II. CONCEPTUAL MODEL OF UI DESIGN USING AHP

A. *Problems of UI of AV remote controls*

The UIs of AV remote controls have conventionally been designed on the basis of the functions of the entire AV device or the AV system. This design method is based on technological ideas, and it has been a technology-pushed design policy.

However, the following problems occur when the remote controller is used by many kinds of user.

(1) Users have different physiologies such as failing eyesight due to aging.

(2) Users have different knowledge, capabilities and experiences with AV systems.

(3) The same user may have a different state of mind depending on the details of the operation, the working environment and other factors.

(4) Each user has an AV system with different equipment.

(5) Each AV device has various numbers of functions.

(6) The device used and performed operations frequently of the AV machinery differ according to the user.

Consequently, what users require of the GUI of their AV remote controls is that the interface should be optimized according to the situation and the condition of the users themselves in relation to the problems above.

B. *Conventional model for GUI design strategy based on AHP and its problems*

In this section, this paper proposes a new model for GUI designs based on AHP to solve the problem of the before discussing the content of this paper.

Fig.1 show the conceptual model proposed by the authors for the GUI design strategy, with the model composed of three steps: goal, evaluation criteria, and alternatives proposal.

The goal of this model is to modify the GUI of a wireless remote controller to one that is the most suitable for each user. Next, the six basic evaluation criteria given below are introduced. Physiological attribute criterion (Phy) shows the user's age, sex, and eye-sight. Knowledge criterion (Kn) means the ability to understand an AV system. Psychographic criterion (Psy) shows the user's feeling based on their situation and operation status. System complexity criterion (Sys) shows

the complexity of the AV system. Operation difficulty criterion (Ope) shows the complexity of operating the AV system. Habit criteria (Ha) show the user's habits.

Finally the authors evaluated the demand of each user based on these evaluation criteria and chose most suitable GUI from the following four interfaces as alternatives.

Fig.1 shows the proposed model for the GUI design strategy based on an AHP. In this figure, the alternative interfaces are abbreviated as follows. *Vision means a vision assistance interface which is for the display method. Cognition means a cognition assistance interface which is for the expression method, Operation means an operation assistance interface which is to select the speed of the reaction, and Memorizing means a memorizing interface where the AV remote controller learns the functions that the user controls frequently.

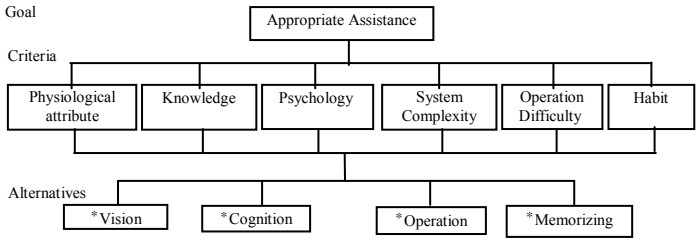


Figure 1. Conventional model for GUI design strategy based on AHP

III. SAMPLE CALCULATION OF SUGGESTED MODEL AND PROTOTYPE

A. Samples calculation of proposed model

This section shows a specific sample calculation using AHP.

The evaluation values for the six criteria give concrete numerical values and calculate heaviness.

Table I shows the values of the six criteria. The assumed user and environment is given below. The user is old with visual problems and limited Knowledge to understand. The AV device and neighboring equipment are not complicated. Also they are using the AV remote controller for the first time. In addition, there is no particular stress for the GUI. The consistency index (C.I.) value is 0.031, which is lower than 0.1, indicates that it is effective.

TABLE I. EVALUATION VALUE FOR THE SIX CRITERIA

Criteria	Phy	Kn	Psy	Sys	Ope	Ha	Weight
Phy	1	1	3	5	3	7	0.320
Kn	1	1	3	5	3	7	0.320
Psy	1/3	1/3	1	3	1	5	0.134
Sys	1/5	1/5	1/3	1	1/3	3	0.061
Ope	1/3	1/3	1	3	1	5	0.134
Ha	1/7	1/7	1/5	1/3	1/5	1	0.032

C.I.=0.031.

Next, the values are set for six alternative design strategies by criteria, as shown in Table II. This is the case of Physiological attribute criteria.

TABLE II. EVALUATION VALUE FOR PHYSIOLOGICAL ATTRIBUTE

	Vis	Cog	Ope	Mem	Weight
Vis	1	5	7	7	0.657
Cog	1/5	1	3	3	0.191
Ope	1/7	1/3	1	1	0.076
Mem	1/7	1/3	1	1	0.076

C.I.=0.025.

The consistency index (C.I.) value is 0.025, which is lower than 0.1, indicating that it is effective. The others five criteria were computed the same way.

Based the results, comprehensive evaluation results were determined using (1).

$$\begin{bmatrix} Vision \\ Cognition \\ Operation \\ Memorizing \end{bmatrix} = \begin{bmatrix} 0.657 & 0.368 & 0.078 & 0.095 & 0.099 & 0.095 \\ 0.191 & 0.368 & 0.538 & 0.249 & 0.523 & 0.249 \\ 0.076 & 0.096 & 0.076 & 0.095 & 0.116 & 0.095 \\ 0.076 & 0.169 & 0.305 & 0.560 & 0.263 & 0.560 \end{bmatrix} \cdot \begin{bmatrix} 0.320 \\ 0.320 \\ 0.134 \\ 0.061 \\ 0.014 \\ 0.032 \end{bmatrix}$$

$$= \begin{bmatrix} 0.555 \\ 0.344 \\ 0.090 \\ 0.215 \end{bmatrix} \quad (1)$$

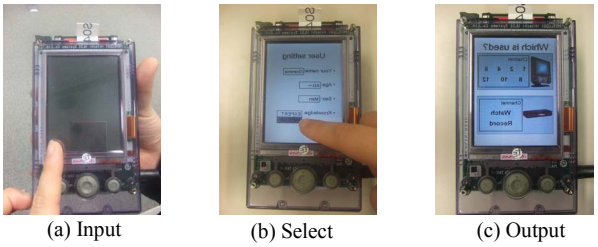
This example concluded that Vision was the most important factor for the user, followed by Cognition and Memorizing, and that Operation was not important.

Next, the case of a child was calculated as an example. This concluded that Cognition was the most important for factor, while Vision was not important. Using evaluation values provided by the attributes of each user in this way, a design strategic policy of GUI suitable for each one was achieved.

B. Example of prototype of the proposed model

This calculation algorithm was used in the evaluation system of an AV remote control. Fig.2 is a prototype of an AV remote controller employing our suggestion model.

This assumed that the prototype is a wireless remote controller for household appliances small resources of a CPU and a real-time OS. This evaluation system confirms its operability.



(a) Input (b) Select (c) Output

Figure 2. Example of prototype of the suggested model

IV. CONCLUSION

This paper has proposed a method of selecting design strategies for user interfaces for AV remote controllers based on an analytic hierarchy process. In this method, the design policy for the optimum UI is selected on the basis of the functions and scale of the AV system and the user's knowledge. The goal of this model is to revise the GUI of a wireless remote controller to one that is the most suitable for all users. This paper proposes a new model with six evaluation criteria; Physiological Attributes, Knowledge, Psychology, Complicated System, Complicated Peripherals, and Habit. As alternatives, we decided our design strategy for user interfaces as Vision assistance, Cognition assistance, Operation assistance, Memorizing.

This paper has described this evolution by incorporating a processor assumed to be for an AV remote controller, and has verified its effectiveness.

This paper calculated the cases of an elderly person and a child. The elderly person has a vision problem, on the other hand the child doesn't.

As a result, vision was the most important alternative for the elderly person, but not for the child.

Using evaluation values provided by the attributes of each user in this way, a strategic design policy for GUIs suitable for each individual was achieved.

Next, this calculation algorithm was used in the evaluation system of an AV remote control, actually selecting the GUI and confirming its operability.

REFERENCES

[1] M. Matsuda, Y. Uesugi, T.Nonaka, and T.Hase, "Design method of UI of AV remote controller based on AHP," in proc of 2008 IEEE International Conference on Consumer Electronics (ICCE 2008), 2008.

[2] T.Nonaka, Y.Uesugi, and T.Hase. "Design strategy of optimal user interface for each user and system using an analytic hierarchy process," in proc of International Conference on System, Man, and Cybernetics (SMC 2008), pp. 1910 -- 1915, 2008.

[3] T.L. Saaty and L.G Vargas, Models, Methods, Concepts & Applications of the Analytic hierarchy Process, Kluwer Academic publishers, Norwell, MA, 2001.