Automatic GUI Generation on AV Remote Control using Genetic Algorithm

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***Abstract*—This paper proposes a method of arranging icons which are different in size and shape on an audio-visual remote control screen efficiently and to create graphical user interfaces automatically using a genetic algorithm. The proposed system displays function icons only of the selected AV equipment that the user wants to operate so as to find their target icon easily. This paper deals with AV systems consisting of five devices. We take each icon as a gene, and take the icon array of the AV equipment group to be operated as an individual. We place the icons according to the array of the individual to create a GUI and add new pages until all icons are in place. The proposed system based on the genetic algorithm continues the calculation until it finds an icon array that meets two requirements, one, the number of pages is the fewest and two, the blanks (spaces and margins) on the pages are the smallest. For verification, the proposed system was fitted to an embedded system, employing a microcomputer with an operation clock of 100 MHz and a touch panel. As a result, a suitable GUI that meets each of the conditions was created within 30 seconds even if five devices were selected and the number of icons for arrangement was the greatest.**

Keywords-Genetic algorithm, remote control, graphical user interface

I. INTRODUCTION

Household AV equipment has become multi-function and high-performance in recent years. Furthermore, as two or more household AV equipment units are combined to make a home theater and lovers of such home theaters increase, the scale of AV systems in ordinary households is getting larger. This trend has promoted the popularization of multi-remote controls, which can control two or more pieces of equipment.

Still, multi-remote controls involve some problems. For example, all family members do not always operate all the AV equipment units even if the household AV system is large. For users who want to operate only a single unit, it is hard work to find the desired button out of button groups for two or more units arranged on a multi-remote control.

In addition, an AV remote control is required to be lightweight and small enough for a user to hold and operate it because of its nature. It is extraordinarily difficult, therefore, to secure the area on the multi-remote control to arrange all the buttons that are necessary to perform all the functions of recent multi-function and large-scale AV systems.

Hence, we focused on a method that employs a touch monitor, instead of physical buttons, on the remote control, and displays function-related icons on the monitor. This paper proposes a method of automatically creating the following reasonable GUI using a genetic algorithm (GA) [1] with one, only those icons that relate to the device that the user wants to operate at the moment, and two, such icons will be on the screen.

II. PROPOSED SYSTEM

In this system, we prepare icons to be displayed on the touch monitor, and they must have a button-like shape as widely used on AV remote controls with which the user is very familiar. Then, from these icons, the system on each occasion selects and displays only those icons that are related to those devices the user wants to operate. In addition, a number of pages on the screen are added until all the selected icons are displayed.

The number of pages will become too many for the user to find their desired icon if the selected icons are displayed only at random. In addition, the layout of a single page may vary widely, making the user a little uneasy at finding the desired one.

To cope with this problem, GA is introduced to efficiently locate icons that are different in size and shape in order to create a GUI that will meet the following two criteria; (1) Total number of pages is the fewest, and (2) Blanks on a page are the smallest.

This paper discusses the GUI of a multi-remote control that can control an AV system consisting of five AV equipment units, including a TV, VCR, DVD recorder/player, CD player and amplifier. For this discussion, a gene, an individual and population in GA are defined as follows.

Gene: An AV equipment icon; 60 icons in total for 5 devices for the AV system being operated.

Individual: An icon array that relates to the equipment selected by the user. The length of an individual changes because the number of icons to be displayed depends on the selected equipment and the number of units. The longest individual takes place when 5 devices are selected (30 icons),

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and the shortest individual occurs when the CD is selected (5 icons).

Population: A set of individuals in which icons are arrayed. In our study, GA processing is conducted where the number of individuals in population is set to 1000.

Gene operation is repeated in the order of selection, crossing and mutation until an icon array (an individual) that meets the two previously given conditions is created. In our proposal, GA operation is conducted by the unit of the gene. Therefore, it is supposed that the gene, or icon, should not transmute when GA operation is conducted within a gene.

In GA, the following cycle is repeated in general: 1) creation of parent population, 2) assessment, 3) selection, 4) crossing, 5) mutation, and 6) assessment of child (parent) population (= process 2). Figure 1 shows an outline of the GA used in this system.

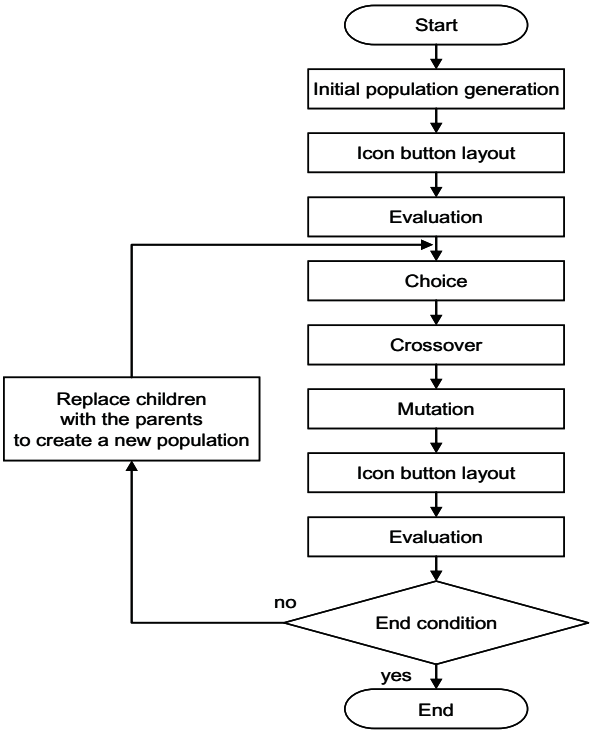

Figure 1. Flowchart of the GA of our proposed system

The proposed system calls only the icons of the operated equipment that were selected by the user from a pre-registered database, and it randomly places them without redundancy. The array of these icons (genes) is called an individual.

Our proposal performs GA in two stages in order to assess adequate icon arrays using two criteria. In the first stage, the system works to minimize the number of GUI screens (pages) needed to display all the icons relating to the equipment that the user wants to use. At the second stage, the system tries to minimize the clearance in a single GUI screen.

If an individual which is assessed highly is created in population, our proposed system finishes the GA calculation process and displays the GUI on the remote control according to the array of that individual.

For selection, we adopt a tournament system in synchronization with the specified assessment function. The number of individuals to be used in the tournament is set to 7. In crossing, the two individuals that survive the tournament are used and the crossing ratio is set to 100 percent. For mutation, the highest value of a reasonable range times 0.01 is adopted to promote quicker calculation.

At the first-stage GA, if an individual is found that has reached the specified number of display screens based on the results of preliminary experiment in the new population created by the above operation, then this generation is sent to the parent population of the second-stage GA. In the second-stage GA, similar parameters are also used, and the operation is ended when the number of clearances on a screen reaches the previously specified number of clearances.

III. Verification Experiments

Supposing that the proposed system would be used with consumer equipment, an assessment experiment device was created for trial using a built-in microcomputer with a 100 MHz operation clock and an embedded real-time OS in order to verify the proposed system.

The user should select their desired equipment for operation on the selection screen that appears after system startup. Figure 2 shows the appearance of the selection screen, and Figure 3 shows the GUI displayed as a result of GA.

Figure 2. Device selection GUI.

Figure 3. Sample GUI for 5 devices.

When 2 devices were selected, 2 device marks were displayed at the top of the screen, making 2 pages, but when 5 devices were selected, 5 device marks were displayed, making 6 pages. The above was completed within 30 seconds on the experimental device regardless of the number of icons and other conditions.

IV. Conclusions

This paper has proposed a method of using GA to display on an LCD all and only the icons that relate to the equipment the user wants to operate, where a touch monitor is used on a multi-remote control. In our proposal, the GA, which takes an icon as a gene, and an icon array as an individual, is built-in in a two stage structure. A prototype, working like a remote control, was used in order to verify the proposed technique.

When the GA ended, the GUI results, in which icons were arranged adequately, were displayed on the LCD screen within 30 seconds. The above results suggest that it is possible and effective to use GA to achieve adequate arrangement of GUI displayed icons on the LCD screen of an AV remote control.

REFERENCES

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