Point and Control: The Intuitive Method to Control Multi-device with Single Remote Control

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Abstract. Remote controls are mainly used to control most of the CE devices in home environment these days. As the number of electronic devices increases in home, each device's corresponding remote may also be added, and user frequently controls several devices at one time. This situation makes a user feel difficulty in finding desired remote control among many of other controllers. To alleviate this inconvenience, a technique for controlling multiple electronic devices with a single remote, well-known as a universal remote control technique, has attracted attention. Generally, when a user uses the universal remote control, she must input a key code of a desired device. If a user were to control several devices interchangeably, she may hang out pushing the key code for one device after the other. This kind of maneuver can be very tiresome, and it may lead to dropping the usability drastically. This paper propose the hardware, and software structure of Point and Control (PAC), which uses the metaphor of pointing a objective target, to select the device user intend to control. By using PAC, users can easily select and control the target device among many of candidates in real time with just simple behavior.

Keywords: Remote control, Universal Remote control, IR LED, IR Image Sensor, Point and Control, PAC, Multi device Control, Concurrent Control.

1 Introduction

As many consumer electronics users using several devices concurrently in home environment, they have a difficulty in finding the right remote [1]. For example, if a user wants to play a DVD title with HTS system, she normally uses at least three remotes. Or if a user wants to turn off the DVD player and watch IPTV, STB controller may be needed. This "finding-exact-remote-control" situation can be very annoying to users. To deal with this problem, techniques for controlling multi-device with a single remote, so-called universal remote control are researched lively these days [2]. In general, when a user uses the universal remote control, she inputs a key code of the target CE device. Once key code of the desired device is inputted, the universal remote recognizes which electronic device to control and the user can control it. But when a user wants to change the target device to control, the user must re-input another proper key code.

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Key-code inputting step is the fundamental reason of controller's falling-off in usability. We evaluated several methods that can replace the inputting key code step, and concluded that the most intuitive way is "pointing" remote to the device that the user intends to operate. We named this pointing based multi-device controlling method as Point and Control (PAC). PAC uses IR LEDs and IR image sensor to determine the target device. Each target device has unique IR LED information, and universal remote control is equipped with an IR LED image sensor to read the target device's IR information. When a user points the remote to the target device, the remote retrieves the image of IR LED data, decides what device to control, and finally transmits the proper key code. Since key code inputting has changed to the pointing behavior, a user can control several devices with ease, feeling much more comfortable.

2 Related Work

In an early stage of universal remote control, it was developed for controlling various type of electronic devices of same manufacturer's particular brand, merged each remote buttons to one single remote. As remote made gradual advances and is recognized as one independent device by many users, the initial concept of universal remote, which can control the various type of devices without limitation of controlling different brands, was set up. But these kinds of remotes had their fundamental limitation that whenever a user wants to control the device, she should pass through too many steps, inputting the proper key code of target device. Recently, universal remote control's usage has moved from device-oriented (ex: turn on DVD player, volume up TV) to task-oriented (ex: play DVD, show TV program). Whenever task-based operation is executed by user, universal remote control transfers sequential control information to proper target devices in order to achieve the goal. This method can be very comfortable and a user can achieve her goal by one or two steps, but installation of task-based macro operation can be a burden to general users.

On one hand, a coordinate recognition technique by using IR LED and IR image sensor has been researched steadily [3]. Some old method of coordinate recognition system was using markers with pre-defined color in a visible ray range. By sticking marker to the moving object or body, we could recognize the coordinate by retrieved image data. But since this system uses a discrete color space, background color similar to pre-defined one caused frequent errors. By this reason, this could be applied in very restrictive situation. To improve problem, method for using IR LED as alternative marker and retrieve coordinate data by IR image sensor has been researched. By using IR method, we could obtain remarkably low degree of coordinate error ratio. Case of Nintendo's Wii, they used Wiimote and Sensorbar [4]. Wiimote has equipped the IR image sensor, and Sensorbar has equipped IR LED array. IR image sensor gathering IR LED images continuously, and by analyzing acquired images, Wiimote senses the 2 dimensional coordinate, moving TV display's pointer. This Wiimote procedure can offer user experience of direct pointing. Also, by using perpendicular axis and diameter of LED image's each point, Wiimote can sense the rotation and distance between Sensorbar and itself. Sony has submitted some corresponding patent. They stuck IR LED to the remote, and retrieve data with IR image sensor nearby the TV [5]. It is similar concept of previous method, but by using reflective tape segment to user's finger, this can response the user's gesture recognition in case of setting IR image sensor nearby the TV.

3 Point and Control (PAC)

As we mentioned, key code inputting step is the main reason that causes the usability of universal remote control to plummet. We propose the method to improve controllability by removing the step of key code inputting and replace it with a more intuitive way. Key code inputting in universal remote control is used as a means for transmitting user's intention that she will control the corresponding device. Without this step, it is impossible to control many devices concurrently with only one remote. This step is very exhaustive, but essential.

Conventional universal remote controls understand a user's intention by receiving key-code. On the other hand, PAC remote can catch it only by pointing of the target device. To achieve this, PAC remote and target devices must satisfy three conditions below:

1. Every target device must have its own ID information.
2. When a user points PAC remote to the target device, PAC remote must identify exact one among the whole candidate pool of controllable devices in real time.
3. PAC remote must keep every ID and control code information that it can control.

3.1 Identification of Each Device with IR LED

To handle the first condition, we identify every target device by using multi-dimensional IR LED. By sticking IR LED to the target device, we can retrieve two types of information from each target device. One is position information and the other is frequency information. Positional information can be presented similar to matrix, which contains row and column data. Frequency information implies each IR LED's flickering data.

3.1.1 Position Information

Multi-dimensional IR LED is composed of several IR LEDs, and each IR LED has its position data. In general, positional information can be presented with combination of row and column pair, just like the component of matrix. Figure 1 shows this. Left figure shows the one-dimensional matrix form, and right shows normal matrix form.

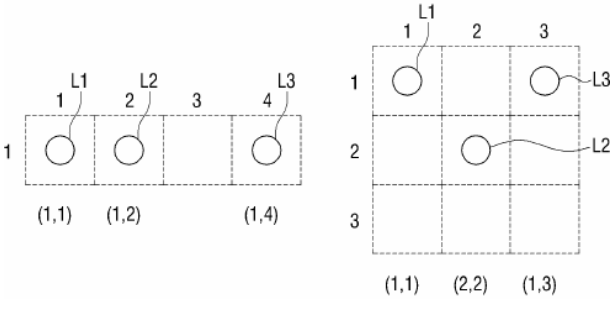

Fig. 1. Positional information of IR LED

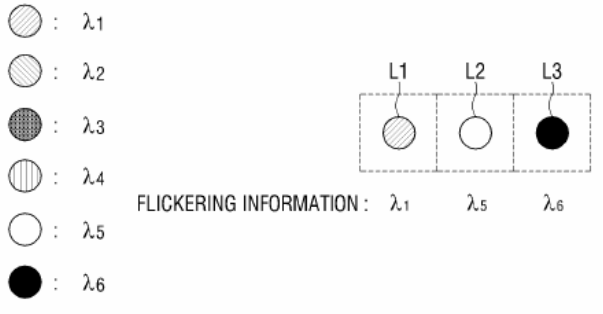

Fig. 2. Sequential information of IR LED

We acquired position data by bitmap image which was retrieved by IR image sensor. Image sensor was 640 x 480 resolutions. IR Image sensor's visual angle may affect result. Our image sensor had 160 degrees viewing angle. We set up HTS and other devices within 2 meter by 2 meters area. PAC wasn't work proper when the distance between IR LED and IR LED image sensor was closer than 1 meter. If distance is too far, we used upscale processing to correct the data. PAC was worked without any problem between 1meter and 7 meter.

3.1.2 Frequency Information

With positional information, each IR LED can represent frequency information by flickering. Figure 2 shows it. We predefine usable frequency like left side of the figure. In this case, number of predefined frequency is six, and each IR LED emits frequency among predefined frequency.

To deal with frequency data, we predefined 9 steps of frequency. To represent the frequency step, we adopted the reformed Morse code. Morse code's short element can be correspond to IR LED's high status (Which is represented with H), and long element can be correspond to IR LED'S low status (Which is represented with L).

We can use this code, but if IR LED blinks repeatedly we may not distinguish 3 and 7. We addressed this problem by adding HLHLH to every frequency. Figure 3 shows final frequency code we used.

Table 1. Predefined frequency using Morse code

Frequency	Morse code	Font size and style
1	. - - - -	HLLLL
2	. . - - -	HHLLL
3	. . . - -	HHHLL
4	. . . . -	HHHHL
5	. . . . .	HHHHH
6	-	LHHHH
7	- - . . .	LLHHH
8	- - - . .	LLLHH
9	- - - - .	LLLLH

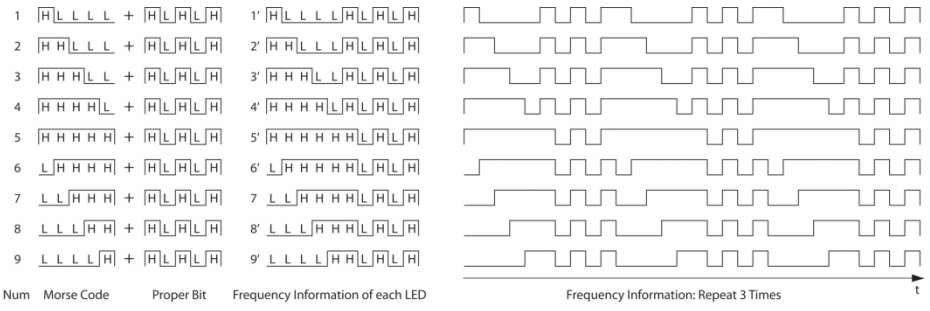

Fig. 3. Predefined frequency adding HLHLH code

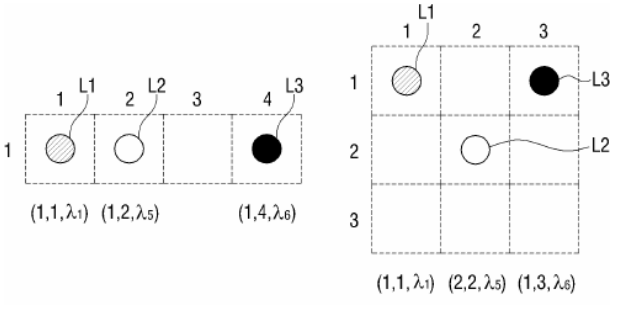

Fig. 4. ID information of target device

Convoluting each IR LED's position and frequency information, each device can have unique ID information. Figure 4 shows the final form of target device.

3.2 Notification of Each Device with IR LED Image Sensor

Second condition can be satisfied by adopting IR LED image sensor to PAC remote. By pointing PAC remote to target device, we can retrieve ID information that can be caught by IR image sensor's visual angle. Figure 5 shows this. Pointing PAC remote, controllable target device within angle can be represented. Controllable candidate is device 220, 210 and 230. Since device 210 is the closest to the center of retrieved image, PAC remote send control code for device 210. Since user using remote with rotating or moving, Retrieved data should be processed with scale and rotate invariant.

3.3 Transmission of ID and Control Code Information of Target Device

To achieve last condition, we sequentially transmit necessary information to PAC remote. Fig 6 shows the transmission sequence of target device's information to the PAC remote. PAC remote has initially paired device's (which is called main device) ID and control code information. By wired or wireless connection with main device, various CE devices (which is called sub device) can transmit their ID and control code information. After main device receives the sub device's information, transmits it to the PAC remote. A PAC remote has s storage structure for ID and control code information, and updates its table when the new device is added.

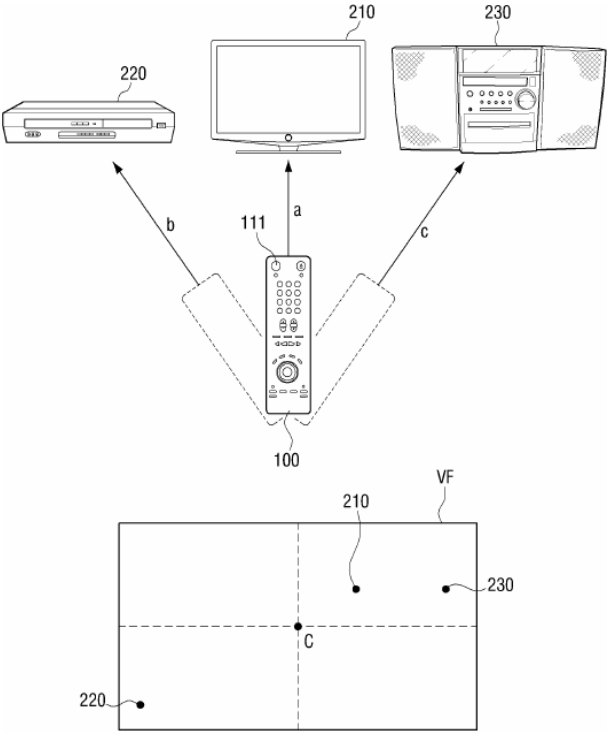

Fig. 5. Notification of target device between candidates

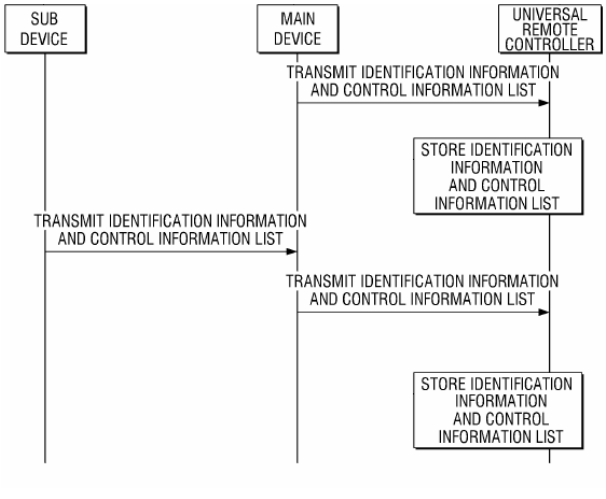

Fig. 6. Transmission of target device's ID information and control code information to PAC remote

4 Conclusion

Many CE users spend considerable amount of time in controlling several devices at a time. Some of them try to find the exact remote of the target device, and others use a universal remote control and go through complicated steps to get what they want. It is obvious that there is no difference between these two approaches because they both drop the usability. This may give a user bad UX anyway. PAC can be the trouble-shooting method compare with these two methods. PAC can be applied for a various type of CE devices like DTV, BD or DVD player, STB, game console, audio player, computer, HTS and mobile devices.

By proceeding usability test, some practical issues for enhancing PAC have been revealed. User may need to point the objective when she wants to select the target. But once the selection ends, she doesn't want to point target anymore, just wants to operate the device without any constraints. We divided remote's mode into two parts. One is pointing and the other is operating mode. Selection for target among many vertically stacked devices is also a problem. Generally, CE devices in home environment are stacked, and in this situation, user may have some trouble in pointing the exact device because inter-device distance is quite narrow. Visual or haptic feedbacks of the target device when they are pointed by the user can be helpful. We are planning to implement the scenario that can be executed device-to-device such as inter-device contents sharing or easy task-based operation.

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