Abstraction Program and Development of PORON (Personal Oriented Robot for ON STAGE)

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1. Introduction

The dance category of Robocup junior has changed to ON STAGE in 2016. Some of rule maker's intentions could be seen in the revised rules and we thought that most of them demanded flexible and various expressions through using variety of programs and rules. ON STAGE required proper allocation of tasks to each team member who must exhibit his or her originality. On the other hand, the difference in skill is unavoidable even in programing ability which is a basis in giving the robot expressions. One solution on this problem was to prepare one or some expert members highly specialized to programming. However it was desirable to eliminate the difficulties of programming due to difference in age or skill level to cope with unexpected circumstances. Further, we began to sense the limitation of variability in expressions of program learning kits as typified by LEGO. In particular, we encountered many opportunities to feel difficulties to make advanced expressions by blocks with advancing age of the user, which imposed another problem of difficulty in exhibiting originality in consequence.
Based on the above, we developed a new robot "PORON" that has systems with properly allocated servomotors to create expressions and LED devices to express emotions. He also could communicate using the ZigBee and could be controlled by the Rapsberry Pi, thus he was thought to satisfy required elements for the current ON STAGE sufficiently. The PORONs could be upgraded by adding new sensors or combining multiple sensors by us to be able to do more activities. Eventually, they might be able to have conversations by the speech recognition functions and AI installed communication systems. Although these functions had been implemented already to other expensive and high performance robots, average persons like us began to have their own potential to develop them without special skills or abundant funding. Further, we applied abstraction to control programs for the robot, which played an important role in simplifying programs for ease of use for many. We brought the scheme of programing sys-

tems of the PORON close to the human conception since it was designed as the ON STAGE robot giving an impression of "humanness".

2. Experiment and discussion

2-1 Design

The most important element we thought was being "KAWAII". The word "KAWAII" is today beyond Japanese and becomes as a global common term, which attracted our attention as it is listed in the Oxford English Dictionary as "KAWAII". It should be emphasized that "KAWAII" is highly abstract concept and perceived based on emotions and subjectivity. Conditions that bring an emotion of "KAWAII" were investigated in this study of the PORON from a view point that sharing a common concept in expression "KAWAII" between we, robot creators and observers was important. Based on the results we made following conditions; round and silky smooth appearance, having big eyes giving expressions (Fig.1), being beautifully colored (Fig. 2), and having an impressively simple design which can be easily taken a likeness (Fig.3). In addition to those external conditions, each part of the robot was enlarged and the chip of the part was pointed to bring the PORON to the attention of observers, who could capture delicate changes in movements easily. Same robots with different outer colors were prepared, which represented a different character for each PORON and this also offered an advantage of appealing the effect of an application of the abstract program explicitly.

Figure 1. Eyes of the PORON

Figure 2.Colorful PORONs

Figure 3. An example of likeness of the PORON

2-2 Reflection of a character of a creator

Expressive motions of the PORON will be described. Movements play an important role in expressions. It can safely be declared that the movement is a true character of the creator. At first, we considered what a character of the creator means. Expression of "joyous" is examined as an example. When we want to give a robot an expression of joy, one may express it by waving around arms of the robot. Another may express it with plural actions of the robot, namely spinning around with waving his arms right and left and saying "Yeah! Yeah!" It is to visualize creator's own emotion regarding to joy. The expressive action of the PORON was realized by use of the "abstract expression". Concretely speaking, some elements (or primitives) like "shaking a head", "waving a hand", and "extending arms" were prepared, and each of them or a combination of some primitives was given a specific name which was an abstract expression. It is possible to combine some abstract expressions to show a different emotion. In addition, more delicate expressions can be achieved by combinations when the primitives are configured more specifically at the first stage. It became possible to express increased range of emotions by combining information collected by sensors of the robot with these abstract expressions. As will be described next, this operation of abstraction became a tool to plug the skills gaps

2-3 Program tool regardless of skill

We found that the abstraction of an expressive motion described above can also be a tool to remove the barrier of the programming skill. In the first place, the reason why each member could not express individuality using the existing tool such as a kit was that it contains a conditional branching and an operation as a package. We thought that the expressional, operational, or conditional branching must be independent to resolve this problem. Based on this consideration, the abstraction program we used will be explained specifically.

First of all, we made primitives (Fig.4) and followed by making of abstract expressions by combining multiple primitives (Fig.5). The "primitive" we are referring here is the smallest control unit to indicate a motion of the robot and is equivalent to something like a monofunction

or an API (Table 1). Then, programs to control a whole system were created which were needed to make the abstract expressions work (Fig.6) and a scenario specifying their ordering was created. Due to the differences in difficulty level among these 4 programs, a service each member can provide depended on his or her age and skill level (Table 1). Based on difference in ability, it was possible to assign a work that could match each member's skill. Further, it was possible to show a wide variety of expressions irrespective of skill levels by sharing primitives with all members, incorporating each member's individuality using the abstract expression program and preparing a scenario taken as a reflection of which, where and how the abstract expression must be used.

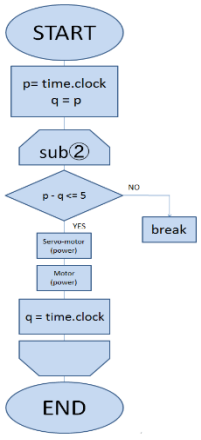

Figure 4. An example program of primitive

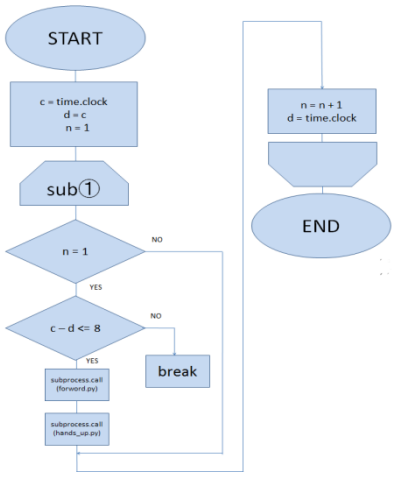

Figure 5. An example program of main program

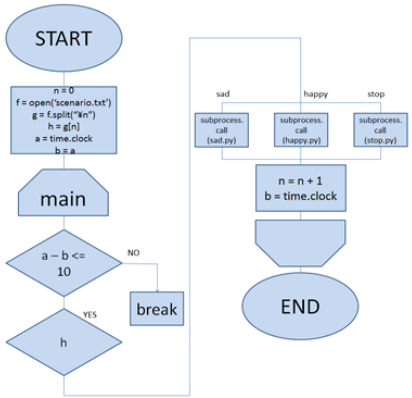

Figure 6. An example program of main program

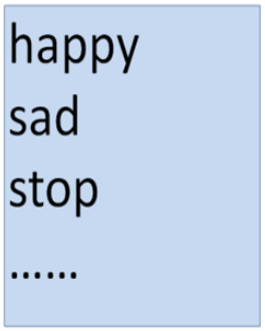

Figure 7. An example of story line

	Types of program(Table 1)				
Knowledge of software (A>B>C)		OS-Device Program	Function	Abstractions	Story line
	A	○	○	△	△
	B	×	○	○	△
	C	×	×	○	○

※ ○ means having proper skill, △ means having a good understanding but too low skill level, and × means being deficient

An example of primitive (Table 2)

Neck	Right arm	Left arm	Ears	Eyes	Legs
Facing right Facing left Shake its head	30 degrees 45 degrees 60 degrees 90 degrees 120 degrees	30 degrees 45 degrees 60 degrees 90 degrees 120 degrees	45 degrees 90 degrees 330 degrees	○○ — ／＼	Front Back Rotate ±45 Rotate ±90

2-4 Benefit of abstraction program

A shortcoming of the abstraction is a lack of personality caused by simplifications. To solve this problem, we prepared as many programs as possible for the abstraction and tried to install a unique abstraction program into each robot to express its specific individuality that was allocated from the beginning. Previous program we have developed enabled to express very delicate signs of emotion owing to its too detailed program configurations. On the other hand, it also had shortcomings: increased number of combinations made processing time much longer and the program itself became quite complicated, causing an increase in programming errors. However, the abstraction program will facilitate the processing procedure and we will be able to concentrate on development of the scenario, which will promote us to emphasize descriptive expressions. In other words, we can create a program according to thinking process of the

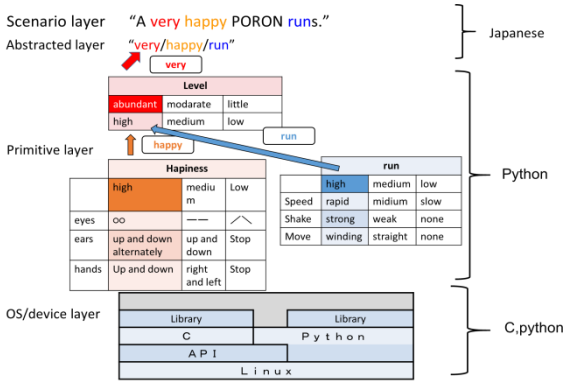

Figure 8. The system

common man. An abstraction method in this case is shown in Fig. 8. When the scenario is “A very happy PORON runs” for example, the term “very” defines a degree of motion, and “an exaggerated and rapid” motion is performed in this instance. These are operated by the Linux OS.

3. Conclusion

We convinced that the abstraction program is a one of effective means to fill gaps among team members in programming skill through the development of the PORON. It can be said that it is also effective as a method to perform “specialty” of each member. We contrived ways to reduce the difficulty in the usage of the abstraction program by allocating character strings easily understandable even by younger users and sharing primitives. It enabled to realize robot performance what a team member really wanted even if his or her skill was not so high and expanded the capability of developing self-made robots. Our experience proved that a lack of money does not necessary prevent creating robots. In course of creating the PORONs, we utilized familiar materials in our circumstances and sourcing itself was accompanied with pleasures. And yet, we think that it is not a dream to create a robot with performances comparable to those of a high-performance and expensive robot made by grown-ups.

From the stand point of our own study, a simply designed robot has the advantage that its motions can be integrated to simpler motions. By searching basic and simple motions using such a robot, we felt that the PORON inspired us in terms of considering what kind of meaning or impression these motions give us.

We expect increase in the next generation ON STAGE robots based on a concept of the PORON.

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