Ping: An Affective Robot Used in Learning by Playing

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Abstract - In this paper, an emotional and sensational robotic system by which the machine perception and the representation of affectivity can be studied is developed. This electromechanical system can be used as a versatile educational kit (module) for researchers and students. An important feature of this new system is that three demonstration modes have been built in the controlling system to perform the activities of playing, news broadcasting and learning. In the Human-Machine-Human (HMH) interaction mode, players communicate with the controller of the robot via face-to-face talking. To facilitate operation so that the robot can be controlled easily, we employ a touch screen panel with preprogrammed macro function keys. With this feature, players of this system will have impressive experiences. In the singing/news-broadcasting (SNB) mode, the robot acts as a singer or a broadcaster. Users can program the system by playing the sound records, or running a document through the Text-To-Speech (TTS) tool in conjunction with the robot expression, to perform the demonstration. In the Human-Machine (HM) interaction mode, a player can communicate with the robot directly. For this purpose, an Idle-Sound-Expression-Action (ISEA) structure that can link the robot's action and the potential player's response is proposed. Based on the educational method of learning by teaching, we will demonstrate a case in which the robot helps the player to learn the 9x9-table of multiplication. In this situation, the robot acts as a weak learner. He requests the player to instruct the 9x9-table of multiplication at every moment. Consequently, the player can improve his performance by going through this continuous teaching process.
To properly control the robotic system for playing games, student developers need to possess and integrate several fields of knowledge such as programming, signal processing, and mechanical structure. It will be shown that by using the proposed robot, the goal of work-integrated education can be reached for everyone.

Key Words- Robot, Education, Robot Learning, AI

1. Introduction

In Japan, according to the survey of 2007, it is found that electronic pets for the seniors born after War II need the ability of expenditure. Owing to the trend of decreasing birth rate, on the other hand, the younger are more interested in computers and internet products that can enhance learning and competition capability. A survey made in the U.S indicates that there is an expected growth in the market of personal service robots [1]. Generally speaking, robots can not only help the elder to improve the quality of lifestyle, but also provide a platform of learning for researches and education.

This paper aims to provide helpful educational aids for kids. By using our facial expression robot shown in Figure 1, kids can acquire knowledge, for example, multiplication table, through the interaction between with our robot and kids. As we can see that kids not only can teach the robot multiplication table, but also can be motivated in learning by playing. So far we have developed the entire robot system already. We also have achieved the educational target we have set.

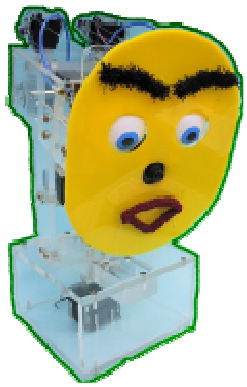

Figure 1. Ping: an Affective Robot

2. Architecture of an Affective Robot

The architecture of the proposed affective robot [2] shown in Figure 2 is comprised of a mechanic unit, a micro controller and the interface.

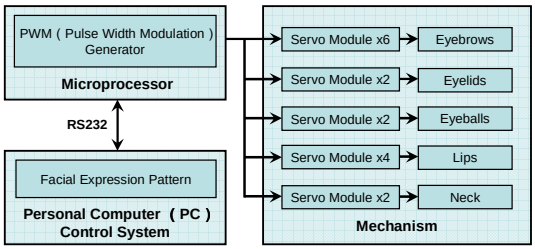

Figure 2 Architecture of an Affective Robot

2.1 The Mechanic Unit

The Facial Expression Robot System (FERS) is designed to mimic human's head. It has some DoFs (Degree of Freedoms) just like eyes, eyebrows, eyelids, mouth and neck as illustrated in Figure 3. The mechanic unit contains several elements including levers, motors, gear wheels, slipping wheels, rotating wheels, bearings, steel silks and springs. These elements are combined together in order to make the robot act like human's face. In addition, degree of freedom, server motors, and interconnection between DoFs and server motors are also include in the mechanical parts.

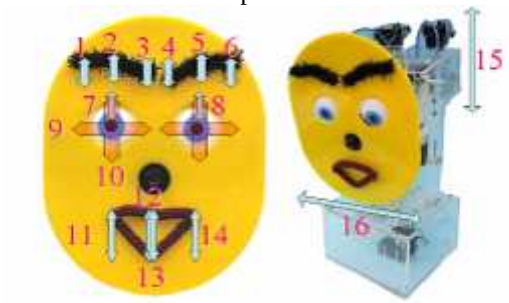

Figure 3. Sixteen DoFs in the Mechanic Unit

2.2 The Micro Controller

The RC server is controlled by the MCS-51, which is a widely used microprocessor in industry and schools. This micro controller operates in 40 MHz clocks, and can generate 16 sets of Pulse Width Modulation (PWM) signals to the input of RC servers independently, See Figure 4.

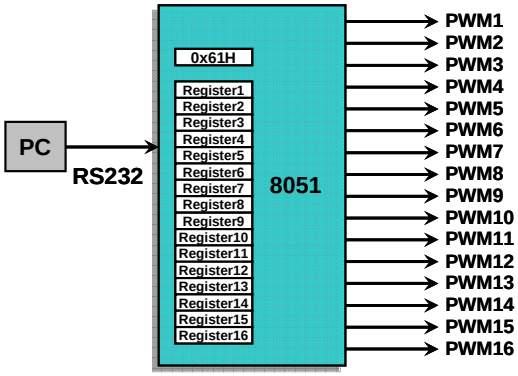

Figure 4. Architecture of the Micro Controller

2.3 The Interface

The PC sends signals to the micro controller via RS232, as displayed in Figure 5.

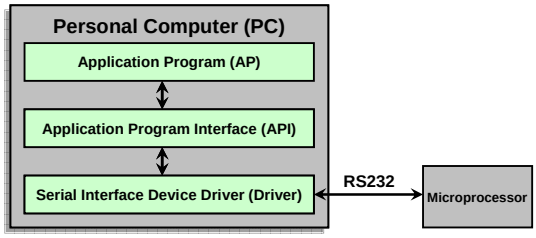

Figure 5. Control architecture of the interface.

3. Three Modes for Learning by Playing

3.1 The Human-Machine-Human (HMH) Mode

In this mode, an interface known as facial expression robot system shown in Figure 1, is developed so that direct communication between the external audience, especially kids, and the robot can be established. The controller behind the robot can see outside vision and hear outside voice through a CCD camera and a micro phone accommodated on the robot, respectively. An API programmed in Visual C++ and Visual Basic is developed for the controller. On receiving operation instructions, the robot will act through the speaker, the DoF or sound to respond the audience. But note that the robot must be controlled by a person.

3.2 The Singing/News-Broadcasting (SNB) Mode

In this mode, songs, for example, "Two tigers" and "Look back, my girl" are prerecorded in the robot. After receiving some programmed input data, the robot can perform different facial expressions. In this way our robot not only can sing songs and broadcast news, but also has the facial expression to reveal its emotion. For completion of relevant works, we have developed a Sequential Emotional Behavior Scheduler (SEBS) interface [3], as shown in Figure 6.

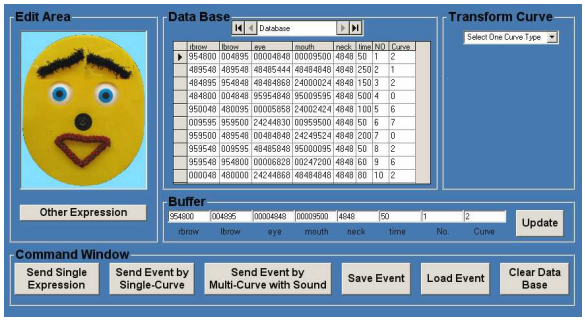

Figure 6. Interface of SEBS

3.3 The Human-Machine (HM) Mode

It is described in the eMuu project [4] that interacting with the screen character or the robot character will make little joy, but presence of a person can motivate people to make more efforts in doing a task.

We use learning of the multiplication table to illustrate the HM mode. Initially, the robot does not know what multiplication table is. Kids can teach the robot to learn the multiplication table just as they are the robot's teachers. Since the kids have to be acquainted with the multiplication table in advance, .they can acquire confidence and get more interests in the process of interacting with the robot. Moreover, the robot's facial expression is attractive to kids. This will further encourage the kids to learn the multiplication table in the process of playing. Since our robot can memorize the input data sent by the users, the more the kids play, the smarter the robot will become.

In this mode, an Idle-Sound-Expression-Action (ISEA) structure that can link the robot's action and the potential player's response is also embedded in our robot. Figure 6 shows interface of the multiplication table learning robot.

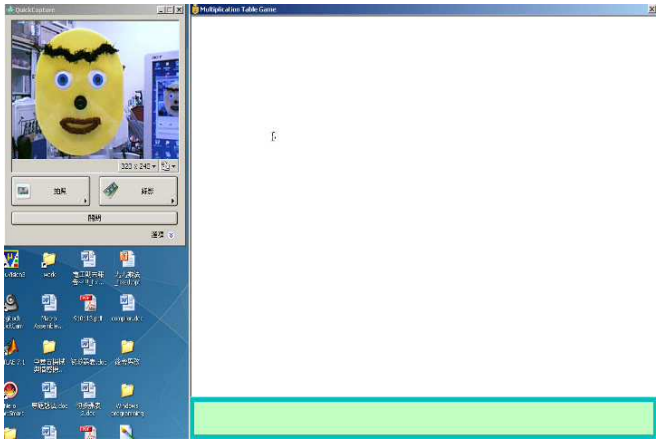

Figure 6. Interface of the Multiplication Table learning robot

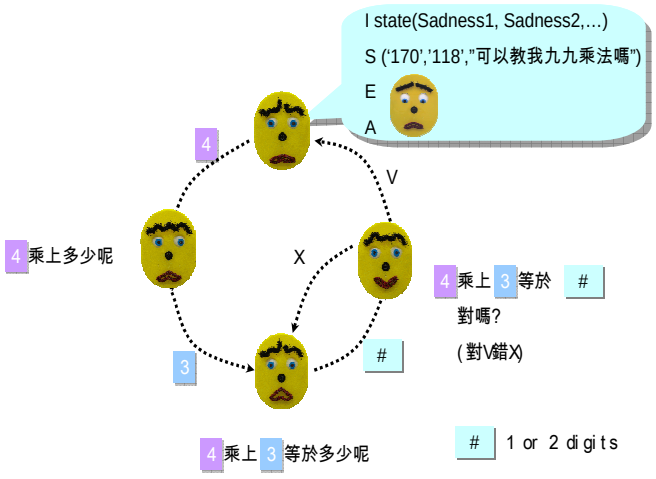

Figure 7. State Diagram

***I* (Idle)** representing states:

The robot can select different expressions of the states listed in the Database randomly by itself (Figure 8).

Figure 8. Database of Emotion and Facial Expression

***S*ound** (speed, pitch, and sentence):

The robot can communicate with kids by the Text-To-Speech (TTS) tool released by Micro Soft Co..

***E*xpression:**

The robot has different facial expressions based on the state played by the kids.

***A*ction:**

The Robot's neck can move up/down or left/right.

3. Application to Learning by Playing

Kids can teach the robot the multiplication table through a touch screen panel. We briefly introduce the operation below via a scenario.

<Begin>

Robot: It is interesting to learn multiplication table.

Can you teach me?

(waiting for 10 seconds)

You can show the number by using the touch screen panel. And I am ready to learn.

Let's begin.

Kid: (Write the number "3" down)

Robot: What do you want to multiply it by?

Kid: (Write the number "2" down)

Robot: What is the result of 3 * 2?

Kid: (Write the number “5” down)

Robot: 3 X 2 =5, right? (interrogative pitch)

Kid: (Write “✖” down)

Robot: What is the result of 3 X 2? (with faster speed)

Kid: (Write the number “6” down)

Robot: 3 X 2 =5, right? (interrogative pitch)

Kid: (Write “✓” down)

Robot: 3 X 2 =6. (affirmative pitch)

Robot: Let’s begin again.

Keep on teaching me.

I want to learn more.

Kid: (Write the number “7” down)

Robot: What do you want to multiply it by?

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Through a sequence of playing process in the HM mode, the robot can interact with the kids through a touch screen panel. Kids can also be motivated to learn the multiplication table. Actually, this mode aids kids to learn in playing. This is much more effective in the field of education engineering.

4. Conclusion

Through the aids of our robot, we can trigger kids’ motivation of learning, and enhance their interests in learning the multiplication table through a playing process. The presence of emotional expressions significantly increases the enjoyment of interaction with the robot character [4]. We will conduct a questionnaire to testify our hypothesis that a robot with expressions and voices can aid kids in education, and can become kids’ helpful learning partners.

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