Mechatronics Education Using Robot Competition in Okayama University of Science

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Abstract

Electronics machines make daily human life more convenient and comfortable and try to ease burdens. When designing and manufacturing such mechatronic systems, the engineers need to have a wide range of knowledge. The purpose of our education is for students to learn to use mechatronic techniques. To realize our goal, we regard "an interest in creation" of our student as an important educational method. In this paper, we propose and try an educational method for mechatronics creation using "their interest". The method is to hold robot competitions between 1st and 3rd year students as a regular curriculum. In order to confirm the progress of our students in our engineering course, in the last year, some students entered the Rescue Robot Contest held in Kobe Japan. As a result, our student team got second place, a great honor considering it was our first attempt. We confirm that the robot competition is a useful method to make students study by themselves.

Keywords: Mechatronics Education, Robot Competitions, Interesting in Creation

Ⅰ. Introduction

Recently, the daily-used electronic machines to help human labor. These machines make daily human life more convenient and comfortable and try to ease burdens. In fact, it is very difficult to find electronic devices that do not use mechatronic components or micro-computers. To design and manufacture such mechatronic devices, engineers need to have a wide range of knowledge. However, it is difficult to learn it in a short period. Especially, in the educational curriculum of universities, there is not enough time to learn the technology in four years. The purpose of our education in our university is to train students to use mechatronics techniques such as microcomputers, motor driver circuits, sensors and create structural drawings. In order to realize our goal, we regard "an interest in creation" of our student as an important educational method[1]. We understand that students who enter in the engineering course have much interest in creative work. In this paper, we propose and try the educational method for mechatronics creation using "their interest". The method is to hold robot competitions between 1st and 3rd year students as a regular part of the curriculum[2-4].

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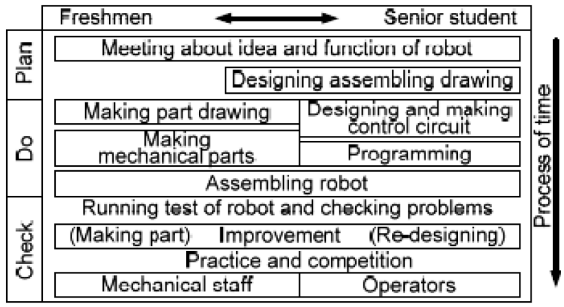
Ⅱ. Importance of Robot Competition in the Engineering Education

In order to make this education more effective, the educational method using robot competitions was used. [Fig. 1] shows the time schedule and working processes of a typical robot competition. In the beginning of the competition, all members held a meeting about the idea and functions of the robot.

Next, the senior students made an assembly drawing of the robot. In the production process, the younger students made the mechanical parts. The senior students made the control circuit using a microcomputer, and wrote some programs for the microcomputer. All the team members assembled the robot. In the checking process, nobody succeeded in making active robots



[Fig. 1] Schedule and processes of typical robot competition

without modifying and improving the robot. After running tests of the robot, the younger students made additional parts modifying the robot, the senior students re-designed and improved the robots from both view-points of hardware and software. Finally, they enter the competition. The process of the robot competition includes “Plan”, “Do” and “Check” processes. The whole process is similar to real creative work in companies. The checking process is a good opportunity to learn engineering knowledge and techniques from their errors and failures. In addition, both processes of the robot competition and company production have a time limit. One is the day fixed for the competition. The other is the appointed date of delivery. To meet the time limit, the leaders must make a plan for making and testing the robot. These experiences help them develop leadership. As a result of the robot competition, even if they fail, they have a good opportunity to get engineering knowledge and techniques. Their interest and the experience of their failures make the educational efficiency higher.

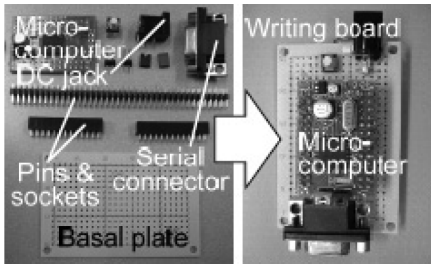
III. Contents of the Mobile Robot Competition using Vibration Motors for Freshmen

For a mechatronics education, the freshmen period when students are taking their first engineering lectures is very important. Therefore, we apply the special curriculum to the freshmen as soon as they enter our university. [Fig. 2] shows a sample of a mobile robot that the 1st year students made. The robot consists of several vibration motors(4 or 6 motors), a micro-computer and a motor driving circuit. The micro-computer can select to drive the motor according to a program, that is, the timing of each

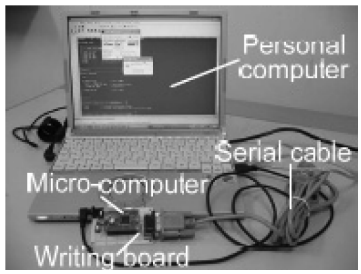
[Fig. 2] Mobile robot using vibration motors

motor is controlled by a micro-computer based on a sequence control program that the students developed. The robot can move in any direction by changing the timing of the driving motors.

In the first 3 weeks, the students make the micro-computer and the writing board that can have the control program installed through a serial communication port as shown in [Fig. 3]. From the 2nd to 8th weeks, the students design the control circuit. [Fig. 4] shows the electrical parts to make the driver circuit and a view of the students working. In this period, teachers only teach the operational principle and a few samples of the electric motor driving circuits. The students must consider how it can connect to the micro-computer using their experience of making the writing board. From the 8th to 10th weeks, the students design the body of the robot using computer aided design (CAD). They make the body of the mobile robot as a card model using cardboard based on the mechanical drawings that they designed. From the 10th to 12th weeks, the students design the control program for driving the vibration motors. It is difficult to control the mobile robot so as to make the robot move straight or rotate without changing the arrangement of the vibration motors. To control the motion of the robot, the students must investigate the mobile characteristics of the robot by changing the arrangement of motors and the control program through trial and error. Unfortunately, the students have not learned programming, a computer language and dynamics. “To win the competition”, they need to modify the sample control program made in C language, that is, they also need to study these subjects by themselves. In addition, some of them will study the mechanism of various mechanical machines and physics such as inertia. They finished making their robots in 12 weeks(18 hours). Before the competition, the students adjust both the software and hardware of the robot at

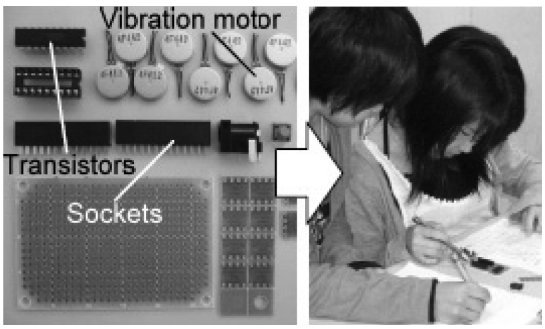


(a) Electric parts (b) Writing board



(c) Setup for testing

[Fig. 3] Making process of writing board

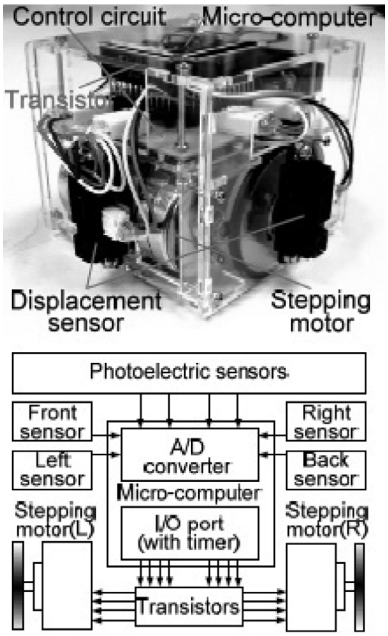


[Fig. 4] Making process of controller

same time. These students' trials make them notice the importance of dealing with both elements of "Software" and "Hardware" as a creative work.

Ⅳ. Creative Curriculum for 2nd and 3rd Year Students

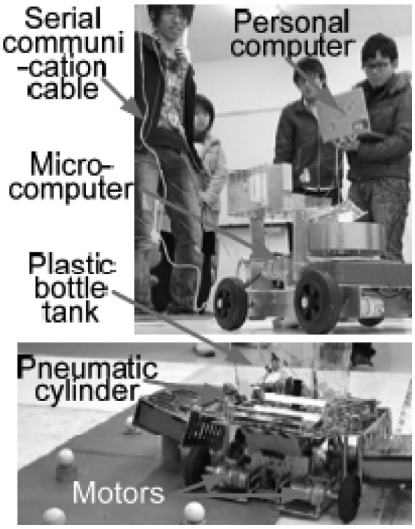
As a training class for the 2nd year students, we hold an automatic searching robot competition[3]. [Fig. 5] shows the automatic searching robot that the second year students made. The robot consists of two stepping motors, four infrared displacement sensors, photoelectric sensors, a micro-computer and a motor driving circuit. The micro-computer can decide the moving direction of the robot according to the output



[Fig. 5] Automatic searching robot

voltage from the displacement sensors and the photo-electric sensors. In the training class, the main purpose of this education is to make the students learn the electric circuit knowledge and techniques and construction techniques of microcomputer programming using C language. The lower figure in [Fig. 5] shows the schematic diagram of the control system in the robot. The micro-computer detects the displacement between the robot and the obstacles through the analog to digital (A/D) converter in the micro-computer and the displacement sensors. It also detects the direction of the target from the output from the photoelectric sensors. The micro-computer selects to drive the stepping motors. The students deal with both the hardware such as the electric circuit, and the software such as C language programming of the robot. These experiences will help them make the various control systems in the factory as a future worker.

As a training class for the 3rd year students, we hold a remote control robot competition[4]. In the competition, we hold two types of competitions. One is a tug-of-war robot competition in which the powerful robot with low speed is one of the advantageous methods to win. The other is a ball toss robot competition that requires speedy robots with good maneuverability. So that only one robot from

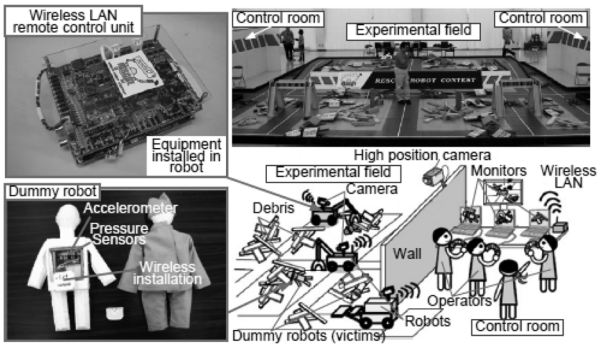


[Fig. 6] Robot competition in 3rd year student class

each team can enter both competitions, the students must consider the tradeoff of the specifications of the robot. From the teachers view point, we mainly aim to develop students' ability to design and plan the production work. This training class is shared by the two curricula. One is a design competition for a mechanical design of the robot based on the strength and materials and the cost planning to make the robot. [Fig. 6] shows the view of the competition and the tested robot. The microcomputer in the robot was connected to the laptop computer through the serial communication cable. The micro-computer selects to drive the various actuators based on the serial code [8].

V. Educational Evaluation

In order to evaluate the development of our students for our engineering education, in the last year, some students entered the “Rescue Robot Contest” that is held in Kobe Japan[5,6]. In order to evaluate the result of our education, this competition is a first-time trial for them. [Fig. 7] shows the image of the competition and the equipment used. The competition uses a one-sixth scale model of a city based on an imagined situation after a huge earthquake. The dummy robot in the field serves as a victim. The dummy robot can detect the damage. It also has a wireless instruction to send the information about the applied force to the host computer. In the competition, the rescue robot works searching for the dummy robot, removing debris, rescuing the dummy robot and acting as an emergency transport. The operators can not look at the experimental field directly. They operate their robot with CCD cameras mounted on the robot. In the operation of the robot, the wireless LAN remote control unit as shown in [Fig. 7] is used. The control unit has 10 PWM output ports, 4 A/D input ports, 3 video input ports, wireless local area network ports and so on. In order to use these functions of the unit, the students need high level engineering techniques and wide areas of knowledge. In addition, in order to design the robot so as to make the best use of the control unit's functions, rich, practical creative skills and experience are also needed.



[Fig. 7] Image and equipments of the rescue robot competition

[Fig. 8] Best robot award

It means that only the engineers who have abilities can win the competition. As a result, our student team got second place in the contest [7] and the "Best Robot Award in the Rescue Robot Contest" as shown in [Fig. 8] was awarded to our team from the Robotics Society of Japan, a great honor considering that it was our first attempt. This story is good evidence of our educational evaluation for our particular educational method[8]. As a result, we confirm that the robot competition is a useful method to make students study mechatronics technology and engineering by themselves.

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