Team Description Paper: BabyTigers - R 2019

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Abstract. From 1998 to 2004, BabyTigers which were the team of Osaka University, participated in SONY Legged Robot League. And from 2005 to 2010, BabyTigers-DASH[1] which consisted of Osaka City University and Ryukoku University participated in Standard Platform League. After 2011, BabyTigers - R[2, 3] of Ryukoku University has participated in RoboCup Logistics League which is one of the RoboCup Industrial.
Our laboratory has two research fields; one is wireless communication[13, 14, 10, 11, 23, 24], and the other is artificial intelligence[15–18, 6, 8, 9, 12]. So in Logistics League, we aim to make communication system with each other robot like as multiagents.
Unfortunately, there are no students who have been attended to RoboCup 2018 Montreal in this year, and all five students, including one master student, are beginners. Therefore, the programming language used by our team was changed from C++ to robView which is implemented in Robotino. In addition, in order to increase the number of participating teams in Japan, we examined a method to make league management simply.

Keywords: Logistics League, RoboCup, BabyTigers - R, robotino

1 Introduction

This paper describes BabyTigers - R in 2019. Our team belongs to the Department of Electronics and Informatics, Ryukoku University, Japan.

There are no students who have been attended to RoboCup 2018 in this year, and all students, including one master student, are beginners. Therefore, the programming language used by our team was changed from C++ to robView which is implemented in Robotino. And from the view of CPU, we need only Robotino in order to attend the RoboCup. The external computer is not required. In addition, in order to increase the number of participating teams in Japan, we examined a method to make league management simply.

Due to the fact that Robotino was used in the World Skills and the World Youth Skills Competition for mobile robot, there are many industrial high schools

that have Robotino in Japan. The changed languge from C++ to RobView aims for them to join RoboCup Logistics League with their technology and equipment, and the preparation of simple Logistics League aims for BabyTigers-R to organize the Logistics League in Japan. From these efforts, the possibility of holding RoboCup Logistics League in Japan will increase. In fact, we plan to implement our simplified version of the Logistics league at JapanOpen, which will be held in August 2019. It will also be held at RoboCup Asia Pacific in October 2020.

2 RCLL using RobView

There are several tasks in order to attend the RCLL with robView on Robotino. First, to communicate with the RefBox, which is the referee computer, is required. Next, to control the external device, like as the gripper, is required. Finally, it is necessaery to run the multiple robview programs sequencally and automatically, because it is diffucult to write a lot of tasks in one robview file.

In this section, we describe the methods how to solve these problems.

2.1 How to communicate with the RefBox

For RCLL, Robotino must communicate with the RefBox in order to get the points. The protobuff of RefBox, which is the communication module, required the Ubuntu 14.04 or higher. But the operatin system running on normal robotino is Ubuntu 12.04 So in order to attend RCLL, the external computer which runs Ubuntu 14.04 or later, is required. Just now we can upgrade the version of Ubuntu on Robotino from 12.04 to 14.04 by the image-file we can get at the openrobotino site [27]. Then we can run the communication program between robotino and RefBox.

But it is diffucult for me to im,plement the communication function block on the robView. So I provide the communication program which bridge the date by using the some files. The communication program with the RefBox makes the some files which includes the data from the RefBox. The program on the robview can get the game status, MPS information, etc. from the data exchanging function block. And if the robview wants to send the data to RefBox, for example, the exploration data, the prepare of Machine instruction, the rebview write the data for some files. After the communication program reads them, it will send it to the RefBox. Note that there are some time delays, about 2s.

2.2 Hot to run the robview on the terminal

We made the communication program with RefBox and the running script on robotino. And we had a test running on German Open 2018 and 2019. We will publish its program in order to hold a Logistics League at Japan Open 2019 and RoboCup Asia Pacific 2020.

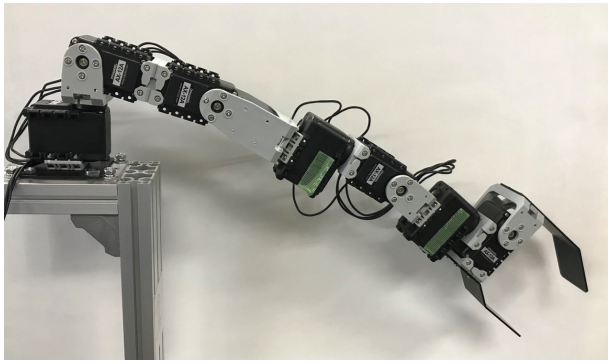

Fig. 1. The gripper hand we use.

2.3 How to control the gripper

Figure 1 shows our new gripper. This gripper has seven motors; one controls the gripping hands, three routates the gripper, the other three motors are connected sequential. We implemented the function block program to View 2 or 3 in order to control the gripper. The movie[26] shows that our gripper gets and puts the work from/to the Cap Station in German Open 2019.

3 Logistics league with Dummy MPSs

At the local meeting in RoboCup 2018, we proposed the RoboCup Logistics League for beginner. This is currently working by Stefan Brandenberger. On the other hand, our motivation of this proposal includes not only to make a new comer to attend easily but also to make the competition easily, that means this proposed method will help the organizer to make the game easily. For holding the Logistics League, fourteen MPSs which are customized for RCLL, are required. Currently, because they are stored at Carologistics it can be used if the competition is held in Europe [28] and it is difficult to hold in Asia and the other area except for annual RoboCup. Now we propose the Dummy MPS in order to hold the Logistics League easily. We can hold it without the modification of RefBox because we make the communication module using Raspberry Pi.

As the robot competitions using Robotino, which is an omnidirectional mobile robot provided by FESTO, in Japan, there are the World Skills (Mobile Robot) and World Youth Skills (embedded Robot Software) Competitions. The direction of this competition has been changed. It requires not only the robot control programming techniques, but also the ability of creating a robot themselves. Then since 2016 teams use not the common robots, Robotino, but the hand-made robots. Currently, it is a transition period from Robotino to a handmade robot, and both robots can be used. But there are many teams that use Robotino as the competition robot even in 2018. Figure 2 shows the number of participating teams and the ratio of the robot type. The ratio of teams using

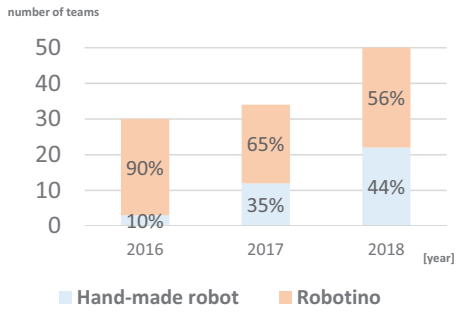

Fig. 2. Number of participating teams and the ratio of the robot type in World Youth Skills Competition from 2016 to 2018

Robotino is decreasing, but the number of teams is not decreasing, and in 2018 it has increased over the previous year. There is a request from those teams to hold a competition that can use the Robotino as the common robot.

Now, RCLL[29] uses the Robotino as the common robot. However, the processing machines required for RCLL are very expensive, and it is difficult to hold the competition outside Germany and Europe. Therefore, in this research, we aim to hold the same competition by processing with human hands without using the processing machine that is essential for RCLL. At that time, the communication program with the RefBox as a referee's program, which controls the flow of the game, is required, since we use the conventional RefBox same as the original RCLL uses. Using Raspberry Pi, a small microcontroller that can be inexpensively purchased around the world, we make a communication program instead of MPS with RefBox, and aim to hold RCLL outside Europe, like as Japan.

In the following, Subsection 2 introduces RoboCup Logistics League, and Subsection 3 describes Modbus/TCP, which is the communication protocol used between RefBox and MPS. Subsection 4 describes the dummy machine that we made, and Subsection 5 shows the survey result. Finally, we conclude this Dummy MPS in Subsection 6.

RoboCup Logistics League In RCLL, two teams divided into cyan and magenta simultaneously explore the work environment, transport the processed products and required parts, and deliver the products using the mobile robot Robotino [30]. There are Modular Production System (MPS) (Fig. 3) and RefBox as the equipment that are prepared by the organizing committee of RCLL. The MPS is assumed as the processing machine in a real factory, and RefBox is a program that plays the role of a referee. The RefBox communicates with another computer using two types of communication protocols during the game. In order to communicate with Robotino as a team's robot, the RefBox uses the Protocol Buffers made by Google in order to share the product information. For MPS, the Refbox uses Modbus/TCP in order to tell the processing information. The game

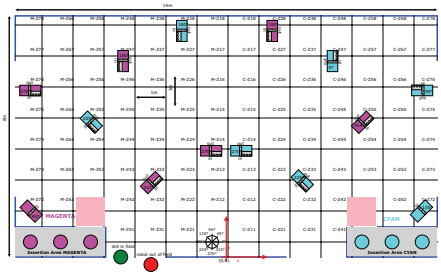

Fig. 3. RCLL game field [30]

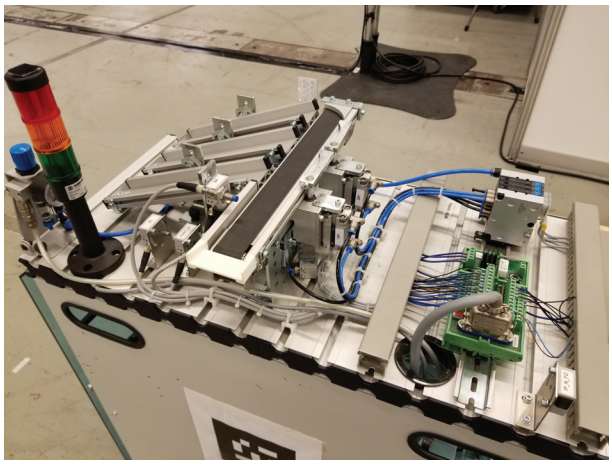

Fig. 4. Modular Production System used in RCLL [30]

field is shown in figure 4. In this figure, the rectangles colored cyan and magenta indicate the MPSs, and there fourteen MPSs in the field, which size is 8 $times$14 [m]. There are five types of MPS; one Base Station (BS), two Cap Stations (CS), two Ring Stations (RS), one Delivery Station (DS) and one Storage Station (SS) per team. The position and angle of the MPS in Fig. 3 is an example, and in an actual competition, it is randomly arranged to be symmetrical to the y axis of the field so that both teams have the same condition.

Modbus/TCP Modbus/TCP [31] is an extension of the serial communication protocol Modbus developed by Modicon for its programmable logic controller in 1979 so that it can be used with Ethernet. For communication, we use the format using Function code (the seventh byte of figure 5). And we se codes 0x04 and 0x10 between MPS and RefBox. These codes means the Read Input Register and the Write Multiple Registers, respectively. Since the value is determined

Format of Modbus/TCP	Transaction identifier	Protocol identifier	Length	Unit identifier	Function Code	Data
	byte 0,1	byte 2,3	byte 4,5	byte 6	byte 7	byte 8

Fig. 5. Modbus/TCP common format [32]

Request		Values
Function code	1 Byte	0x04
Starting Address	2 Byte	from 0x0000 to 0xFFFF
Quantity of Input Registers	2 Byte	from 0x0001 to 0x007D

Response		Values
Function code	1 Byte	0x04
Byte Count	1 Byte	2N
Input Registers	2N Byte	value of Input Registers

N: number of the input registers of Request

Fig. 6. code0x04 Read Input Register[33]

automatically from the 0th byte to the 6th byte, the program set the data after the 7th byte onwards.

The code 0x04 means a code that reads the value of a register in the server. As the Request, we put 0x04 in the 7th byte, and the start 2 bytes address for reading are set at the Starting Address. Finally, we set the number of data to read in 2 bytes at the Quantity of Input Registers. The format of Response requires the same code as the received data in the 7th byte, and puts the length of the returned data to Byte count. Then, the actual data are put in Input Registers.

The code 0x10 means a code that rewrites the value of the register in the server. As the Request, we put 0x10 in the 7th byte, and the start 2 bytes address for writing are set at the Starting Address. We set the number of data to write in 2 bytes at the Quantity of Registers. And the actual data are put followed by it. We can set the same data received up to the Quantity of Registers by Request to Response. In either case, no checksum is required.

The process of Dummy MPS In order to play the RCLL competition, the RefBox as a referee program controls the flow of the game. Therefore, it is necessary to implement communication program with MPS in order to make the Dummy MPS instead of a real MPS. Here, we propose this communication unit is implemented using Raspberry Pi, which is an embedded microcomputer. Also, in the original RCLL, MPS has automatically processed the product, but in Dummy MPS, the referee (as a person) performs it manually. The replaced MPS is called Dummy MPS and is shown in Figure 8.

In MPS, Modbus/TCP (ref fig04) is used as a communication protocol with the RefBox. Usually the client of Modbus/TCP is as the personal computers

Request		Values
Function code	1 Byte	0x10
Starting Address	2 Byte	from 0x0000 to 0xFFFF
Quantity of Input Registers	2 Byte	from 0x0001 ro 0x007B
Byte Count	1 Byte	2N
Registers Value	2N Byte	the value of the registers

N: Quantity of Input Registers

Response		Values
Function code	1 Byte	0x10
Starting Address	2 Byte	from 0x0000 to 0xFFFF
Quantity of Input Registers	2 Byte	1 to 123(0x7B)

Fig. 7. code0x10 Write Multiple Registers[33]

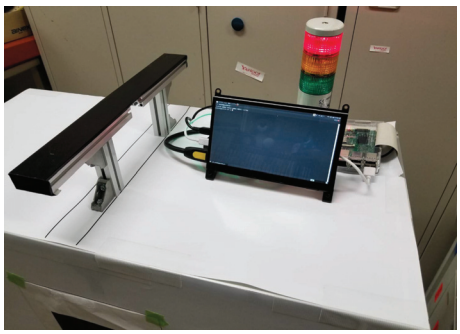

Fig. 8. made Dummy MPS

etc., so there are a lot of packages for Linux distributions. On the other hand, the server side of Modbus/TCP is an industrial electronic device, so there is no need for general users to touch it and there is little information. Therefore, by analyzing the communication packet between RefBox and MPS, we make a communication program same behavior as the RefBox.

The communication type between the RefBox and MPSs is the client-server type; the RefBox works as a client and MPSs work as servers. The RefBox checks the state of MPS using Function code 0x04. Normally, the communication should be requested only when the state of the MPS changes, but since only the client can start the communication, the RefBox always checks the state with the MPS. Using a Function code 0x10, the RefBox controls the signal of MPS so that the status of MPS can be seen visually. By using Dummy MPS with communication with the RefBox, it becomes possible to confirm the game status visually from the change of signal.

Survey results We had the meeting for our simple logistics league using dummy mps at Okazaki Technical High School in Aichi Prefecture in December 2018.

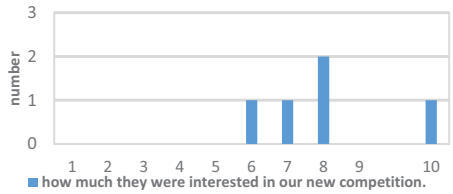

Fig. 9. Rating of our proposed competition's interest (10 stages)

We gave an explanation of RCLL using DummyMPS to five teachers from the teams in Aichi Prefecture and Mie Prefecture. At that time, teachers answered how much they were interested in our new competition. The results are shown in Fig. 9.

All teachers answered that they were interested in (more than 5) for our survey. The DummyMPS proposed by us is for organizing the competition using Robotino easily, and it can be expected as a competition that the teams of the technical high schools will be participating. From the survey results and the number of teams using Robotino in Figure 2, we think that the participants are interested ing our proposed competition and our competition becomes successful.

summary We received a request from the team participating in the World Youth Skills Competitions using Robotino. In this research, Dummy MPS was proposed in order to hold the RoboCup Logistics League easily. As a result, holding the RCLL competition becomes low cost. And we confirmed that a lot of teams were interested in our competition.

4 Conclusion

Our labolatory consists of two research fields, one is the wireless communication, and the other is the artificial intelligence. This year, we have two research themes. And we make our program using C++ on fawkes. Through RoboCup competitions, we would like to improve and exchange the technology.

Acknowledge

We thank to a travel grant from the ICOM Fundation, Japan.

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