Team Description Paper: BabyTigers - R

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Abstract. From 1998 to 2004, BabyTigers which consisted of Osaka University, participated in SONY Legged Robot League. And from 2005 to 2010, BabyTigers-DASH[1] of Osaka City University and Ryukoku University participated in 4-Legged Robot League. And from 2011, BabyTigers - R[2] of Ryukoku University has participated in Festo Logistics League. At 2008, 4-Legged Robot League renamed to Nao League (Standard Platform League). So our team spirits are based on both AIBO and SPL which aim to compete with identical robots. Then we use original robots which consisted of normal components without any additional hardwares. And we try to modify software programming in order to apply for the hardware's function. However, for the Technical Challenge, we modify and add the hardware components in order to show the potential of Robotino.

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

1 Introduction

This paper describes BabyTigers - R. Our laboratory aims to adapt the communication theory to robotinos. Our researches consist of two parts, one is the communication method that uses only robotino's components. And the other is the communication method that uses additional components with Visible Light Communication. Through RoboCup competitions, we would like to improve and exchange the technology.

2 About distance IR sensors

Using effectively sensors mounted on a robot is important for its movement. In particular, a robotino has 9 distance IR sensors every 40 degrees, so it is necessary to use these sensors in order to search around it. However, sensors have two kinds of error, which are statistical error and systematic error. Statistical error is a difference in the product. And systematic error is made from noise of circuit. These errors occur at random based on their probability and the measured values

are changing randomly based on its probability. From the view of a robot, it can observe only its measured values, so that, it means posterior probability. When we calculate the occurrence probability for each noise, the prior probabilities are needed.

At first, we made measurement on the occurrence probabilities for each sensors per distances (shown at figure 1). The standard deviations are from 0.005 to 0.013. Unfortunately we don't find out the relationship between errors and distances in individual robots. And at least more than 10 points are required in order to hold standard deviations (shown at figure 2). By the way, GP2D120, which is distance IR sensor on a robotino, spends 38.3ms for each measurement, then it spends about 0.4 seconds to get 10 points

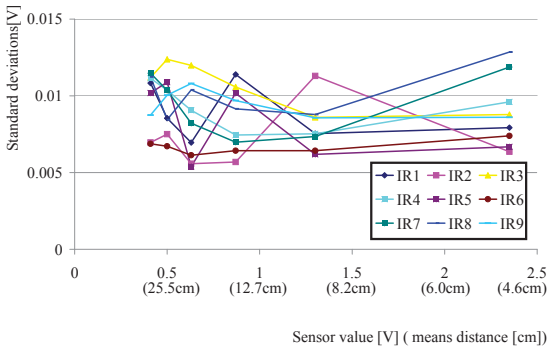

Fig. 1. the occurrence probabilities for exch sensors per distances on 1 robotino.

3 Using Visible Light Communication

Generally, the communication between robots uses Wireless LAN such as IEEE 802.11a/b/g/n. Because the directionality of wireless LAN is however wide, especially, the frequency of IEEE 802.11b/g is 2.4GHz. So interferences between communications happen when there are many robots. In this section, we propose the Visible Light Communications as communication between robots.

Visible Light Communication uses blinking LEDs at high speed which include the information. So we use an LED as a sender, and a photo transistor as a receiver. For example of modulation methods, PWM is a pulse modulation method and PPM is a pulse position method. Examples of modulation are PWM and PPM, PWM is a pulse modulation method and PPM is a pulse position method. The characteristics of VLC are almost same as the infrared communication. In

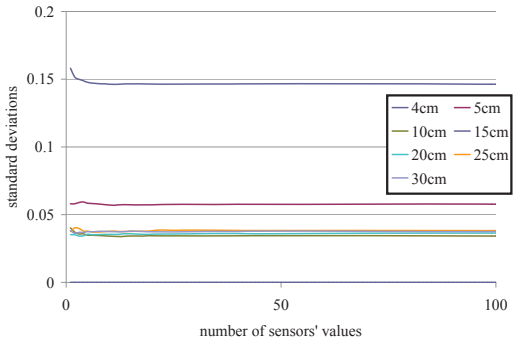

Fig. 2. The distribution of standard deviations against the number of measured points.

addition human can see status and area of communication. We can use the wireless communication using VLC where using wireless LAN is not permitted such as hospitals, However, because of its strong directivity which is same as infrared communications, there is the problem that the receiving signal level becomes lower if the sender does not face to the receiver. So the location and orientation between a sender and a receiver is very important to communicate with each other effectively.

The simple method to adjust location and orientation is the method that uses one sender and multiple receivers. Then we can estimate the brighter direction calculated from signal levels of multiple receivers In this method, however, we use such multiple receivers only to adjust the direction. In other words, we don't use them at the sending information by visible light communication. In this paper, we propose the adjusting method which uses multiple senders and one receiver. And the multiple LEDs can send the same information in order to improve the signal power in the visible light communication.

When one receiver receives multiple signals from their sender, its receiving signal has a composite waveform. We can decode from a composite waveform to each signal by encoding each sending signal using CDMA (Code Division Multiple Access). Generally, CDMA needs spread spectrum wireless data communications. However, we spread it to time scale instead of frequency band. Therefore, we need not vary color of LED in frequency. Instead of changing color, we need to keep the condition of environment while we send its spread code.

Now we make a prototype of this communication system, and use it for experiments. Figure 3 shows the experimental result, where data are encoded and decoded by PN code which is a pseudo random noise pattern. PN code is not a walsh code, so the distribution of the signal power is not good. For the

future, we will use a walsh code in order to make a strong correlation between signal level and distance. And by using this proposed system, we can adjust location between multiple robotinos easily.

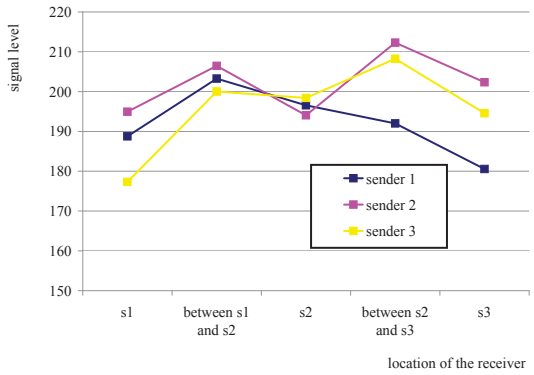

Fig. 3. We estimate the receiver's location by receiving signals with 3 senders' LEDs.

4 Communication between robots using IR sensor

When the wireless LAN between robots and an access point is down, the novel communication method which uses only components mounted on its robot is required. So we propose the communication method which uses mounted IR sensors[3].

We assume the case when two robotinos go to the same machine place, that is, a near miss between two robotinos happens. Usually, each robotino exchanges the information which includes its own destination via wireless LAN. However, in this section, robotinos can get only its location information because the wireless LAN is down. A robotino which is in the product phase of the pack at the machine can sense the other robotino's approaching via IR sensors. However the robotino in the product phase of the pack can not move. On the other hand, the robotino approaching the machine can sense the robotino in the product phase of the pack via IR sensors, and can avoid the collision. That is, the robotino approaching the machine can move to any direction. It measures distance to the other robotino, and it selects to move closer to the other or to leave from the other. So it can select binary actions. And the robotino in the product phase of the pack can get binary information because it can sense the other robotino's actions which mean that the distance between robotinos is decreasing or increasing.

Figure 4 shows the experimental result through the simulation. The performance means the received information rate without error when the sending robotino selects two actions which are decreasing and increasing the distance between robotinos. We can send information correctly when the moving distance between binary information is from 9.6cm to 11.2cm.

By the way, we believe that the rule of 2013 permits this method because it uses no additional sensors. However the rule says that any additional communication is not permitted.

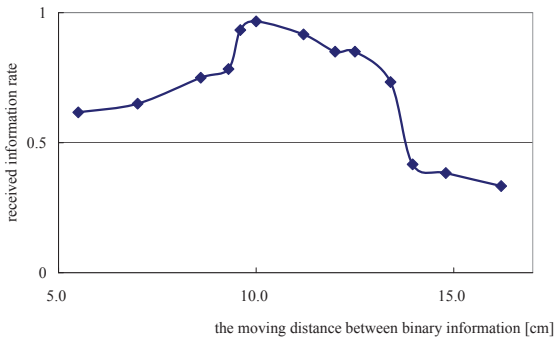

Fig. 4. We estimate the moving distance between binary information.

5 Escape from the Inflexibility on Multi-agent

At the multi-agents environment, where each agent selects actions independently, sometimes inflexibility and breakdown happen after actions selected by agents with thier policies. In order to escape from the inflexibility, two agents are

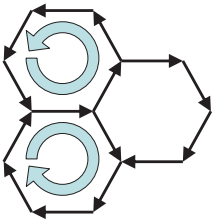

Fig. 5. Rotation and Not-Rotation panel in order to avoid the front crash.

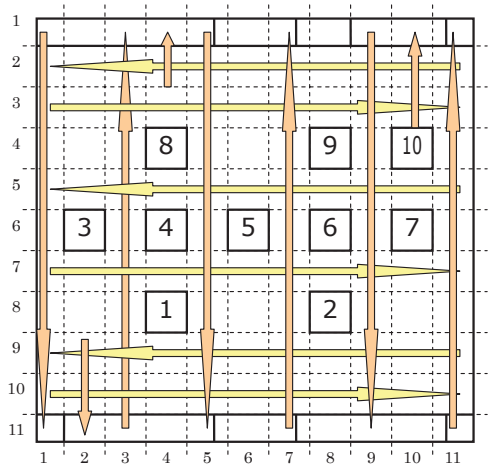

Fig. 6. the onw-way traffic street rule such as the network of streets sections off the city as neatly as the grid on a *go* borad.

required, one is the agent which proposes a escapting plan, and the other is the agent which decides its plan communicating with it. In [4], we propose the method which selectes such two agents where three or more agents are inflexibile state.

This method is based on the proposal[5] for the ad hoc network where there is no base station such as an access point. All nodes on the ad noc network are identical, so there are no master and slaves. Then in ad hoc network, sometimes two or more nodes send the packet at the same time. In particular, when sender nodes are far away from each other, the hidden node problem will happen where there are conflicts in only receivers which are between senders. Usually CTS/RTS method in which not only a sender but also a receiver send packets, avoids this problem. This method is effective at unicasting, however in multicasting or broadcasting we cannot use this method because multiple receivers reply at the same time.

[6] selects the reply node from multiple receivers. And a send node and a reply node can uni-cast packets to each other. The other receivers listen to this communication, so we can broadcast packets. Multiple receivers reply after the delay time which is decided by the received signal level in order to avoid the packet collisions. Then the node with the highest signal level, that is, the nearest node from the sender node is selected. So the communication between these nodes has little effect on the other communication.

We apply this method to the agents in order to escape from the inflexibility.

6 Coordination to Avoid Conflicts

We need to make rules in order to avoid collisions. For example, at the RoboCup Festo League, we change the problem into the moving grid problem by subdividing the field into 11 times 11 grids. [7] uses rotation and not-rotation panels at the hyper-density environment in order to avoid deadlock (shown at figure 5). In this paper, we introduce the one-way traffic street rule such as Kyoto City where the network of streets sections off the city as neatly as the grid on a *go* board. Robotinos can run in direction of arrows, so they can avoid the frontal crash (shown at figure 6). We've been applying this one-way traffic street rule to Robotinos from RoboCup 2010.

7 Conclusion

Our laboratory aims to adapt the communication theory to robotinos. Our researches consist of two parts, one is the communication method that uses only robotino's components. And the other is the communication method that uses additional components with Visible Light Communication. Through RoboCup competitions, we would like to improve and exchange the technology.

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