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 RoboCup Logistics League (which old name is Logistics League Sponsored by Festo). Our laboratory has two research fields; one is wireless communication, and the other is artificial intelligence. So in Logistics League, we aim to make communication system with each other robot like as multiagents.

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

1 Introduction

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

From 2014, we use c++ as the programming language instead of robotino view 2. So we can control roobtinos more accurately. And we can use previous AIBO's programming codes which are written by BabyTigers - DASH. In addition, we can adapt the researches from BabyTigers - DASH to BabyTigers - R.

Most of our team members are bachelor students. So their researches are very basic because their aims are to handle the robotinos. In this year we have four research themas; localization, routing, interface, and sensor.

2 About localization

In this section, we describe the localization which estimates the robotino's position on the field. In order to localize itself, the robotino uses the laser range finder which is URG-04-LX-UG01 made by HOKUYO. From this sensor, we can get about 5,000 points per second. So we need to estimate the location of the robot from these sensing data. However there are some same places where we can get the same sensing data due to the limitation of its observation. We can separate these places using the history. Then we implement the particle filter to distinguish these places and to estimate its location (shown at figure 1).

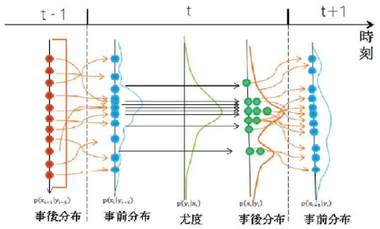

Fig. 1. The particles are distributed randomly. After one step, we calculate the next position of each particle and estimate each particle.

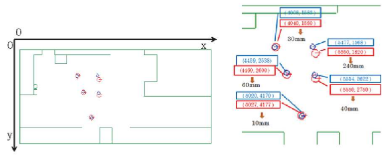

Fig. 2. The positions of the robot are marked as red. And the estimation position of particle filters are maked as blue.

We implement the particle filters in order to estimate the robot's location. This system needs the map information which includes walls information around the robot. Figure 2 shows the setting positions of robot and the positions of both self localization and real setting.

The average differential distance between the estimation position (colored in blue) and real setting position (colored in red) is about 9.65 cm. The closer the robot go to the objects such as walles, the smaller the differential distance becomes. So this particle filter is efficient for the localization.

3 About routing in order to avoid conflicts and dead lock

This section describes how to make the route in multiple robots.

In recent years, the factory required many kinds with a small quantity of production. So the factory migrates automation by robots to improve work efficiency and safety. However robots cause conflicts and deadlockd by actiond of each other and coursed of planning are closed. Therefore we need to get the relationship between routing method and conflicts incidence. And we inspect a rule of routing method that is avoid to generate conflicts.

There is a traffic rule called the Round About to avoid congestion of cars. This method makes one way rotary instead of traffic signal (shown at figure 3-Left). The car joins after having given priority to the car which has already run when we invade the rotary. And the car turns the rotary and goes out to the direction of the purpose. In this way, the round-about can work fluidly when there are little traffic. However it is easy to generate the deadlock when there is much traffic. Because cars cannot go out to the direction for the purpose from the rotary while a large quantity of cars are going to come to the rotary when there are much traffic. The movement rule on the edge of the hexagonal panel is suggested as deadlock avoidance under the super high density environment having few such movable space (shown at figure 3-Right) The hexagon with the rotation arrow is called as a rotation panel, the other hexagon is called as a non-rotation panel. There are divergence vertex and join vertex when hexagon panels are paved in this way. In divergence vertex, robots move to close vertex to destination. But when there is another robot in the vertex of the movement, the robot moves to the other top. When there are other robots in both, it stays here. In join vertex, the robot waiting more time is given higher priority. The robot can evade deadlock in this way.

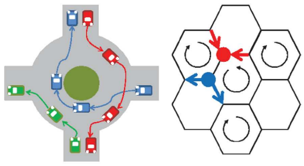

Fig. 3. Left: The round about in order to avoid the traffic jam. Right: Hexagon palens with the rotation and without rotation in order to avoid the deadlock under super high density environment.

It becomes the form such as the grillwork when line up Round About. Then we can consider the car will move on a quadrangular edge. The robot moves on the edge of the hexagonal panel in the figure 3-Right. In this way, it is thought the car and the robot move on the edge of paved polygon panel. Then we research relationship of paved pattern of polygon panel and density. And we inspect a rule of routing method that avoids to generate conflicts. Also we check influence on give conflicts incidence by adding a rule for movement (shown at figure 4).

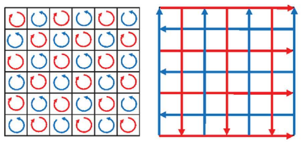

Fig. 4. Left: The square panels with rotary panels rule. Right: The square panels with grid one way rule.

In this experiment, we compare about paved panel pattern of hexagon and square. We use rotary panel rule (Fig. 4-Left) and grid one way rule (Fig. 4-Right), bidirectional movement rule for square panels. We use rotary panel rule, bidirectional movement rule for hexagonal panels. We make a simulator and carried out each experiment. We place the number of the robot into a quadrangle form in 1 to 60. And the destination of the robot is a coordinate of the opposite side of the initial position. In this experiment, we evaluate it with the number of each step as an evaluation axis. Figure 5 shows the experimental results.

In this experiment, we proved that square panels with grid one way rule is valid routing to conflicts when the number of robots was from 1 to 60. And the hexagonal panel and square panel with the rotary panel rule are not valid routing for conflicts. Also it is observed that deadlock that robots offered a course to each other and repeated the same

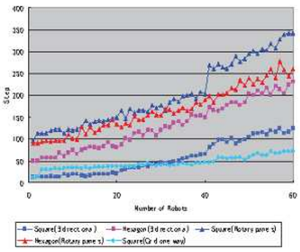

Fig. 5. Left: The square panels with rotary panels rule. Right: The square panels with grid one way rule.

In this research, we prove that square panels with grid one way rule is valid routing to conflicts when the number of robots was from 1 to 60. On the other hand the hexagonal panel and square panel with the rotary panel rule are not valid routing for conflicts. We have to perform simulation when we increase the number of robots and paved others Graphic panels pattern from now on. Also there is problem that robot with different routing moves in the same field. We have to lead valid routing in such a situation.

4 interface for robotinos

The Kinect is a device for the Xbox360 that Microsoft released. The Kinect has the RGB camera, the distance camera, equipped with four milti-array microphones. Kinect can recognize and track the skeleton information of the person taken by the distance camera. It is possible to obtain the movement of the person in the three-dimensional data. Microsoft Corporation has been published. SDK (Software Development Kit) from not only the game field, and is also used for other areas of the screen operation device during surgery and rehabilitation etc. In this section, we use Kinect in order to implement the existing interface virtually.

For the extraction of movement instruction of omnidirectional mobile robot in this section, car type, motorcycle type, and joystick type the three types of interfaces are created. Car type performs the traveling direction of change of the steering with both hands, makes a determination of the acceleration in the longitudinal position of the right foot. Bike type acceleration determined by the longitudinal position of both hands, do the traveling direction of the change in the tilt of the body. Joystick type longitudinal position of the right hand,determination is made move from the left and right positions.

Performs a movement instruction to the omnidirectional mobile robot using the three existing interfaces in the experiment. Then we will evalution it. In this section,we used the robotino made by FESTO corporation. Robotino has three omnidirectional wheels are arranged in the drive wheels. We make a course made up of straight lines and curves(right curves and left curves). The operator moves by tracing over it using each interface. After the operation ends get answer multiple items about turning,acceleration etc.

The result is shown at figure 6. Low evaluation turning and stability was obtained in the bikes and joystick. In the following evaluation of turning of the respective interface Bikes and joystick is able to turning to an unintended direction. It is considered as caused by that acquires the position of the body tilt and position of the hand. Kinect is it is we thought the cause of the low evaluation of turning and stability sense of direction change instruction has been carried out of getting to the robot. Since operator in the automotive type steering is located in front of the handle, operation can be grasp of turning. Instructions unconscious operation as of the turning movement of the omnidirectional mobile robot as Kinect does not recognize. We think more suitable dead zone settings and the need for a way to understand the current conducted to have the operation instruction.

In this section, we extracted of movement instruction to the omnidirectional mobile robot from a virtual interface that we created. The result from the evaluation of the time of performing the operation of the omnidirectional mobile robot in existing interface. High evaluation car type of turning operation, low evaluation was obtained turning operation and stability of the bike type and joystick type. From the results obtained this time, by adding the evaluation axis, such as whether the reaction is sensitive or insensitive to the input operation, will be more extraction movement instruction method corresponding to the degree of freedom of omnidirectional mobile robot.

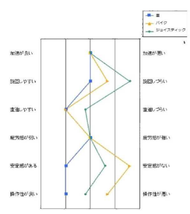

Fig. 6. Three interfaces' usability.

5 simple measurement range sensor

In recent years, it attracts attention that autonomous mobile robot to work in public facilities and homes. The environmental mapping is important to autonomous movement. The environmental mapping to measure the obstacle such as a wall (2D or 3D), it is to accumulate the measurement point. By this map, a judgment of the traffic right or wrong is enabled. LRF (laser rangefinder) which is a range measurement sensor is often used for the 2D measurement. URG-04LX-UG01 made in Hokuyo electricity company is often used in a robot study and measures 5000 points per second. However, it has excessive performance in environment with many surfaces. Therefore We made simple range measurement sensors with a little measurement point in this research. We evaluate the environmental mapping of the sensor. The environmental mapping system of the autonomy mobile robot can be classified into a range sensor and a control part (shown at figure 7). Range sensors include infrared rays, supersonic wave, LRF. We make a range measurement sensor with an infrared range sensor by this experiment and compare the precision with LRF.

Fig. 7. Environmental map creation system

We suggest a method to make a simple range measurement sensor with a range sensor in this chapter. LRF which is a range measurement sensor performs the range measurement by reflecting a laser beam in a turning mirror. We let a range sensor exercise with a servo motor. We imitate the movement of LRF by doing so it. We used arduino for a servo and the control of the range sensor. We can hope that we simplify control by doing so it. In addition, we output the value of the range sensor to a control PC using serial communication. The infrared range sensor has a long measurement time than LRF. When 180 degrees turns with the maximum velocity of the servo, the angle resolving power becomes approximately 6 degrees and becomes the coarse measurement. We used two range sensors in this research and moved a measurement side of the range sensor 90 degrees and fixed it. A result, the number of the measurement per time double, and an angle to work on coming and going becomes half. Because the output of the infrared range sensor is an analog value, the influence of an error and the noise with the circuit is big. PSD of the infrared range sensor may cause a sudden voltage descent at the time of the measurement. We connected a bypass condenser to the power supply circuit of the sensor to reduce a noise. With that alone we adopted a median filter and removed a noise level because we could not completely prevent a noise. A median filter is a filter adopting the median of plural measurements. Because angle resolving power decreases when we increase the number of the measurement to enhance the effect of the filter, adjustment of the length of the filter is important. We made an environmental mapping using LRF and a simple range measurement sensor. We compare the difference in map by the difference in median filter length of the simple range measurement sensor. We perform the experiment at a place before Ryukoku University 1-432(shown at figure 8.

Fig. 8. experiment space

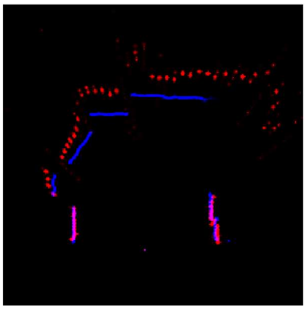

Fig. 9. Sensor data from IRSensor and Laser Range Finder

We made the experimental device for approximately 8,000 yen (= 65 USD). This is approximately 90 proportion of cost cuts. 9 put the map of the simple range measurement sensor on a map of LRF. A map of LRF is blue, and the map of the simple range measurement sensor is red. We demanded scanning time necessary to make a clean map by an experiment. It was necessary for result, at least one second. The map mentioned above was made in repetition movement of one second. The different point is the length of the filter(shown at figure 10). There are several common points of three figures. The first is to have made a map of similar form. The second is that a far-off red point is far from the blue point. The different is intervals between the points. The thing of the form that was similar in all figures is that a noise level is not included. In other words it may be said that it is all right even if the length of the filter is short. However, all maps react to the distant place than a fact to a far-off obstacle when that compare it with LRF. It is thought that this is because a coefficient to convert the voltage into distance is wrong in a distant place.

In this research, we suggested a method to make a simple range measurement sensor with a range sensor. We changed the length of the filter by the experiment and made a map. We compared the map which we made of the range measurement sensor with the map which we made of LRF. The sensor which we made was able to do enough cost cuts. In this device, we were not able to shorten scanning time. we understood that the reason why an error occurred in the long-distance domain was that a coefficient for the voltage reading at the long distance did not accord. We find an appropriate coefficient depending on distance and want to do it to a good range measurement sensor of the precision more in future.

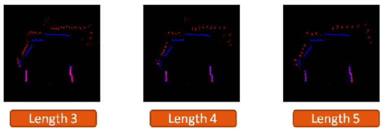

Fig. 10. fidelity of each filter

6 Conclusion

Our labolatory consists of two research fields, one is the wireless communication, and the other is the artificial intelligence. This year, we have four research themes. And we make our program using C++. However this year the competition of Logistics League is changing dinamically. So we need more effort to modify our program to Logistics League. Through RoboCup competitions, we would like to improve and exchange the technology.

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