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Technical Report · July 2017

DOI: 10.13140/RG.2.2.28705.92003

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Humanoid KidSize League of Robocup 2017

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Abstract. This paper explains briefly about the design of Ichiro's Robots. Ichiro's Robots using platform of Darwin who has change a lot of modifications on the hardware and software to adjust the development of the game rules in RoboCup, which is about the use of artificial grass, the use of balls with FIFA standards and the goalkeeper that both have the same color, the white color. By implementing several methods of trajectory planning pattern and optimization algorithms, the robot can walk on artificial grass with the capability of running speed is 25 cm / sec. In the vision capabilities, we optimize the algorithm using various methods so that the robot can detect and distinguish between the ball and the goal which have the same color. Several algorithms and behavioral strategies robots have been prepared for Robocup 2017.

1 Introduction

Ichiro is one of the Robotics team in ITS who research on humanoid robot soccer. Ichiro Team established since 2012 of undergraduate students. Our robot used the platform of Darwin which has many modifications every year on mechanical, electronic and program [3].

Every year, Ichiro team participating in Indonesian Robot Soccer Contest (KRSBI), which is a soccer competition between robots that adopted Robocup competition. Team Ichiro got second rank in Indonesia and always met with EROS team when the final game. In 2015 and 2016, Ichiro team win with the EROS team in the current final regional competition. But when the national game in 2015, one of the robots is injured, so the robot can not compete with the good cooperation between the team when the final match. In 2016, there is a problem with the leg of robot, causing the robot can not walk well from the movement of enemy robots during a match semifinal.

In 2016, the team signed up at RoboCup and pass the qualifying round. However, because there is a problem with the lack of funds and a very near time for preparation

to join KRSBI and Robocup competition, so the team decided to resign in RoboCup and begin preparations early for the RoboCup 2017.

This year, the team has developed a robot about balancing robot walk on artificial grass, optimization of the detection object the features of goalkeeper, the ball and localization. In addition, the team making development a new robot platform, which is ICHIRO-2, which has the capability of mechanical and electronic higher than ICHIRO-1.

This paper will discuss the hardware and software on Ichiro Robot, which has been done in preparation for Robocup 2017 in Nagoya, Japan.

2 Research Previous Work

Ichiro Team uses the platform of Darwin's Robot to develop research on the humanoid robot soccer. In 2014, the robot modified on the camera with has more angle view and the addition of a magnetic sensor for determining the orientation towards enemy territory and the area itself. On detection of the ball, the detection is done by combining the features of a color field to distinguish between the ball or noise. If it got the same color as the color of the ball but on the outside of the field, then it would not be considered a ball, whereas if it were around the ball in field color, then it will be considered a ball. In addition, the localization algorithm to recognize the added features that are present in the form of a ball field, and the goal line. By knowing these features, the robot will be able to know his position in the game field [2]. Methods for obtaining the position x and y position of the robot using a triangulation method and the orientation is obtained using a magnetic sensor.

In year 2015, robots are added with cooperation algorithm through coordination between robots. Communication in collaboration of the robot using the UDP protocol with share information about state robots, orientation and knowledge of robot. Type of broadcast communication using UDP because of the absence of handshaking to initiate communication connection, so it has the ability to fast communication. Delivery of data information between the robot performed every one second, considering the response of the robot and the network load. The results of the inter-robot coordination, it was found that the robot is not located in the area of vision around the ball will certainly know the position of the ball if one of the other robot knows the ball [4]. Other robots will share location information so that the position of the ball will be known by the other robots. To make strategy collaboration of the another robot, the localization field is divided into 24 grid shown in Figure 1 [9]. Each robot will share information grid position of the robot, and if the robot gets the ball, then another robot can get to the position of the grid in order to keep the ball if at any time the ball is out of range of the robot.

Fig. 1. Grid division of the Ground to Localize in Cooperation Between Robots.

In year 2016, the development of robots are focus in walking gait on artificial grass. The algorithm of developed walking done by considering a new walking gait and trajectory planning based on control robot position when walking. On the foot robot are puts 6 cleats at each foot corner for use on artificial grass [5,8].

3 Hardware Overview

ICHIRO team has 4 robots that have the ability in walking, vision and robot behavior. The third robot used platform Robot Darwin OP which has many modifications [3]. This robot is the first generation robot on ICHIRO's robot. Meanwhile, one of the next robots is a second generation robot called ICHIRO-2 which is currently in the process of development. In this hardware overview will discuss the mechanical system and the electronic system on each robot.

3.1 Mechanical System

Mechanical systems on ICHIRO-1 has modifications on the parts of the camera and the base footwear robot. In the camera of robot using the camera Logitech C920

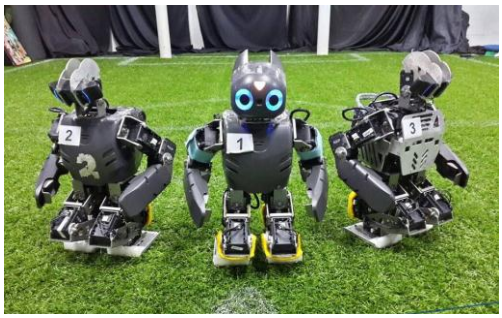

Fig. 2. ICHIRO-1 robot which is the modification of Darwin OP

which have more angle view than Logitech C905, which is the native camera from Darwin OP. While at the base footwear robot added 6 cleat robot that will be touched on the artificial grass. The addition of this robot cleats makes robot can run well on artificiall grass. So that the footwear section is not flat because it will have difficulty in walking at artificial grass. With the addition of cleat will affect of the balance robot at artificial grass.

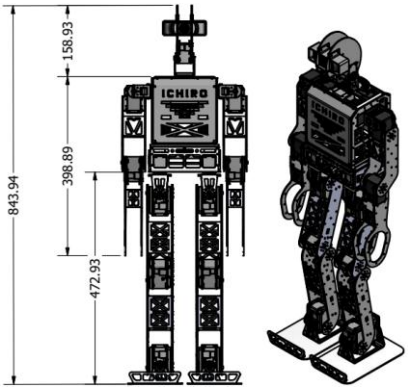

Fig. 3. ICHIRO-2 Robot Design

In ICHIRO-2 has height of 84.394 cm with using 20 degrees of freedom (DOF), including 6 DOF put on the feet using a servo Dynamixel MX-106T, 3 DOF placed on the arm using a servo Dynamixel MX-64T while 2 DOF put on head using servo Dynamixel MX-28T. ICHIRO-2 robot is still under development and will be scheduled to play in Robocup 2017. Design of ICHIRO-2 robot exist in figure 3.

3.2 Electronic System

In ICHIRO-1, the primary computing process using FitPC2i which has the ability to process a 1.6GHz Intel Atom Z530 single-core and has a capacity of 1Gb RAM. In the servo controller using STM32F103 ARM Cortex 32 Bit. Sensor of this robot uses a sensor Inertial Measurement Unit which is a combination of the three axis gyroscope, three axis accelerometer and 3 axis digital compass.

In ICHIRO-2, the main computing process using the PICO-CV01 which has ability to process a 1.6GHz Intel Atom N2600 dual core and has a capacity of 4Gb RAM. In the servo controller using STM32F103 ARM Cortex 32 Bit. Robot Ichiro-2 has same sensor with robot Ichiro-1. It uses sensor Inertial Measurement Unit which is a combination of the three axis gyroscope, three axis accelerometer and 3 axis digital compass.

4 Motions

Basic proficiency of soccer robots that required is to be able to do walking, searching for the ball and kicked the ball toward the goalpost. In addition to these capabilities,

the robot also required to be able to make cooperation in the team and give response when the robot falls in the field. According to the robots ability would be similar to the human ability in playing football and even can beat the world champion football team in 2050 [7].

4.1 Motions Control and Gait Walking Robot

There are many robot motion in humanoid robot, but in the basic motion of the robot is the ability to walk, kick and get up after falling. Motion get up and kick has a different algorithm than the algorithm in walking. Method to make motion robot on get up and kick using trajectory planning by making changes in certain corners in every joint robot. Then every change is stored in a form of step and every step raised with certain speed and time. Trajectory planning generated by the movement of the open-loop style so, there is no feedback is used to improve the condition of improper changes. This is because get up and kick movement is not done continuously.

Unlike the case of the kicking motion and get up movement, in the walking motion, the algorithm runs on the robot is raised by close loop style with the condition of the robot when Single Support Phase (SSP) and Double Support Phase (DSP). Trajectory Planning on walking motion generated using inverse kinematics by see the equilibrium position at the Center of Mass (CoM). CoM position on the robot is used as a reference for generating the balance of walking robot. The process of balancing robot raised in the movement of the foot and the hand when over the limit of the robot's equilibrium position. By using cleat on walking in artificial grass, it can be seen that characteristics position of CoM has changed due to uneven bases. It can be used as a reference for optimization to get new walking gait movement on artificial grass. Through the optimization algorithm, the robot can walk on artificial grass and has a running speed of 25 cm / sec.

4.2 Behavior Robot

Game strategy in robot is on robot behavior. This behavior of robot is using Finite State Machine (FSM). In this act, the state machine process is divided into two main parts, the first part is when the ball is not known, so the state will be in a condition of searching ball. If one of friends found the ball, then the state will move towards the position of the friend who is found the ball. In the second part, when the ball is known, the state is state of ball approaches, ball control and ability to detect the goal. Robot behavior created differently in artificial grass and green carpet. On the use of artificial grass, when get the ball, robot will dribbling the ball up close to the goal. If the location is already close to the goal, then robot state is in a state of kicking the ball. This is because of the kick ability of the robot is less far, as a result of the robot and servo that has a low torque. This strategy is more optimal than kicking directly after getting the ball.

5 Vision Robot

Vision ability is the main thing in the game of robot soccer. Ball, goal, and line have same color, which is white[1]. Various methods have been tested and optimized in order to distinguish between the ball, the goal and the line.

At the ball recognition, the ball detection feature using the Histogram of Oriented Gradient (HOG) method. Characteristic of HOG features of a ball is showed by gradient distribution in the form of vector line. HOG feature results in doing the process of learning using Support Vector Machine (SVM) to generate a model that is used as a reference for detection. So that the process of ball recognition will be obtained [6].

On the goal recognition, because of the color and the shape of the goal has a same construction with the line, so the goal recognition feature is added with the color of the field. In this case, the goal which is detected will always be perpendicular to the goal line. When the goal line and the goal intersect, it will become an interved T-shaped, and then it will be drawn upwards to the boundary line of the color of the field. If the obtained data lines reach the perimeter of the field color, then it will be used as reference of goal data. So in this case, the process of goal recognition begins with line recognition feature. The line recognition using hough transform method which obtained two crossovers, then the line is searched middle position value using the following equation :

$$(P_x, P_y) = \left(\frac{(x_1y_2 - y_1x_2)(x_3 - x_4) - (x_1 - x_2)(x_3y_4 - y_3x_4)}{(x_1 - x_2)(y_3 - y_4) - (y_1 - y_2)(x_3 - x_4)}, \frac{(x_1y_2 - y_1x_2)(y_3 - y_4) - (y_1 - y_2)(x_3y_4 - y_3x_4)}{(x_1 - x_2)(y_3 - y_4) - (y_1 - y_2)(x_3 - x_4)} \right) \quad \textbf{(1)}$$

When the midpoint of the intersection line is found, then every side in the midpoint of the intersection line will be checked. If it got 2 points, the line is known as the L-line features. If there are 3 points, then the line is known as the T-line features. Intersection of L-line is always at the end of the field, while the T-line is in the middle of the field. It can be used as a reference for recognition of localization position of each robot. When the position of the robot location known by using the line features, the goal position can be predicted [4].

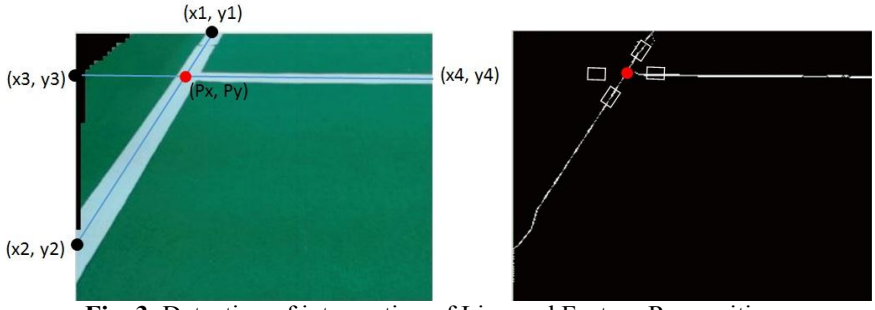

Fig. 3. Detection of intersection of Line and Feature Recognition

6 Conclusion

The test results of Ichiro robot development in this year includes the design and development of the walking and the vision of robot. On the development of walking, the robot can run on artificial grass by changing trajectory planning on walking gait. The result of the walking test on synthetic grass is robot speed is 20 cm/sec. The vision design include ball, goal, and line recognition, which are have white color. Ball recognition is using HOG method which is successfully detected, whereas goal recognition is using detection methods based on the position of line and color field. Hardware design is currently in the ICHIRO-2 under development and planned to play in RoboCup 2017. So now, Ichiro team already has an ability to join RoboCup 2017.

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