ICHIRO Kid-Size 2016 Team Description Paper

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Abstract. This paper is the qualification procedure in the RoboCup Humanoid Kid-Size Robot League of ichiro team, Institut Teknologi Sepuluh Nopember, Indonesia. In this paper will describes the hardware, framework, self localization, position determination based on goalpost, grid and field line, also in this paper will describes about robot behaviour, and communication between robot.

Keywords: Robocup 2016, Ichiro team, hardware, framework, self localization, goalpost, grid, field line, robot behaviour, communication

1. Introduction

Ichiro is the representative team from Institut Teknologi Sepuluh Nopember, Indonesia to participate Humanoid Kid-Size Robot League, Robocup 2016 in Germany. Team member of ichiro consist of seven undergraduate student in electrical engineering and informatics engineering department, and two lecturer from electrical engineering department.

Ichiro Team born since 2013, and develop Darwin-OP platform for doing research. The concern of research ichiro team on self localization, position determintation based on goalpost, grid and field line, also the research concern on robot behaviour, and communication between robot.

This year, is for the first time ichiro team participate for Humanoid Kid size robot league in Robocup competition. During this time, Ichiro team is one of participant on Indonesia RoboSoccer Humanoid League Kid Size. In 2014 and 2015 Indonesia RoboSoccer Humanoid League Kid Size, Ichiro team get 2nd ranked.

2. Hardware and Framework

Ichiro Team using Darwin-OP platform, but, there are some part of hardware developed, there is PC that are using fitpc2i, Wi-Fi module, logitech C920 camera, motor servo MX-28T dan CM730 controller. PC in the robot used for main processor with lynux OS. This PC can connected to the nircable networkwith Wi-Fi module. CM730 controller module is microcontroller ARM based that use for control 20 servo motor MX-28T.

Contoller Module communicated with main processor PC via Serial Communication. Sensor in the controller module is gyroscope and accelorometer that used for robot motion stabillizer and detect if the robot is falling down. Camera in the robot use to get visual data around the robot.

Beside that, the robot added IMU (Innertia Measurement Unit) sensor Ardupilot Mega that are combination of 3 axis gyroscope, 3 axis accelerometer and 3 axis digital compass [1] that used to help find the orientation robot in the field. Framework in ichiro team based on framework of Darwin-OP platform it self [2]. Here is the figure of Darwin-OP Framework Class Library Diagram.

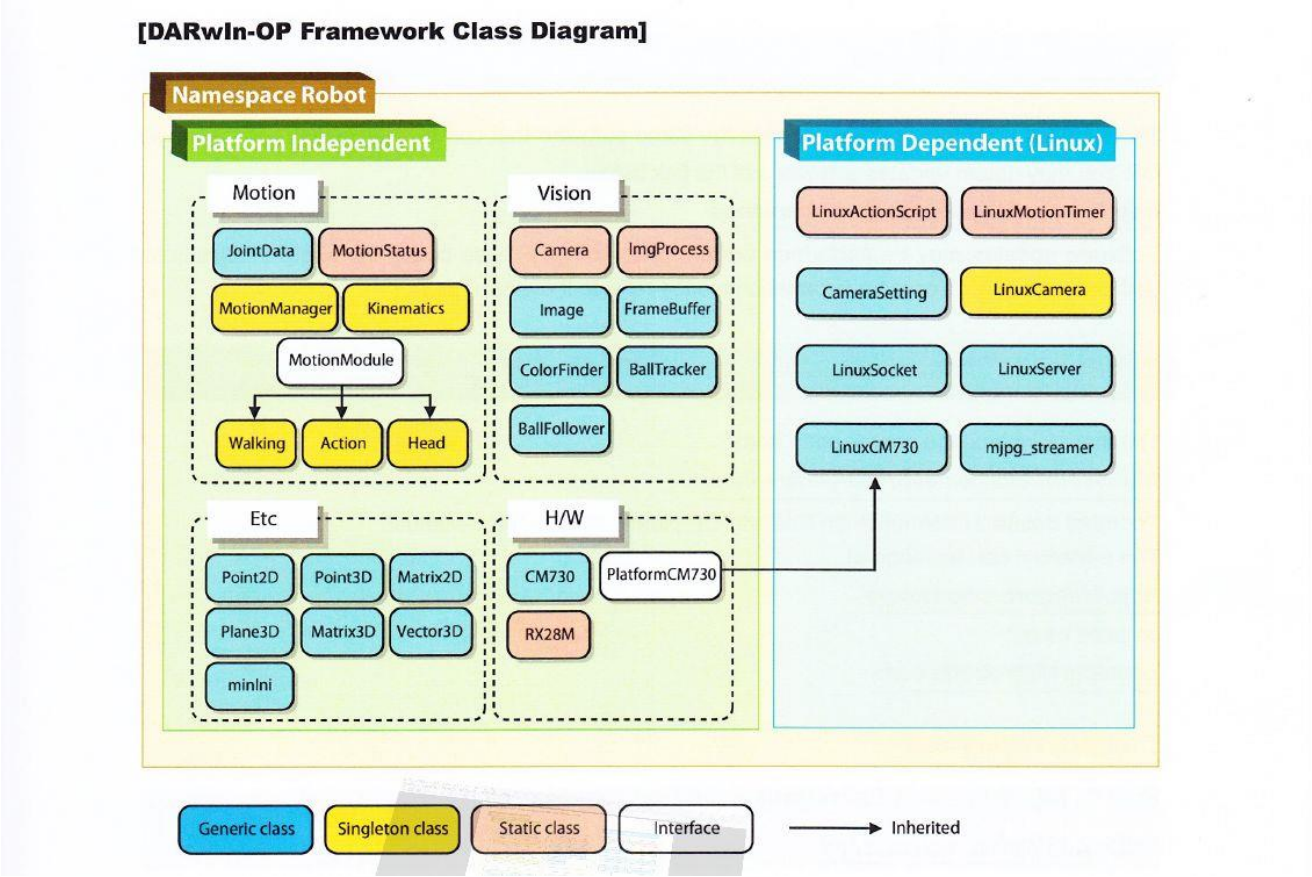

Fig. 1. Darwin-OP Framework Class Library Diagram

3. Self Localization

Self Localization that implemented on Ichiro team is using robot ability to detected features in the field. The feature is used as reference for position determination. The position of robot determined by estimated relative position of the field features. After we got the relative position of the field features, then we can know robot position in the field. [3][4].

When determination of robot position in the field, the robot are helped by two features in the field, there are goalpost feature and field line feature. We do this because,on the previous research [1] when just using goalpost for marker features, the robot have got the blind spot of the goalpost for the detection.The blind spot are happen when the robot are behind the goalpost, so the robot cannot detect them. That problem can solved by adding the field line feature in order to determined the position when the position determination are cannot be done by goalpost. Combination of position determination flowchart using goalpost and field line are shown by the image below.

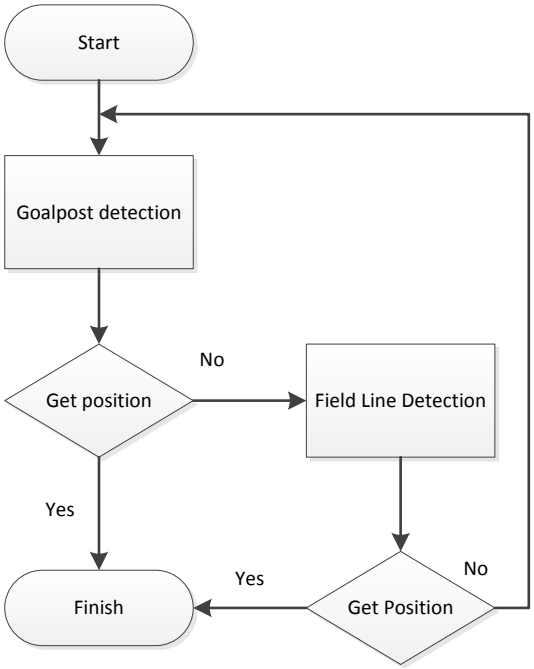

Fig. 2. Flowchart of Self Localization

3.1. Position Determination Based On Goalpost

3.1.1. Image Processing

Goalpost Identification that implemented on Ichiro team is using relative distance from the robot to the goalpost, the relative distance are known from the goal post height by the robot. In order to robot can detect the goalpost height, firstly we must do the image processing.

The first step to detect the goalpost, we must threshold the HSV colorspace. The process of the thresholding is used to goal post color segmentation so the image that are processed only at the part that has goalpost color. Bound of thresholding are obtained from the calibration data in the Darwin-OP framework.

After the binary image are thresholded then the noise must be reduced. This thing are be done in order to reduce the noise colour beside the white colour of the goalpost. After that, the next step is edge detection of binary image using canny method [5]. After we got the edge detection, the next step is detect goal line. This line is used to representation the shape of the goalpost. To get the goal line we used Hough Transform Line [6].

The next process of goalpost detection is detect the pole of the goal post. The detection of the pole is in order to get the height of the pole in pixel. From that, the height of pole will be processed to determine robot position with the goal post reference.

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3.2. Position Determination Based On Field Line

Beside position determination based on goalpost, Ichiro team also implemented position determination based on field line. Feature Field line detecting 2 line intersection (L) and 3 line intersection (T) in order to help determined robot postition in the field. The robot can rotate till 180 degrees. So that in one pose of robot orientation, robot can have vision orientation till 180 degree. Positioning by using the feature field line utilize a combination of orientation angle of the robot with pan head, so we can get the pose of robot in 360 degree.

The first step for posistioning by using the features of this field line is to take a combination of data field line with the buttom of goalpost at each grid. Grid data was taken as a grid that has the possibility of blind spot of the goal, and the grid is very close to the goal. Thing to do after making feature field line is doing pattern matching using euclidean distance. The illustration of orientation division robot with pan head at the same angle feature combinations of data in the grid can be seen further on previous research [7].

3.3. Position Determination Based On Grid

Implemented self localization easier, ichiro team adding feature for determination position based on grid. The output of the positioning robot is coordinate field, same as research[8]. Coordinates used has units in meters and processing the value of the position is formed in the scale. Scale that we use is 1:1,5, where 1 index scale represent 1,5 meter. Scalling is done in both axes so we get a few small areas in the field. These small areas referred to as grid [9] in figure 2.

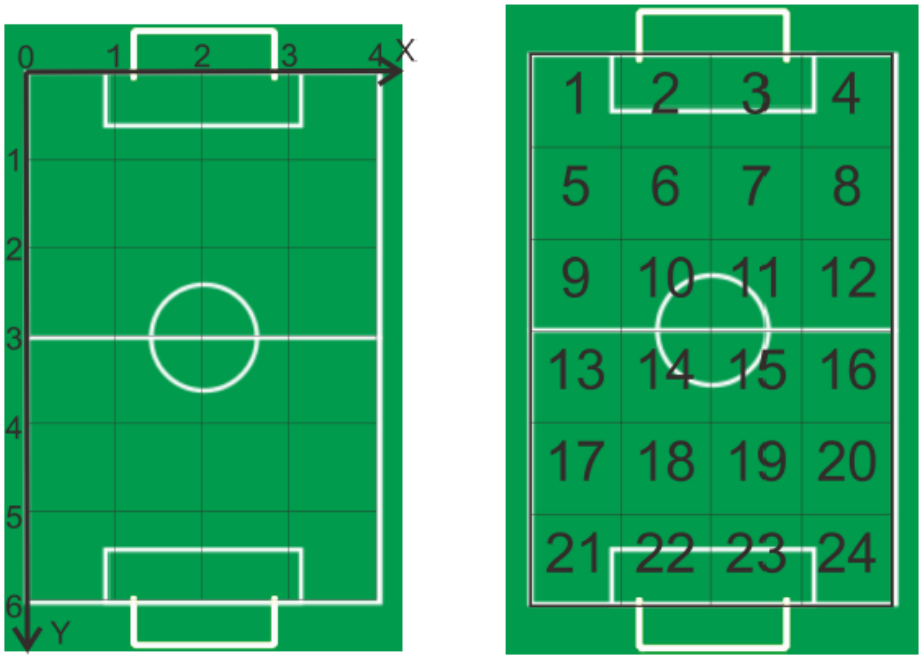

Fig. 3. Allocation of coordinate field (a) and Field Grid (b)

Grid-based positioning with this has been dones in previous research [10]. Grid size 1x1 meter was applied to the field size of 4x6 meters.

3.4. Estimation Distance and Positioning Robot

After robot can detect height of goalpost, the next to do is calculate estimation distance between robot and goalpost, this process making robot easier for get their position in the field. Pole goalposts that have been detected have pole height features. Distance estimating is to know relative distance to goalpost as a landmark to determine position itself. After that, the position can be known using triangulation and trigonometry [7].

Position determination using goalpost has two method. The first is using trigonometri method, this is used when the robot just detect one pole. The second method is using triangulation method, this is used when the robot detect two pole of the goal post. The illustration of robot orientation and determination of robot position using trigonometri method can be seen at the image below.

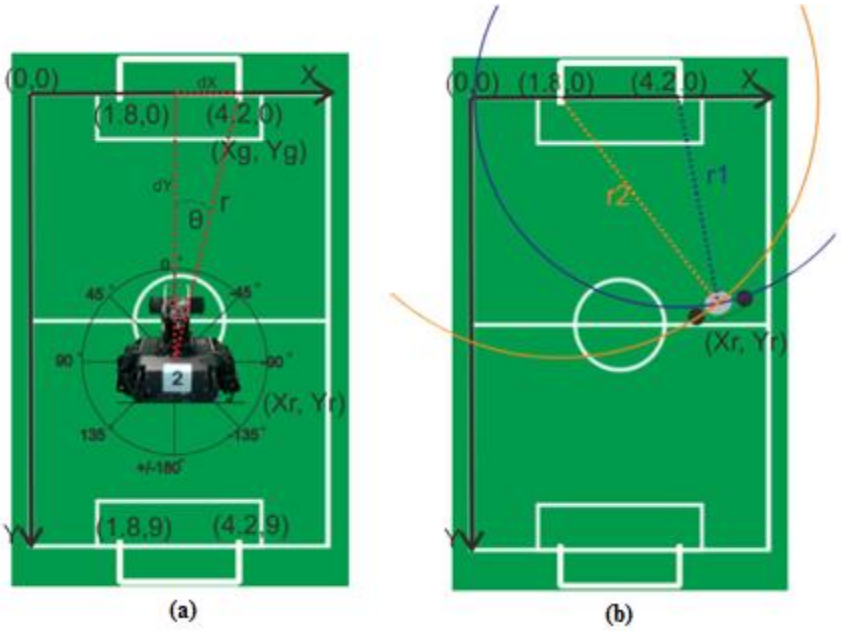

Fig. 4. Robot Orientation using Trigonometry (a) and Triangulation (b)

4. Robot Behaviour

Robot Behaviour on playing soccer league of ichiro team have many kind of it. Here is the algorithm of robot behaviour on game play. First, the robot is on the initial status. When the robot have been received the gameplay data, robot will start finding the ball. The nearest robot to the ball will move toward the ball until the robot in the range to kick.

After that, the robot will find the goalpost as target. When the goal is found and target has been determined, robot will move around the ball until the robot has possible position to kick to the target. If goalpost can't be found, robot will move around the ball until the position is straight to enemy's area. After got the good position even though has been found the goalpost or not, robot will kick the ball. Every case such as robot lose the ball or the robot is falling down, the robot will back to finding mode.

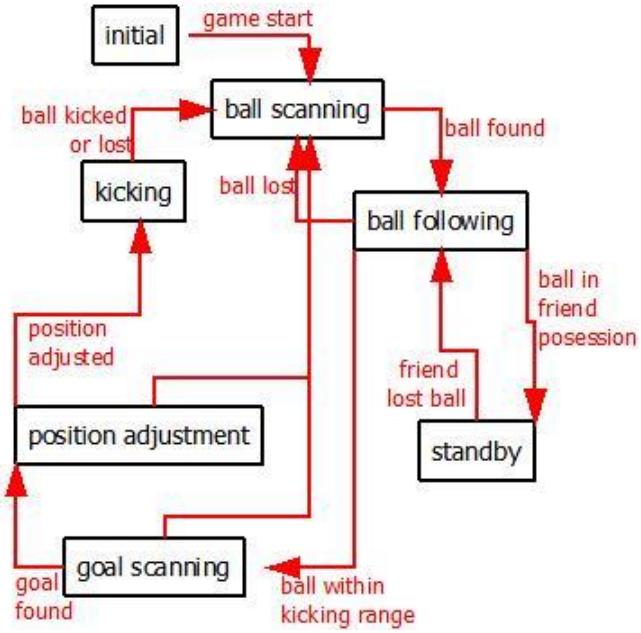

Fig. 5. Finite State Machine of Robot Behaviour

5. Communication Between Robot

A good game on Humanoid Soccer League is a game that has a good cooperation betwwen the players. To make it happen, ichiro team making the players uses the strategy of cooperation in the form of data communication using UDP broadcast protocol. UDP data communication is data communication without using handshaking to initiate a connection as in [11].

The data packets are transmitted in the form of information about the position ofthe robot of each player along with other information. Data transmission is done every 1 sec with consideration of the response robot and network load. Because,if done without the lag time, would be ineffecient and robot does need to update data without pause and this will wiegh on the network.

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