Barelang FC Team Description Paper
Humanoid Kid Size League of RoboCup 2018

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Abstract. This paper describes the robot system designed by Barelang FC team
from Politeknik Negeri Batam, Indonesia, as a qualification requirement of Ro-
boCup Humanoid Kid Size competition in Montreal, Canada 2018. Full details
of our robots including robot architecture, mechanical design, and vision pro-
cessing system will be discussed. The robots upgraded on mechanical design and
vision processing system to improve performance. Improvement in vision pro-
cessing algorithm results in the more robust detection system and increase detec-
tion range of objects. The new mechanical design improves performance in kick-
ing and walking speed.

Keywords: Humaniod Robot, RoboCup Humanoid.

1 Introduction

Last year is first participation of Barelang FC team in RoboCup competition. This team
managed to get semi-final position. The robots got several problems during the game.
The first problem is unstable walking on artificial grass because of the artificial grass
on the RoboCup field thicker than the field in our laboratory. The vision system also
failed to recognize the white ball in long range because of captured image resize in
small resolution to meet computational performance of minicomputer. Therefore, the
optimization of the vision system becomes a big task in RoboCup 2018 competition.

2 Robot Architecture

The architecture of the robot system divided into software and hardware part. Fig. 1
illustrates the hardware system of the robot. Robots consist of 3 main parts (input de-
vice, processing device, and output device). Input devices consist to several sensors that
used to collect environmental data from the robot. Sensors used in the robots are
webcam as vision sensor, orientation, accelerometer, and gyroscope sensor. Vision

sensor used to recognize ball and goal from image data combined with orientation sensor that provide an information of robot heading. Accelerometer and gyroscope sensor used to stabilize robot while walking in the artificial grass. Sensors connected to the main processing device via a sub-controller that used ARM Cortex-M3 microcontroller. The main processing device used minicomputer with Intel i5 processor to acquire the data from all sensors, process the data, and control the actuator. The output device consists of twenty servo motors connected to the sub-controller to manipulate the robot movement.

Fig. 2 show the software system applied to the robot. This part implements the robot strategy in order to act on the field. The robot strategy was developed by getting data from sensors, vision sensor, coordination data and game controller data. We used different application which runs independent to collect the sensor data, process image, make decision and generate motion.
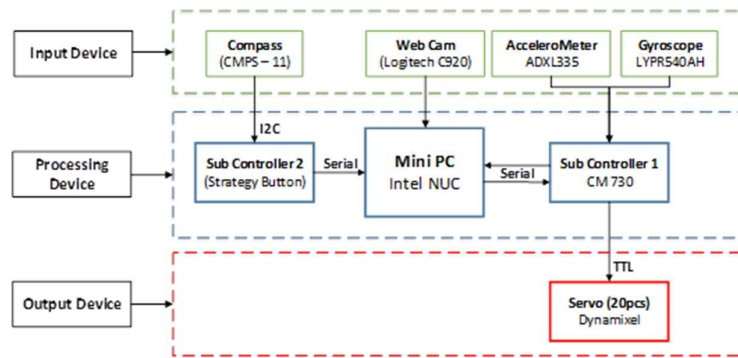

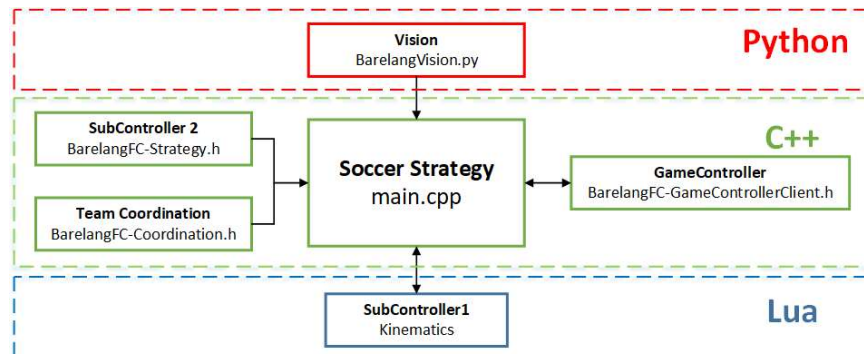**Fig. 1.** Block diagram of the hardware system.

Fig. 2. Block diagram of the software system.

3   Mechanical Design

The old robot used 5052 aluminum parts with 2 mm and 6 mm thickness as the main material. The new mechanical design used 5052 aluminum parts with 3 mm and 6 mm thickness for the main part of the robot body. The new robot design has approximately 64 cm height, while the old robot design only has approximately 58 cm height. The new leg construction used Dynamixel MX-106 series with more higher torque than the old design (Dynamixel MX-64 series), for more details can be seen in Fig. 3. The new robot becomes to have more power to act as a footballer. With the new design, our robot has an ability to run faster than before. The new mechanical design also improves the ability of the robot to kick harder than before. The ball can move approximately half of the field after being kicked. The detail of actuator that we used in the new design can be seen in Table 1.
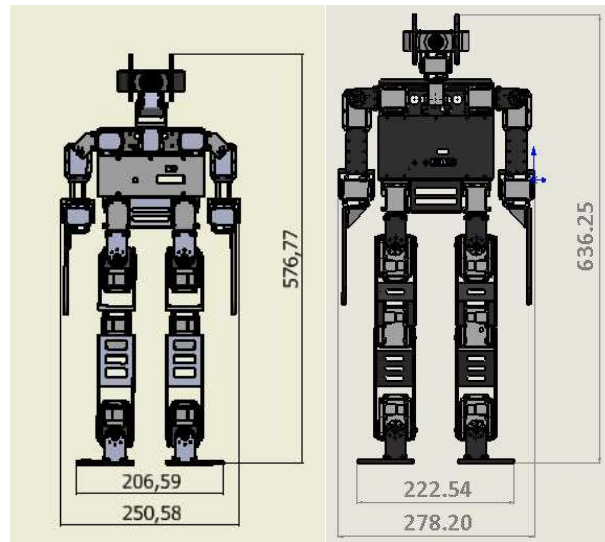

Fig. 3. Mechanical design of Barelang FC robot.

Table 1. Comparison actuator of old and new robot design.

Sub Body	Old Design	New Design
Neck	MX-28, MX-28	MX-28, MX-28
Shoulder	MX-28, MX-28	MX-64, MX-64
Arm	MX-28	MX-64
Hip	MX-64, MX-64, MX-64	MX-106, MX-106, MX-64
Knee	MX-64	MX-106
Ankle	MX-64, MX-64, MX-64	MX-106, MX-106, MX-106

4 Vision Processing System

We used a vision processing system which shows in Fig. 4 and Fig. 6 to recognize the ball and goal position on the soccer field. The USB webcam Logitech C920 is used as main device of the vision sensor. Vision processing algorithm is divided into 2 parts, preprocessing and detection. Preprocessing system used to separate field area with unused image outside the field. The details of preprocessing algorithm can be shown in Fig. 4. Preprocessing algorithm start with acquiring an image from webcam, converting color space, filtering specific color, morphological process, detecting contour using convex hull and the last one is masking an image. The result of preprocessing algorithm which shows in Fig. 5.
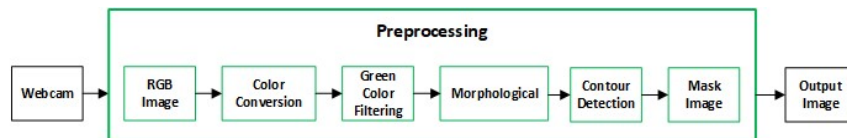

Fig. 4. Block diagram of preprocessing algorithm.
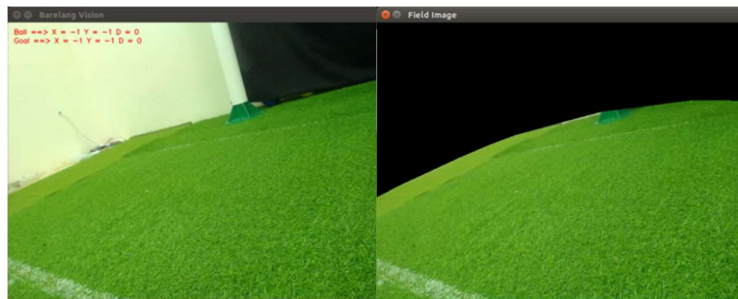

Fig. 5. RGB Image from webcam and result of preprocessing algorithm.

The detection algorithm can be seen in Fig. 6. The image data from preprocessing algorithm will be used in this detection process. Image data will be converting to HSV color space then filtering to a specific color (green or white depending on the priority). The morphological process used to reduce noise from the binary image that results from color filtering. Contour detection is the main part of recognizing objects (ball and goal). Contour detection will give an information about properties of the object such as width, height, width and height ratio, number of pixels which have a specific color, and the size ratio of contour and image frame. All properties of the detected contour will be selected using decision tree algorithm to conclude type of objects.
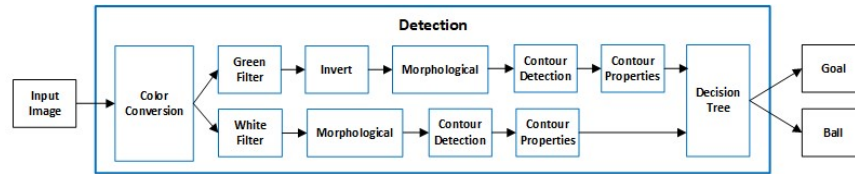
Fig. 6. Block diagram of detection algorithm.

The main priority of vision processing system used green color filtering mode, with this system binary image from green color will be inverted before contour detection process. With this method, our vision processing has an ability to recognize ball in the maximum range close to half field shown in Fig. 7. The green color filtering mode has disadvantage while detecting an object near white line. The failure to recognize the ball caused by the merged color of the ball and the white line.
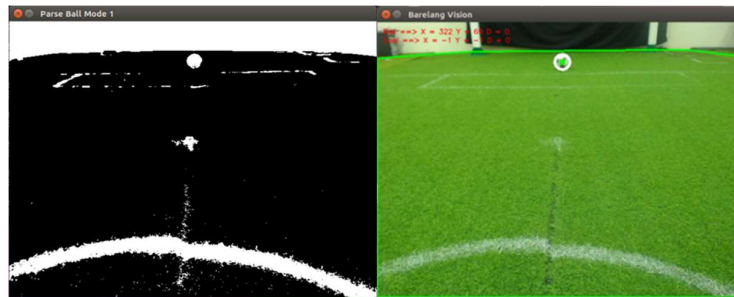

Fig. 7. Result of ball detection using green color filtering.

We used white color filtering mode to recognize goal and recognize ball in second priority if the green color filtering system failed to recognize the ball. The white color filtering mode has an advantage while detecting ball near white line shown in Fig. 8, but it has disadvantage while detecting a ball is far away. We combine those two methods in our robots depending on where is the location of the ball.
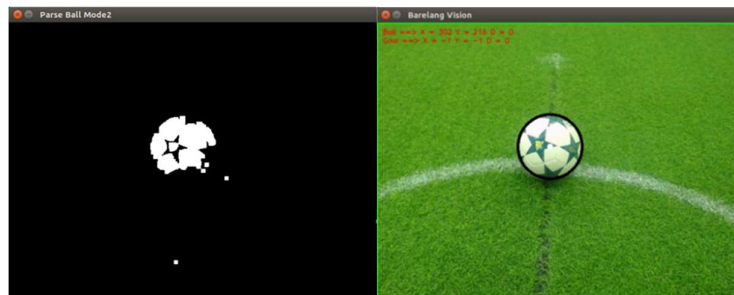

Fig. 8. Result of ball detection using white color filtering.

Fig. 9. Result of goal detection.

The new vision processing system has many advantages compared the old system. In the old vision processing system, robot unable to recognize the white ball in a range of more than 2.5 m. Noise from outside the field also another problem in the old vision algorithm. New algorithm improves detection range of the object to approximately 4.5 m. Noise from outside field also removed by preprocessing process.

5　　Conclusion and Acknowledgments

This year the robot is improved on the mechanical and vision system. The result, robots can run faster and kick harder than the old one. The robust vision processing system also applied, and the detection range of ball also increased. Finally, Barelang FC team confidence to compete with other robotics teams in RoboCup 2018 Canada.

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