EROS TEAM

Team Description for Humanoid KidSize League of Robocup 2014

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Abstract: This paper describes the development that has been done on the robot EROS. Online walking pattern generation system, by adding the FSR sensors on both feet robot. Sensors are used to detect touch and activate the walking pattern generation systems. In addition, the development of inter-robot communication system for playing soccer is used for coordination between players. Each robot mapping the location of itself simultaneously, we utilize shape perception of the goal to obtain the current location. The result is that the robot has the ability to walk on uneven ground and know the location of the robot in the field. In coordination, each robot sends location data to the robot partners through client-server communication system.

1 Introduction

The purpose of the International Robocup competition is to develop a team of robot soccer players that can play against soccer team world cup winner in 2050 [1]. In order to achieve the desired target range of technologies applied for generating a humanoid robot like humans and have a ball playing skills. On the other hand it becomes the motivation the development and research of new scientific fields such as mechanical, electronic systems, such as human and artificial intelligence.

Robocup 2014 competition will be held in Brazil. We build 4 robots, three attackers and one goalie. In the 2103 competition in Eindhoven we are progressing very rapidly results in the development of the system compared to the previous 2 years. We use 3 robots and each robot has a height 52 cm and torque motors on the join stronger thus allowing the robot to walk at a speed of 40 cm / sec, and produce kick the ball as far as 6 meters. Part of the vision sensor is able to see the ball to a distance of 4 meters and speed of scanning to find the ball an average of 6 seconds.

adfa, p. 1, 2011.

The change of rules on using the same of the goal color in 2013 as a challenge problem in the field mapping system that must be completed by each robot. We employ the use of magnetic field sensor to get directions opponent's goal. The use of these sensors is still constrained interference magnetic field generated by the motor in the robot. Magnetic field sensors placed on the palm of the hand, where this part has the smallest value of interference than other parts of the robot body.

In the preliminary round, the robots win with high score. The last game, EROS against team DARWIN to determine group winner. The result DARWIN won with the score 4-1. During the game EROS experienced 2 unsuccessful attempts to kick the ball toward the goal, this is caused by faulty operation of the referee box application. In the quarter-finals, playing against AUTHMAN and defeated with the score 1-3. Our robots kick the ball towards his own-goal. This error occurs only once on the entire game in this competition.

Currently development is to improve the ability for field mapping. Magnetic sensor placement in a protected part of the interference combined with a gyroscope and accelerometer sensors inertia. This data is used to support the position and direction system mapping robots simultaneously. This paper discusses the explanation of the development has been done before. This is followed by the design of the current system, which consists of mechanical systems, hardware, and vision systems. At the end we include the willingness of participating in the competition Robucup 2014.

2 Previous Work

Overall system consists of three parts, which are shown in Figure 1. The first is the part that serves to perceive objects in the field, the second is the identification and modeling of the field environment, and actuators combined with inertial sensor system.

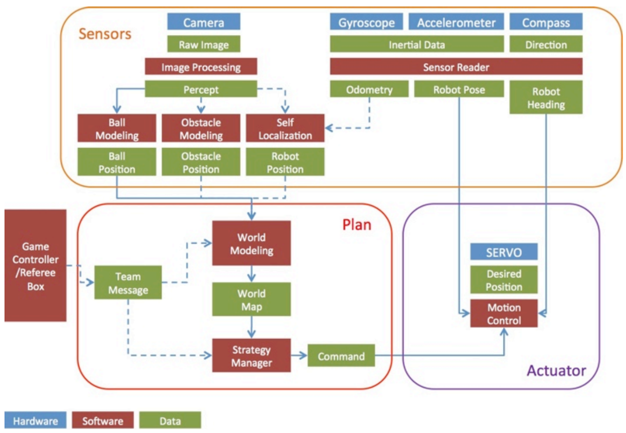
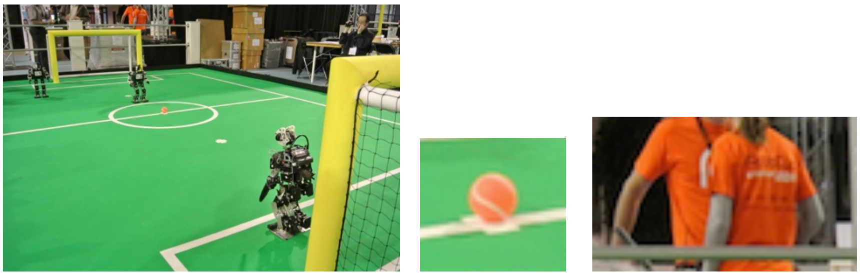


Figure 1. Overall system configuration of EROS

Object field identified by recognizing the basic color of each object. Each time an image captured by the camera followed by object segmentation based on color. Groups of pixels that have a color close to the color range of colors such as orange, then the object is identified as a ball. It was also performed on other objects. Decision-making is done by combining two related objects, for example, to ensure that the colors used are known as ball balls color combination AND the color field. It is useful to avoid other objects that have the same color as the color of the ball is identified as a ball. This method is implemented by the time the competition is running Robocup 2013. This example is shown in Figure 2 below.



(a) (b) (c)

Figure 2. Real condition in the soccer field segmented by color based and the identification object recognition.

Segmentation results obtained two objects are colored orange. To determine the ball, done by looking at the color of surrounding objects. If color is the color of the field, then the object is a ball.

All goals has a yellow color, so it used the data of the Earth's magnetic sensors to obtain the absolute direction and make sure the object is identified as the opponent goal or the property itself. Interference of the magnetic field generated by an induction motor drive muted by activating the low-pass filter function. The results of measurements on the determination of the direction error had no more than 180 degrees.

3 Mechanical, Electronics, and Kinematic System

The robot has a dimension, height 55 cm, width 21 cm, and weighs 4.25 kg with the total number of degrees of freedom are 22. Motor on of each joint using two different types of torque. The foot consists of 10 DOF 60kgf/63 rpm with maximum torques and the other body parts total are 12 DOF using servomotors with stall torque 25kgf/55rpm. Mechanical configuration and dimensions are shown in Figure 4.

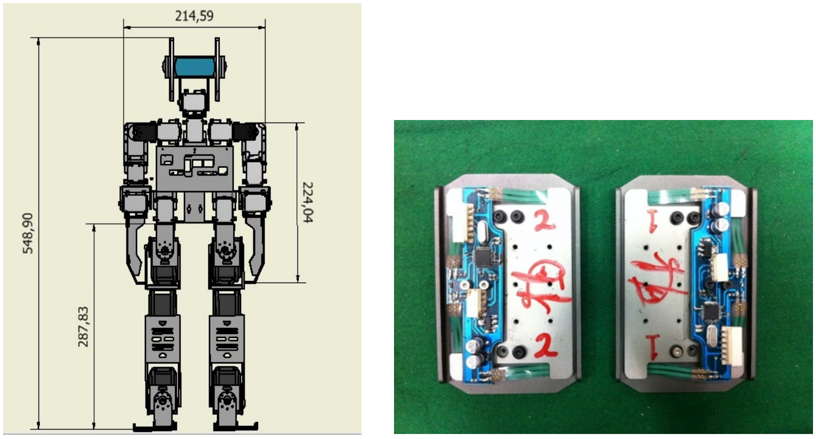


Figure 4. Mechanical dimensions and the FSR sensors on the soles of feet

On the sole is equipped with sensors FSR (Force-Sensing Resistor). This serves to detect when the foot touches the ground and measure the force field due to the beat of the feet touching the ground. Measurement data is used as a feedback control system for landing legs. At the specified value, the system activates a new walking pattern generation or new Trajectory. Figure 5 shows the trajectory pattern of walking on the left and right ankle. Time interval of each leg is a constant. This trajectory models can only run on flat ground without distraction in the field. Based on the graph stepped foot interval are 50 units.

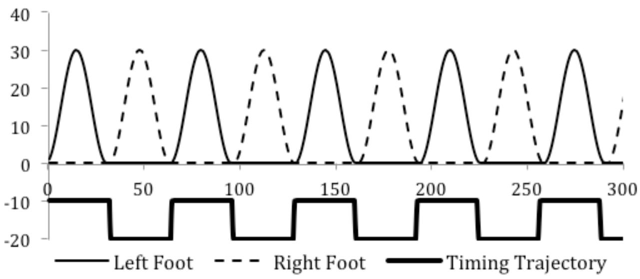


Figure 5. Default walking trajectory on the ankle joint

At FSR enabled gait trajectory changed shortly before the foot touches the ground, as shown in Figure 6.a. controller responds by accepting a new walking pattern. This pattern adjusts with stability condition of the robot poses. Response made by the controller cause changes in the timing interval walking trajectory. Figure 6.b the 150th time interval changes as a response controller decided to wait until the pose becomes stable and continue to the next step.

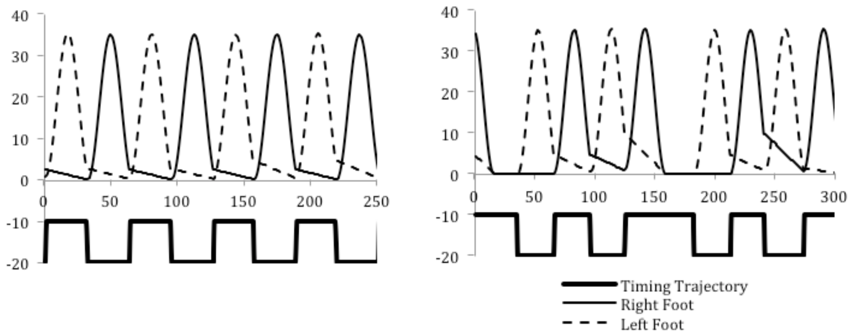


Figure 7. Walking trajectory (ankle joint) and timing diagram of landing controller.

From the results of the experiment, the robot is able to walk on the surface of the pitch with uneven contours.

4 Inter-Robot Communication System

Inter-robot communication devices using Wi-Fi 802.11B/G embedded in the CPU based on the TCP / IP protocol. Each robot can act as a client or server. One robot acts as a coordinator and as a server. Server work sends a broadcast message to all the clients.

The server can be changed if conditions robot can not be played or replaced with a new robot players. With the rules defined, developed the system configuration is shown in Figure 8. Communication executed by opening 2 ports at the same time that serves as the control and data lines.

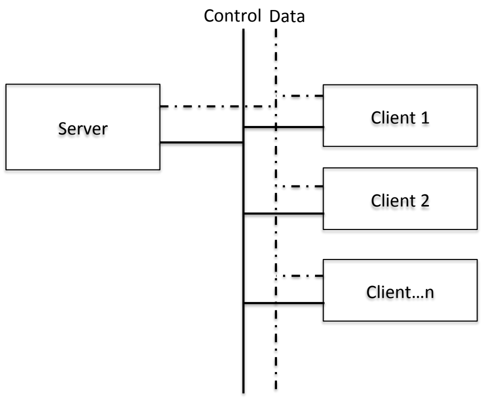
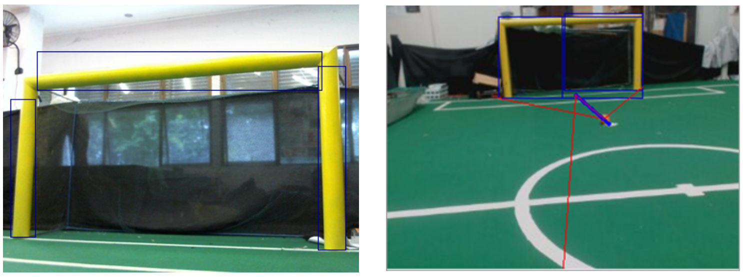


Figure 8. Client-server configuration for inter-robot communication

Path control is used for communication between robots to control exchange functions as a coordinator. While the data lines are used for data communication required to coordinate among the players. For example, the robot position information is sent to the server and forwarded to all players. All the players receive and process information is then stored. With this information the entire robot can know the position of the last entire playing partner. Communication process continues until the game is over.

5 Localization and Mapping

Localization and mapping are useful to obtain the robot position in the field of information. Soccer field has a specific shape and a specific size. It is considered to construct a reference map. Some objects in the field such as the goal, and the field line have a fixed size and position. This information is recorded as knowledge of data stored by the robots. In addition the camera calibration performed to obtain the size of the object in pixel units.



(a) (b)

Figure 9. Object segmentation and identification of goal on the field

Objects that is identified in field shown in figure 9. Figure 9.a obtain the goal object and object 9.b obtain goal from long distance. Then continued to calculate the slope of the goal. The results of the calculations used to determine the location of the robot is located left side or right side of the goal had seen. Horizontal axis coordinate position on the field is divided into three, left, middle, and right of the goal. coordinate position the vertical axis is also divided into 3, rear, center and front of the goal.

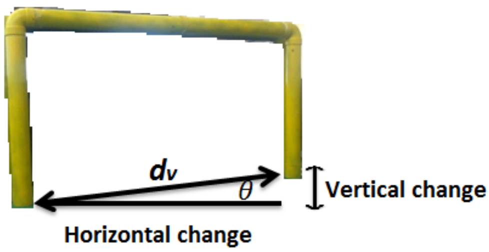


Figure 10. Slope angle formulation of the goal.

The position on the vertical axis obtained from the calculation of the tilt angle, height, and width of the goal. Figure 10 shows, dv is the width of the goal, theta is the angle calculated by the tangential width of the goal function results calibration and width measuring results on the image. High goal ratio of calibration results obtained with the high goal from the calculation used to obtain the distance the robot with the goal.

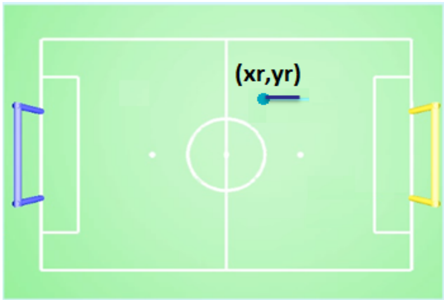


Figure 11. Localization mapping result

Figure 11 shows the results of mapping are shown on the display, where the position of the robot is in the area of the coordinates (left, middle). This information is used to coordinate with other robots. For robots that are being dribbled, it has its own location information and knows the location of partner player, so it becomes easier where the ball should be passed. It can also be used as a reference in decision making to execute the tactics that will be executed.

6 Conclusion

The result that has been done on the development of EROS includes the use of FSR sensors as a feedback control system walking stability. The robot can walk on uneven field conditions. Communication systems can be used to transmit and receive location information of robots, and localization mapping to determine the location of the robot in the field. This development increases the determination, pass the ball, and kick the ball into the goal. By this result, the robot EROS has become increasing performance and increasing the amount of ability. Some errors in mapping the coordinates of the location and the increased resolution field map will continue to be done to improve the performance of humanoid robot soccer players.

7 Statement of Willingness

Based on the results of the development we have done, we are hoping to qualify for Robocup 2014. We hereby declare the ability when administered the opportunity to participate and will be very happy to be present to participate in the Robocup 2014 competition in Brazil. We delegate an official member Mr. Endra Pitowarno as a representative for duty as a match referee and other tasks assigned by the committee.

References

1. http://www.informatik.uni-bremen.de/humanoid/bin/view/Website/WebHome, last accesed February 2014.
2. Ill-Woo Park, Jung-Yup Kim, and Jun-Ho Oh, Online Biped Walking Pattern Generation for Humanoid Robot KHR-3(KAIST Humanoid Robot – 3: HUBO), in *Proc. IEEE Int.Conf. on Robotics & Automation*, pp. 398-403, 2006.
3. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson Education; International ed of 6th revised ed edition, May 2012.
4. M. Friedmann et al. Darmstadt Dribblers. Team Description Paper for Humanoid KidSize League of RoboCup 2010. Workshop Robocup Singapore 2010.
5. Azhar Aulia Saputra, A. Harist A.,Ahmad Subhan KH, EROS Team Description for Humanoid Kidsize League for RoboCup 2012, EEPIS Robotic Research Center, 2012.
6. Durrant-Whyte, H.; Bailey, T. (2006). Simultaneous Localization and Mapping (SLAM): Part I The Essential Algorithms. Robotics and Automation Magazine 13 (2): 99–110. doi:10.1109/MRA.2006.1638022. Retrieved 2008-04-08.
7. Robertson, P.; Angermann, M.;Krach B. (2009). "Simultaneous Localization and Mapping for Pedestrians using only Foot-Mounted Inertial Sensors". Ubicomp 2009. Orlando, Florida, USA: ACM. doi:10.1145/1620545.1620560.
8. Jaulin, L. "Range-only SLAM with occupancy maps; A set-membership approach". IEEE Transactions on Robotics, (2011).
9. Azhar Aulia Saputra, Ardiansyah A., Ahmad Subhan KH, EROS Team Description for Humanoid Kidsize League for RoboCup 2013, EEPIS Robotic Research Center, 2013.
10. Azhar Aulia S, A. Subhan KH. Ali Husein A., Dynamic Control and Online Pattern Generation on Humanoid Robot EROS (EEPIS Robot Soccer), Dipl. Eng. Final project 2013, *EEPIS Robotic Research Center*, 2014.