Team Description Paper: IRIS Team 2020

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Abstract. IRIS is a robotic team that compete in the soccer robotic league. The team was founded in the mid-2016 with the ambitious goal of competing in the international robotics competition. This paper presents the information of middle-size league from IRIS team including team information, hardware information, and software information for RoboCup 2020. In this paper, we will introduce our mechanical system, electrical system, and software of the robots.

Keywords: RoboCup, Middle Size League, Robot Operating System, Soccer Robot

1 Introduction

IRIS (acronym for ITS Robots with Intelligence System) is a robotic team that compete in the soccer robotic competition, especially Middle-Size League. The team members are students of Institut Teknologi Sepuluh Nopember Surabaya, which are consist of 28 undergraduate students and a Doctoral Student. The team was found in the mid-2016 with the ambitious goal of competing in the international robotics competition. IRIS is a team that annually compete in the middle-size soccer robot competition which held by Ministry of Research Technology and Higher Education of the Republic of Indonesia. This competition was first held in 2017 and our team has won various awards. In 2017, we won 3rd place and best design in Regional and won best innovation and best design in National competition. In 2018, we won the 1st place and best strategy in Regional and won the 2nd place in National competition. We also participated in the Robosot League in 2018 FIRA RoboWorld Cup and won 1st Place Passing Challenge, 3rd Place Obstacle Avoidance Challenge, and 3rd Place Localization Challenge. In 2019, we won the 1st place in Regional and National League while also participating in RoboCup 2019 Sydney. The team also won 2 silver medals in FIRA 2019 Korea. As time goes, our research focuses on mechatronics, computer vision, and software architecture and engineering.

2 Mechatronic

At the start of the research, IRIS decided to develop its own robotics platform. MSL is autonomous robots play soccer. Meanwhile, football is a sport that has strong direct contact between players. Robots are designed and made with wheels as a driver and programmed to get attack and defense strategies like a football game. That's the reason why we designed the robot with the mixed capabilities of high speed and flexibility as well as robustness. Now, we have finished building our second-generation robot and are currently doing research for the third generation.

2.1 Mechanical System

(a)

(b)

Fig. 1. (a) Second-Gen. Design of the Robots (b) Robot Photograph

The mechanical system of the robot was based on 4-Omni wheels so that the robot can move forward, backward, and even diagonally. The base design also represents the rectangular-cut edge with a 45cm x 45cm dimension. Aluminium plates are used for the entire body of the robot. For the robot actuator, we use 4 High-torque DC motors as a robot movement, a pair of High-speed DC motor as a ball handling, and a brushless motor with a High-torque gearbox as a kicking mechanism. We also use two external encoders mounted at the bottom of the body robot to mapping the field and find out the coordinates of the robots.

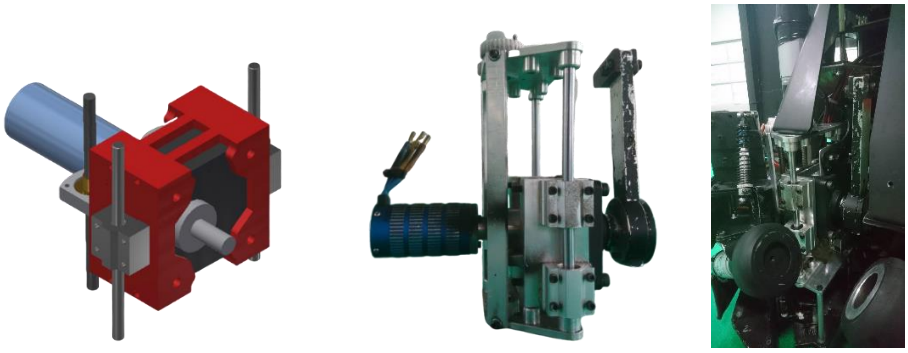
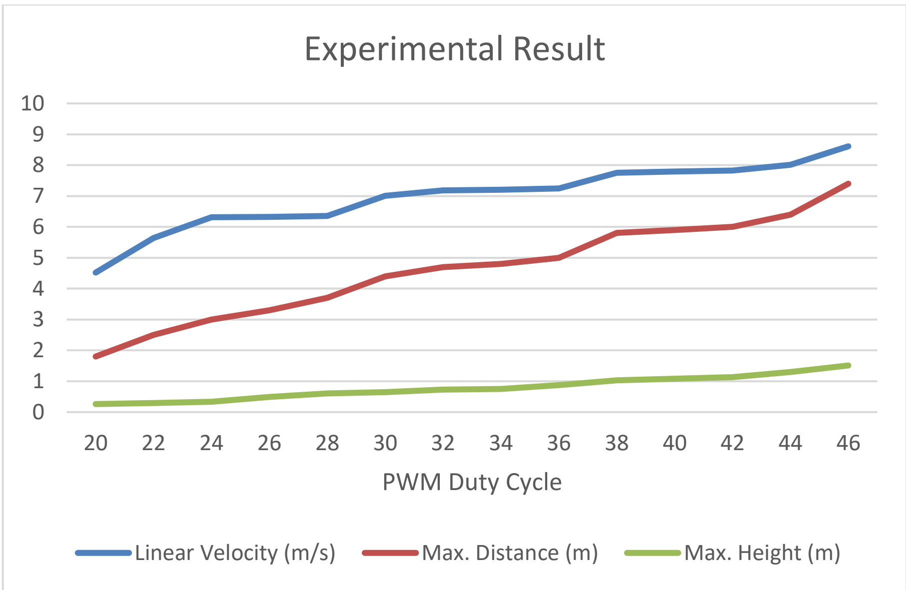


Fig. 2. Kicking Mechanism

The kicking mechanism use a Brushless DC motor that are controlled by microcontroller (STM32F4 Discovery). Our robots kicking mechanism is not static, so it can move up and down. The mechanism is driven using High-torque DC motor which is controlled by microcontroller as well. This system allows the robot to be able to adjust the height of the kicker (low pass and lob pass) and the speed of the kick based on the distance of the target to the robot's position. Based on the results of our research we get the data as in the following graph.



Graph 2. Experimental Result

There are three graphs displayed, PWM (%) with linear velocity graph, PWM (%) with kick distance graph and PWM (%) with kick height graph. From the three graphs it can be concluded that the greater the PWM value given, the greater the value of linear velocity, kick distance and kick height produced.

2.2 Electrical System

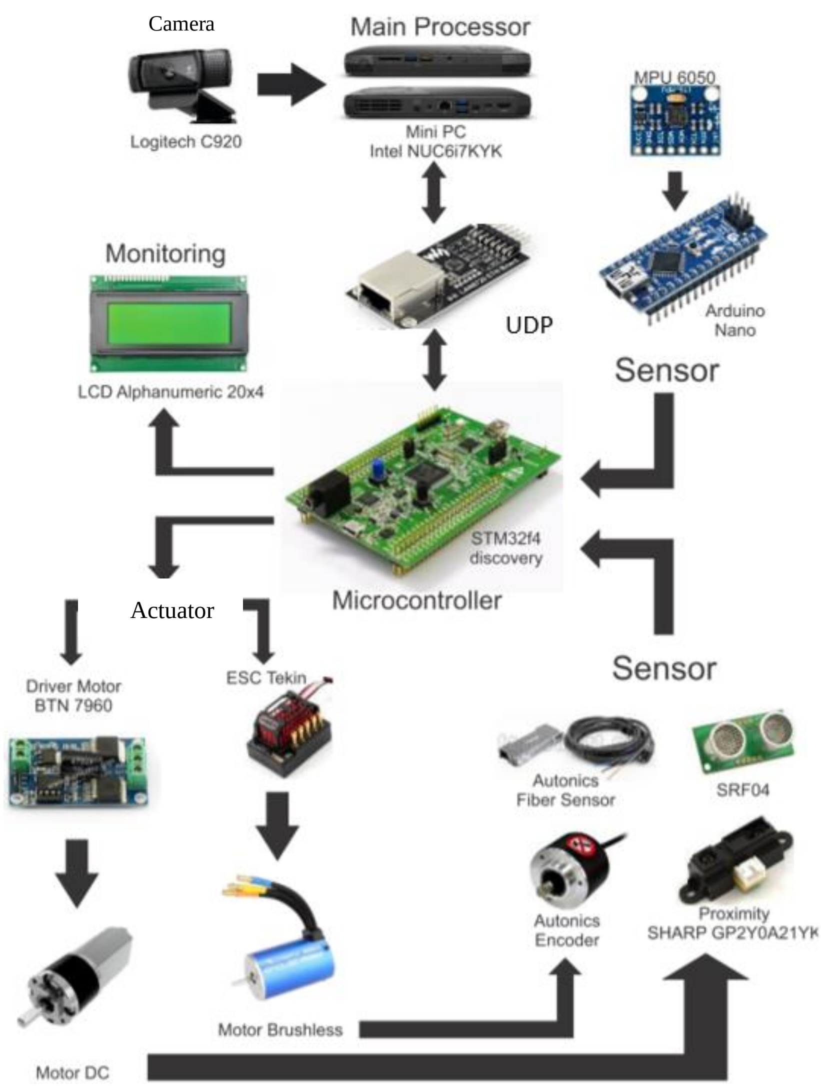


Fig. 3. Electrical System of the Robot

Our Electronic systems use two 6 Cells Lithium ion Batteries, which are the first batteries powers the PC as the main processor and the microcontroller as the low-level controller. The second batteries power the actuator such as DC Brushed motors and

BLDC motor for the kicking mechanism. The electronic systems then divided into three main parts, the actuators, the sensors, and the controllers. The Sensors and controllers then divided into two, the main and the low-level. The low-level sensors consist of 200 PPR-Rotary encoder to acquire the 'x' and 'y' value of the robot which stands for the coordinate of the robot, MPU Gyro sensor to acquire the final orientation of the robot, ultrasonic sensor to get the distance sensor between the ball and the robot, and fiber optic sensor to calibrate the Gyro sensor. The analog and digital string data from the sensors then gets processed by the microcontroller STM32F407VG as the low-level controller.
After the data has been acquired in the microcontroller, the data then get sent into the main processor, the Mini PC. The protocol sends this data via UDP Ethernet connection. The data will be collected as the memory copy in order to maximize the communication protocol, hence the Mini PC will get faster process in the CPU Core. We also use LCD to monitor the on-board condition of the robot which connect to the microcontroller STM32F407VG. Below is the electrical system design of our four-wheel based robot.

3 Software

This section will explain the 3 main algorithm of IRIS' robot, and their role at forming the robot's in-game behavior. These 3 algorithms are image processing, communication as well as strategy planning. Each of these algorithms will be explained in subsection 3.1, 3.2, and 3.3 accordingly.

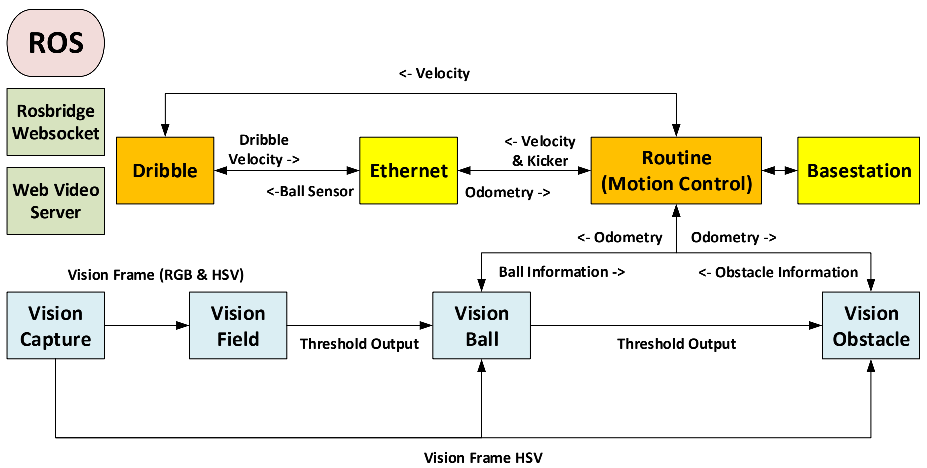


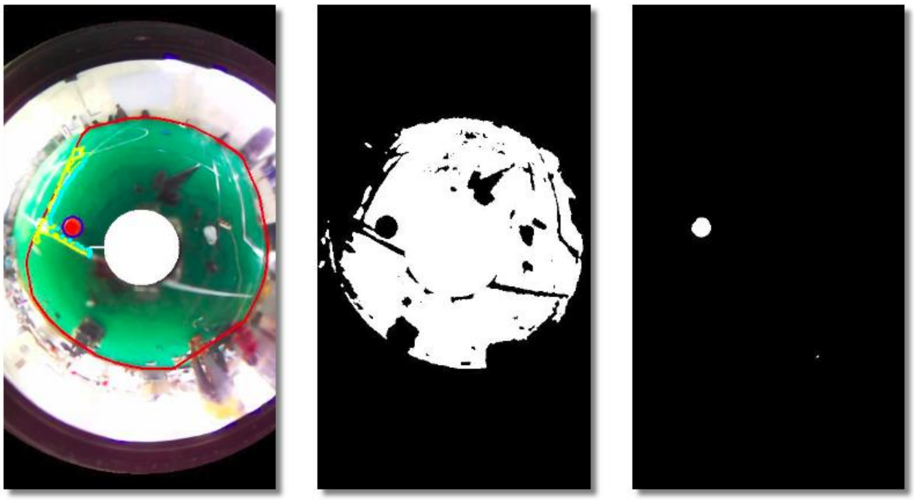
Fig. 4. Program Architecture

Our entire program, build upon a software framework named Robot Operating System (ROS). This framework has a vast amount of tools and libraries meant to simplify robot programming. We use ROS kinetic version runs on ubuntu operating system in our robot[1]. This framework has the ability to run multiple process simultaneously using ROS Node. The robot program architecture is shown on the fig 4, where the rectangle part described ROS node, and the arrow part described the information that were given from one node to the other.

Each of these nodes are handling different algorithm. For vision capture, vision field, vision ball, and vision obstacle handle the image processing algorithm, basestation and ethernet handle the communication algorithm, and for strategy planning algorithm is handled by routine and dribble node. As for rosbridge websocket and web video server was only there for debugging purpose.

3.1 IMAGE PROCESSING

The RoboCup Middle Size League environment is currently color-coded, so we focus to design vision systems to recognize color-coded objects in the RoboCup environment. At the early version of our robot, the proven concept of omnidirectional vision is implemented. The omnidirectional vision system consists of a hyperbolic mirror and a webcam camera (Logitech Webcam Camera). Because of the wide angle of view in omnidirectional vision, the robot does not need to look around using moving parts (cameras or mirrors) or turning the moving parts.



(a) **(b)** **(c)**

Fig. 5. (a) Original Display (b) Field Contours (c) Ball Countours

The method that we use to recognize the environment is by thresholding using HSV colorspace. HSV (hue, saturation, value) colorspace is a model to represent the

[1] http://wiki.ros.org

colorspace similar to the RGB color model. Since the hue channel models the color type, it is very useful in image processing tasks that need to segment objects based on its color. The orange color will be the ball, green will be the field, and the other colors will be recognized as an obstacle. By the end of this process, the robot will obtain the position of ball as well as the obstacle that may accompany it.

3.2 COMMUNICATION

Communication based node has the role to communicate each robot to basestation, as well as sharing information between pc (as the main system) to micro controller as the controller of the whole actuator. All communication is handled with UDP protocol.

3.3 STRATEGY PLANNING

The basic strategy of IRIS' robot consists of ball handling, passing, and shooting. All of these algorithms have been set on robot's in-game behavior. To enhance the robot in-game behavior and decision making, the robot needs to have the ability to positioned itself accurately on given position, as well as determining its current position. The technology used for this purpose is rotary encoder. Rotary encoder is a device that can measure how far the robot has moved. With this technology, the robot can determine its current position based on the initial position and the distance they have moved.
Although this technology is enough to roughly estimate robot's current position, it still far from perfect. Rotary encoder tends to have an increasing error of estimation the longer the robot moves. Therefore, we constantly use calibration method to re-calibrate the error to minimum. We use field line, and line sensor to do this calibration. Every time the calibration function is called, the robot will move to a specific location and look for the field line. This way, the robot can estimate the current location based on the line they detect.
The ball handling and shooting algorithm is enhanced with obstacle avoidance algorithm. This algorithm will instruct the robot to evade enemy robot and look for clear shooting sight. By doing this, we will have higher chance on scoring goal.

4 CONCLUSION

Based on the achievments of our team in National Leagues and the experience in participating in 2019 Robocup, IRIS will have a strong commitment in joining the Robocup 2020 proven by the development of the robot in the software platform and electronic system.
The major improvement that were made for this past year is mostly about software platform. We used to have OpenFramework runs on microsoft visual studio as a platform to run the whole program. Although there was no significant error from this platform, we decide to improve our processing capabilities by using ROS (robot operating system) as the main platform. The communication is also being improved in UDP to

get faster data streaming. By doing this, we have gained a system that run smoother, easier to modified and easier to debug.

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