KIKS 2010 Team Description

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Abstract. This paper is used to qualify as participation to the RoboCup 2010 small-size league (SSL) about team "KIKS". Our robot is designed under the Rules 2010 in order to participate in the SSL competition held in Singapore. The overview for robots' hardware of our team is described .

Keywords: RoboCup, small-size league, brushless DC motor, motion control, IR-sensor.

1 Introduction

Main purpose of our participation to the RoboCup world competition is confirmation and evaluation of the results of the PBL (Project Based Learning) experiments. We have educated the creative minds of students using the robot contest held in our department of electrical and electronic engineering. For the RoboCup world competition, our team has participated for six years since 2004, continuously. We came in the top 8 in Graz 2009. Thus, since the aim will be higher, further improvements are also needed in this year.

Recently, most of best top teams use the brushless DC motors. But we still use brushed one (REmax 24). If we can replace to the blushless one, the robots must have more torques and speeds. So, now we try to replace that and also review whole mechanical design.

The main topics of developed system in 2010 are following term,

・ Enhancement of the performance of dribbling and kicking devices of the robot in SSL.
・ Evaluation of the performance of ring-wheels and chip-kick devices.
・ Development of the circuit for DC blush less motors.

2 Development of new robots

2.1 The entire structure design.

At present time, we have changed three parts.

1. Replacement to brushless DC motors (Maxon EC45flat) from brushed one (Maxon REmax24).
2. Redesign of chip-kick device.
3. Whole mechanical redesign taken into account of maintenance.

First, the motors which connect four ring-wheels were replaced to brushless motors (Maxon EC45flat). They were used pinion gear with 20 teethes and internal gear with 72 teethes. That is, the reduction ratio is 1:3.6. The robot has not enough space to set the gear box. So, we had to redesign to take account of narrow space between motor's axis and wheel's that as shown in Fig. 1.

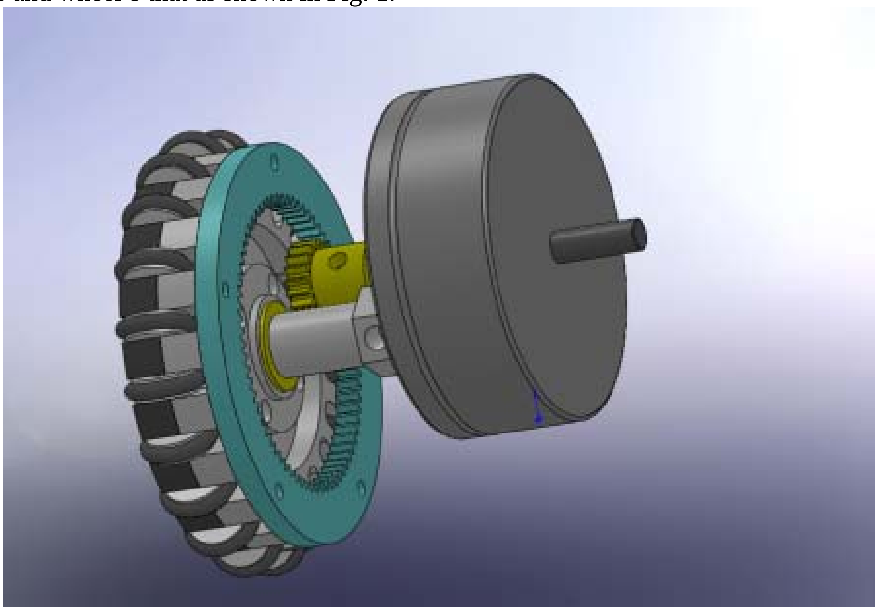


Fig. 1 Ring-wheel and internal gear

Second, the chip-kick devices were redesigned. The solenoid of chip-kick device was under a normal kick device for previous design. But the solenoid often electrically short out because of rubbing itself against floor. Thus, we replace the solenoid of chip-kick device on that of the normal kick device as shown in Fig. 2. As the results, we solved the problem mentioned above. Furthermore, because of large space between chip-kick device's bar and solenoid, it could get more kick power due to the principle of leverage. In addition, the redesigning brought many advantages for robot performance, e.g., more precise pass by kicking the center of a ball.

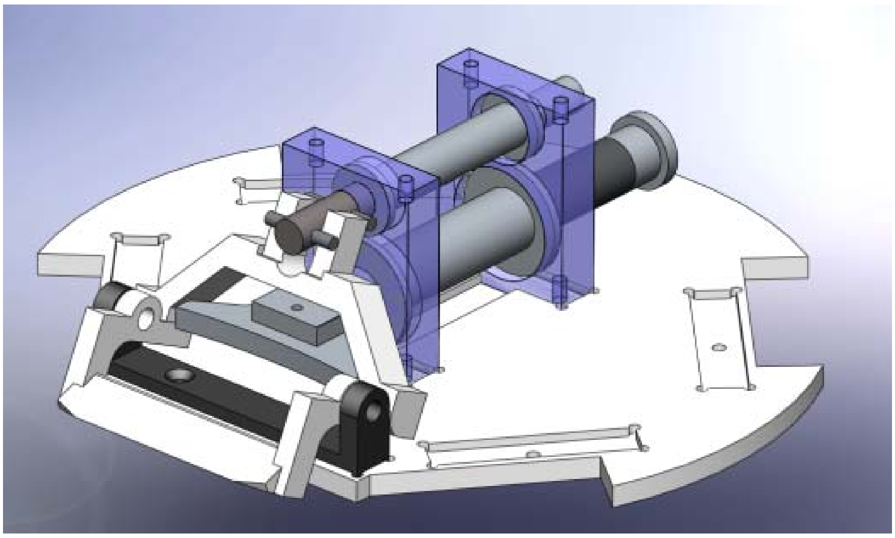


Fig. 2 Chip-kick device

Finally, whole mechanical structures were improved taken into account the maintenance. Our robot had many problems in play because of components from a lot of hand-made parts. At present, we replaced the base-plate to thick one and also made the dents on the plate. The wheel units and kick devises were embedded in the plate as shown in Fig. 3. As the results, the number of screws to fix on the body were able to decrease because of the dents were worked effectively as shock-absorber against the forces from various directions. If the robot is broken, it will be fixed up easier due to the geometric design.

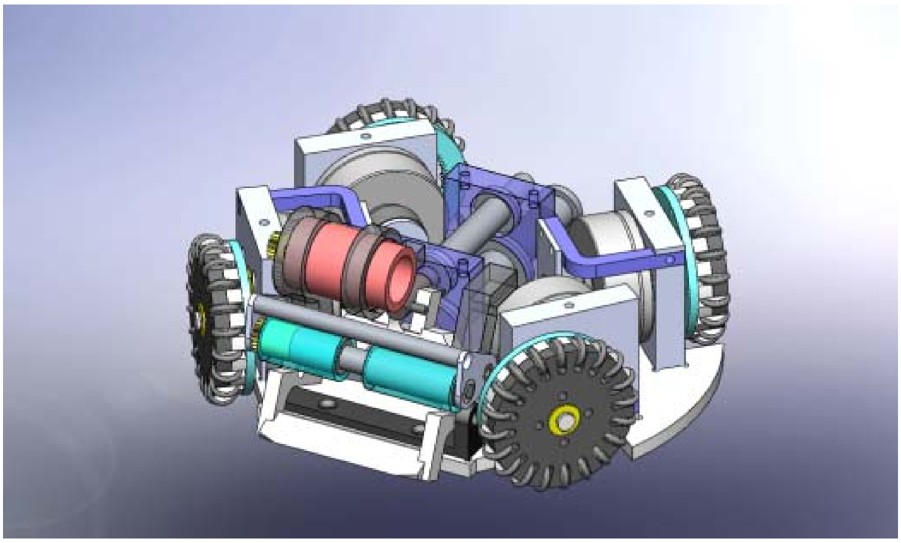


Fig. 3 Whole mechanical design

2.2 Evaluation of wheel structure.

Robots could run faster than last year by replacing the motors. As the results, robots were required high performance for ring-wheels. So, we tried to improve the ring-wheel's structure. We had tested some types of ring-wheels as shown in Fig. 4(a)-(d). The (a) is the present type which has thin single tire with every thin unit house. The (b) type has double small tires with every unit. The (c) and (d) types have thick small tires which made normal rubber and silicone rubber tube, respectively.

(a) with single ring tires

(b) with double ring tires

(c) with thick rubber ring tires

(d) with thick silicone rubber ring tires

Fig. 4 Various type of the wheels used for evaluation.

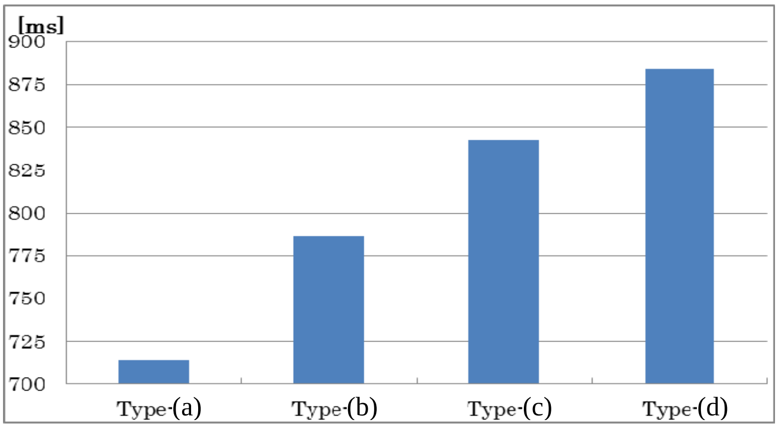


Fig. 5 Average time to reach to 1[m/s] from static condition for the robot

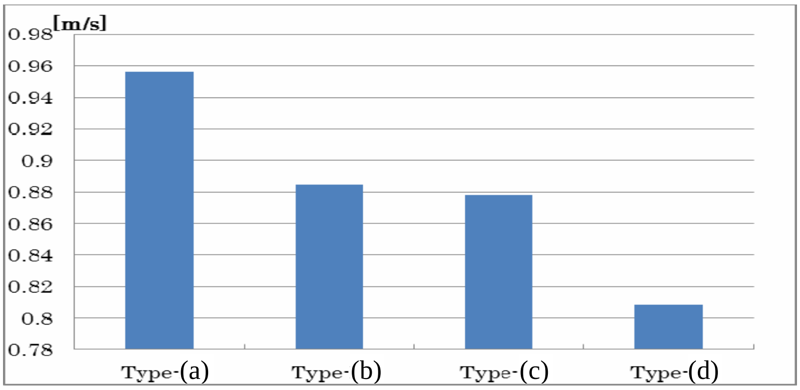


Fig. 6 Average speed of the robot on the same condition

The experimental results of their performance are shown in Fig. 5-Fig. 6. Figure 5 shows the average time to reach to 1[m/s] from static condition. Figure 6 shows the average speed on the same condition. Summarizing the results of our analysis, the (a) type showed the most stable and best performance. The reason why the (a) type showed the better results than the other types is not clear. It might be depended on the number of unit houses. Anyway, we decided to use (a) type.

2.3 Chip-kick device structure

We tried to improve the chip-kick device to investigate the relation between the length of rotation axis and angle within the limits of the space. By determining the length R and angle θ, respectively as shown in Fig. 7, we have measured a range of ball when the R and θ were changed. The result shows that a range of ball is strongly depend on the θ as shown in Fig. 8. On the other hand, the R is shown enough to have only a few cm. Thus, we decided tentatively that the R is 25mm and the θ is 60°. A kicked ball reaches a height of approximately 600mm. That actual performance is shown in Fig. 9.

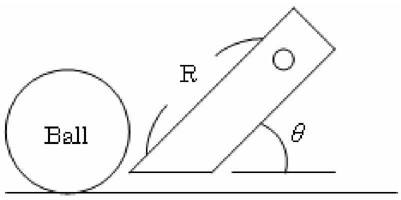


Fig. 7 Length of rotation axis R and angle θ of the chip kick device

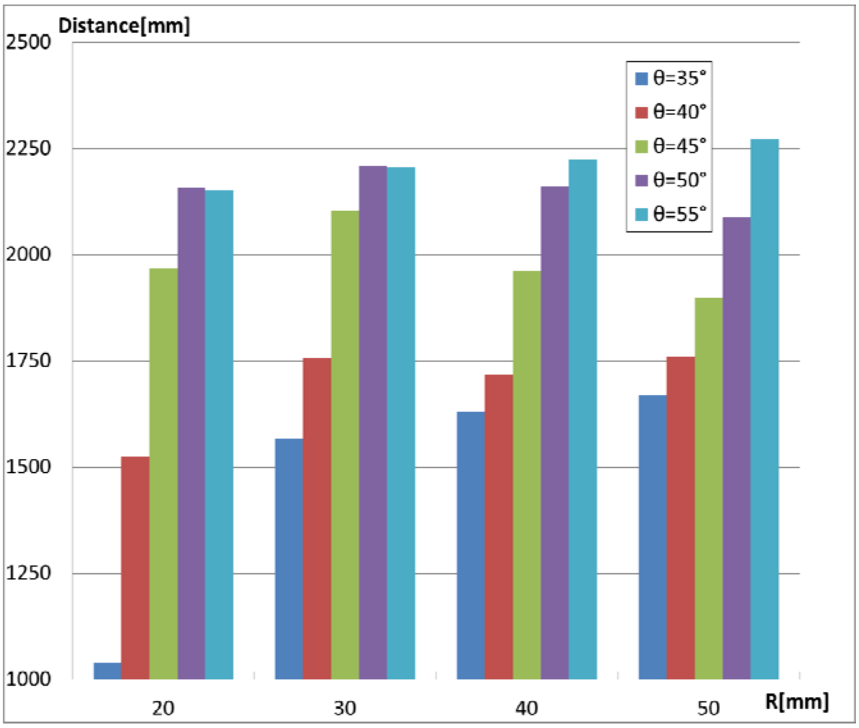


Fig. 8 Experimental results of chip-kick device

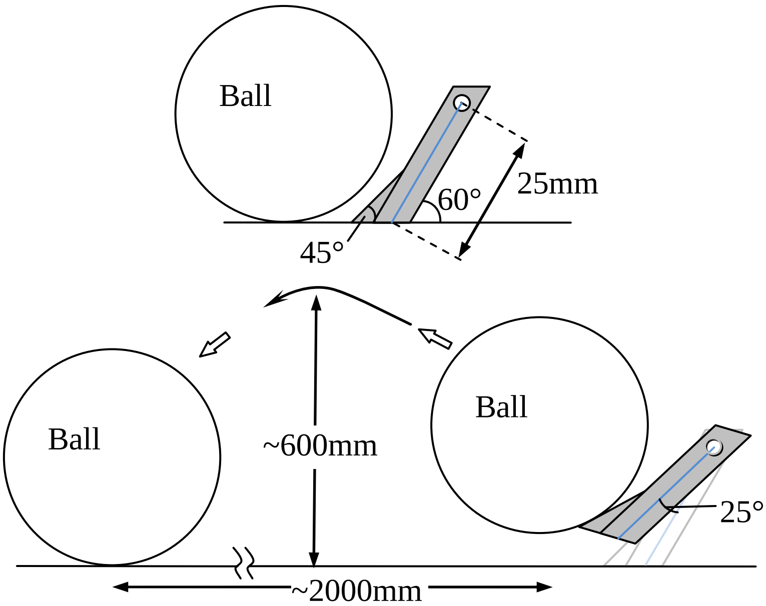


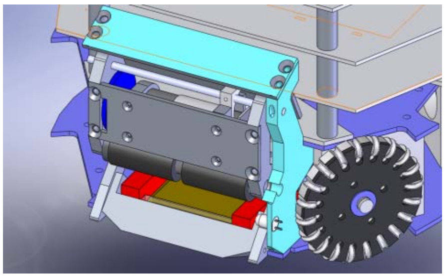
Fig. 9 Specification and performance of actual chip-kick device

2.4 Dribbling device structure

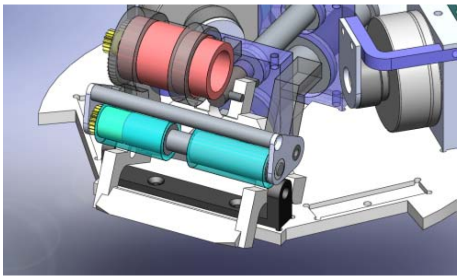
In previous robot, we have used the RE-max17 motor for the dribbling devices. But the motor did not have good enough performance for pass and shoot. So we tried to change that motor into RE-max24. The motor's power has increased from 4W to 10W. In addition, we just changed the dribble devices. Table I shows the performance of new dribbling device. The previous and new dribbling devices are also shown in Fig. 10.

Table I. Characterizations of new and previous motor.

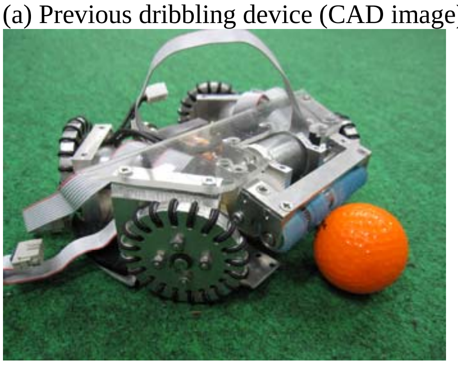
Element＼Motor	New(Re-max 24)	Previous(Re-max 17)
Power	10 Watt	4 Watt
Diameter of Roller	~15mm	~13mm
Rotation Frequency(Roller)	8800rpm	3900 rpm



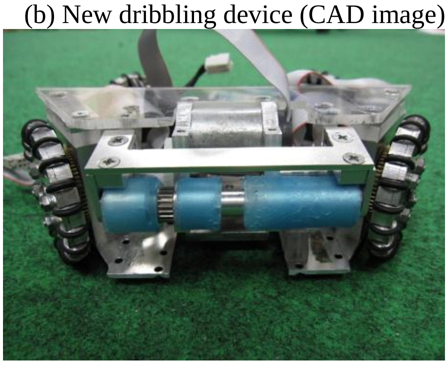
(a) Previous dribbling device (CAD image)



(b) New dribbling device (CAD image)



(c) New dribbling device (side view)

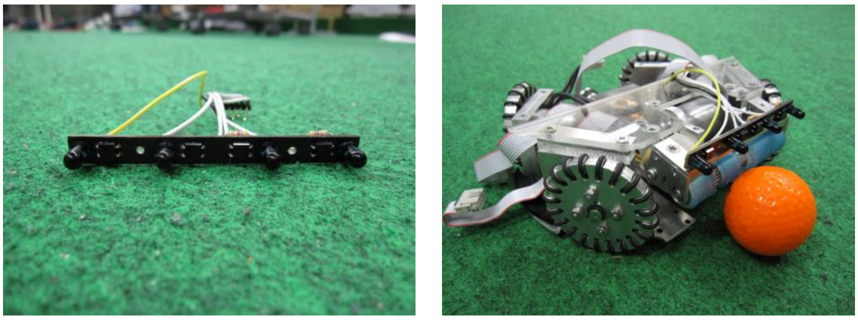


(d) New dribbling device (front view)

Fig. 10 Previous and new dribbler device

2.5 Detecting device for a ball

Up to now, the IR-Sensor was only used to find a ball in our robot. So, we attached a new another IR-Sensor to check the position of the ball, and to enhance the performance of catching the ball. As the result, the robot came to check the difference of the position between the ball and robot, and obtained the good performance for catching the ball. Attached new IR-Sensor is shown in Fig. 11.



(a) IR-sensor (b) Body with IR-sensor

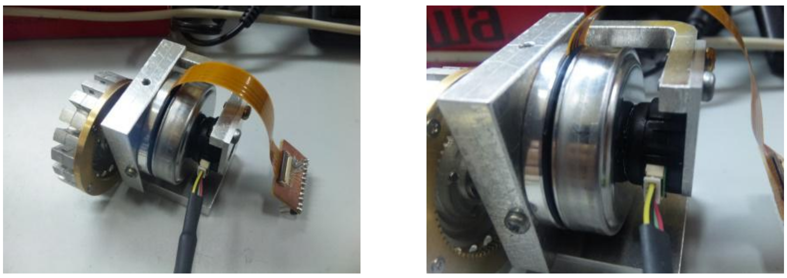
Fig. 11 Detecting device (IR-sensor) for a ball

2.5 Electronic circuit for brushless DC motor.

We decided to use brushless DC motor because it is becoming one of the standard equipment of the robots among the best teams in SSL. We replaced the motor to Maxon EC 45 flat from Maxon RE-max 24. The motor is popular in the best team. The motor’s power is more than six times compared with conventional RE-max24. Therefore, the gear ratio could change from 8:60 to 20:72. As the result, the machine was able to run more than 1.5 times faster than previous one.

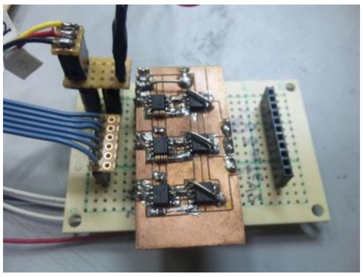
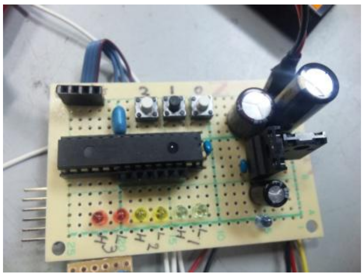
There are two sensors in the motor. That is, the encoder and the hall sensor built in the motor. E4P made by US DIGITAL was chosen as the encoder. Since its resolution is 1440 pulse per revolution, it came to control easier in detail.

The Microchip dsPIC30F4012 was used for each motor’s control. The PICs were connected to the motor through FET drive circuit. Each PIC was commanded by SH2-7144 of Main MPU.



(a) Brushless Motor (b)Encoder

Fig. 12 Brushless motor and encoder

(a) FET circuit (b) Control circuit

Fig. 13 (a) FET circuit for motor drive unit and (b) its control circuit

3 Conclusions

We have improved the robots for SSL as well as last year. The performance of our robot is getting high over the year. Most of devices are hand made by students. Thus, the cost performance is very high in fact.

We hope that our robots will perform better in this coming competition than that of last year. We will have a plan to join such competitions continuously in the future.

References

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